An Implementation in AODV based on Active Route Timeout between sensor nodes in Wireless Sensor Networks

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***Abstract*— Wireless Sensor Network is a technological development of small, low cost, low power devices that combine data processing with multiple sensing and the ability to communicate wirelessly. Routing in sensor network is a point of concern for researchers. Many researchers has been proposed various routing algorithm for conserving network resources specially energy consumption due to transmission of sense data in the network. AODV is a reactive source-initiated routing protocol which is sensitive to several parameters such as ACTIVE_ROUTE_TIMEOUT, NET_DIAMETER MY_ROUTE_TIMEOUT, and RREQ_RETRIES, HELLO_INTERVAL. In this paper we proposed a dynamic version of AODV i.e. ARTO-AODV in which active route timeout varies from one second to many seconds. ARTO-AODV can be used in large , middle and small networks depending upon the type of application such as battlefield monitoring system, hospital monitoring, wireless remote meter-reading system and so on. Simulation shows that ARTO-AODV clearly outperforms with respect to packet delivery ratio, throughput, average end to end delay, and energy efficiency.**

Keywords- WSNs, AODV, Active Route Timeout, My Route Timeout, Throughput.

I. INTRODUCTION

A wireless sensor network is a large scale wireless network of hundreds or even thousands, number of tiny sensor nodes those are capable of sensing, communication, and computation. These networks allows measuring physical parameter such as temperature, pressure, or relative humidity and also allowing coordinated signal detection, monitoring, and tracking to enable sensor nodes to simultaneously capture geographically distinct measurements. A sensor node having four basic components: a battery power source for communication; a match box size processing unit for local computation; a small sized embedded operating system with small data memory; and MEMS sensors unit for sensing the environment. In sensor networks, sensor nodes are densely deployed [1, 2].The position of sensor node need not be pre- determined; this flexibility allows random deployment of nodes in inaccessible regions. This applies that the sensor network protocols and algorithms must possess self-organizing capabilities. Sensor networks are self organized networks, which help us for dangerous and harmful situations. It is important to apply some level of security so that it will be difficult to be attacked, especially when they are used in critical applications [3]. In the next section a brief description of various issues and challenging of wireless sensor network. In section 3 discuss the classification of routing protocols in sensors network, section 4 we will study AODV routing protocol and in section 5 we will discuss the related work. Then we will propose a dynamic version of AODV called ARTO-AODV: Active Route Time Out –Ad hoc On-demand Distance Vector routing protocol. At last we will present simulation results and conclude with future work.

II. DESIGN FACTORS AND ROUTING CHALLENGING ISSSUES IN WIRELESS SENSOR NETWORKS

The network design factors are important part of concern because they serve the principles to design a protocol or an algorithm for sensor network. Following are the main design factors in sensor networks -

Fault-tolerance, Scalability, Production cost, Hardware constraint, Sensor network topology, Environment, Transmission media, Power consumption, Reliability, Adaptively, Self-configurability, Channel utilization, Security and QoS support.

The design of routing algorithm in sensor networks is different from MANETs because of several network constraints. Sensor networks suffer from the limitations of numerous of network resources such as transmitted power, on-board energy, data processing capability, and storage capacity. The reduction of difficulties occur during the routing of sensed data in sensor network due to low energy capacity, localization of sensor nodes in the environment and data aggregation are points of anxiety of many researchers.

III. CLASSIFICATION OF ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS

Routing protocols [4] are categories as Proactive protocols which first compute all routes and then go for routing the data; Reactive protocols which computes routes on demand and Hybrid protocols which are the combination of above two types of protocols or an improvement over proactive and reactive protocols. In this paper we are interested in reactive routing protocol AODV: Ad hoc on demand distance vector protocol is one of the reactive routing protocols. The classification of routing protocols in WSN as shown in Figure 1.1.

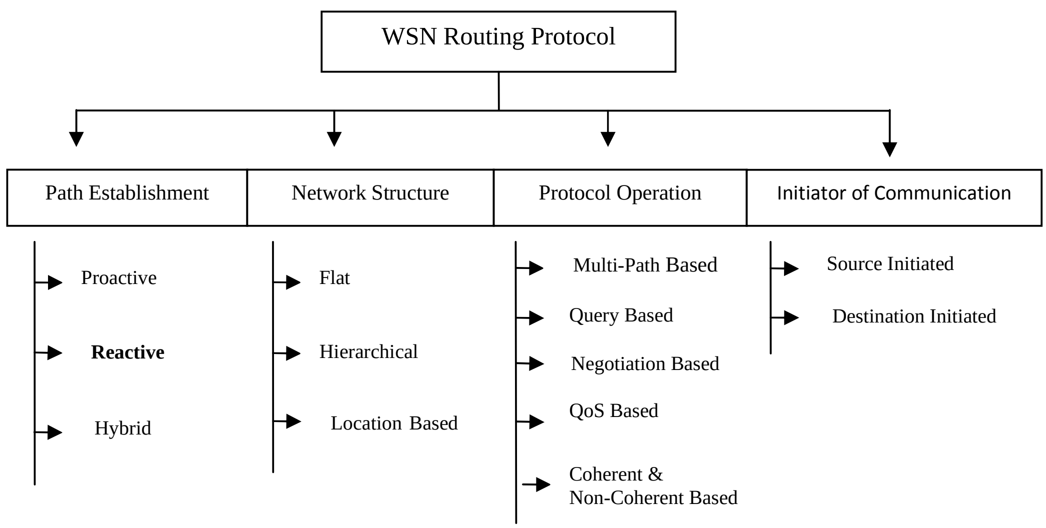

Figure1.1: Classification of Routing Protocol in WSN

IV. AODV: A REACTIVE ROUTING PROTOCOL IN WSNS

AODV is an “on demand routing algorithm”, meaning that it establishes paths only upon demand by source nodes. It maintains these paths as long as they are needed. Nodes that do not participate in active path, neither maintain any routing information nor participate in any periodic routing table exchange. AODV established path based on route request- route reply mechanism.

AODV uses source sequence number and destination sequence number to resolve the freshness of routes. To find a new route, AODV proceed by broadcasting the route request (RREQ) packet. If the neighboring nodes which receiving the RREQ has no route information about the destination then it will further broadcast RREQ packet in the network otherwise it will send answer by the route reply (RREP) packet to the sender from which RREQ is received. RREQ contains source address, source sequence number, broadcast_id, destination address, destination sequence number, and hop count as shown in Figure 1.2; broadcast_id uniquely identifies a RREQ, where broadcast_id is incremented when a new RREQ is issue by source. The immediate node which receive a RREQ, keeps a forwarding pointer (next hop) towards the destination. This process continues “go back up to the source” is looped by all nodes that participated in this path discovery mechanism. When the RREP reaches the source, the route is ready, and the initiator can use it. A neighbor that has communicated at least one packet during the past active timeout is considered active for this destination. An active entry in the routing table is an entry that uses an active neighbor. An active path is a path established with active routing table entries. A routing table entry expires if it has not been used recently. In this main content that AODV uses the route expiration technique, where a routing table entry expires within a specific period, after which a fresh route discovery must be initiated.

Type	**Reserved**	**Hop Count**
broadcast_id		
Destination IP Address **Destination Sequence Number**		
Source IP Address **Source Sequence Number**		
Request Time		

Fig: 1.2 Structure of an RREQ packet

The nodes participating in an active route are notified by RERR (Route ERROR) packets when the next-hop link is down. The Route error propagation in AODV is achieved by all nodes participating in the route. Each one of them forwards the RERR to its predecessors. Consequently, all routing tables must be updated after this process. Nodes launches the RERR message in three cases: 1- detection of a link break for the next hop of an active route in its own routing table, 2- getting a data packet intended to a node that does not have an active route, 3- receiving a RERR from a neighbor in relation to one or more active routes. AODV uses the lifetime field to determine the expiry time for an active route. It also is also used to define the deletion time for an invalid route.

V. RELATED WORK

In [5] the authors proposed an adaptive version of AODV (A^2ODV) where the protocol adapts the routing decision based on the state of behavior and the state of networks. A^2ODV proved as improved AODV which incorporates the reliability of routes during the route discovery process.

In [6] the authors categorize the performance of AODV-ES protocol based on Wireless Ad-hoc Sensor Networks. AODV-ES was proposed to control the overhead and minimize the time delay with improved effectiveness. It performs better than AODV in terms of PDR, end to end delay, and NRL for all mobility rates.

AODV-I [7] is an extension of traditional AODV by adding congestion control processing and the route repair mechanism which the packet loss rate and end to end latency. It also increased the resource utilization. In [8] the authors tried to reduce delay and improve packet delivery ratio by merging multipath and path accumulation with AODV routing protocol. It also reduces the routing overhead by reducing frequency of route discovery process.

In [9] the author addressed the issue of reliability by designing and developing an enhanced fault tolerance mechanism of Ad-hoc On Demand Distance Vector routing protocol for WSNs called ENhanced FAult-Tolerant AODV (ENFAT-AODV). The basic scheme used in ENFAT-AODV utilizes the backup route techniques to improved reliable data packets delivery and keep the system operations still running continually in presence of link breaks and node failures.

AODV-ZFA [10] is a routing protocol based on flooding and AODV. The proposed protocol has higher reliability and lower overhead than AODV. AODV-ZFA can be suit for dynamic topology. However, the end to end delay of the protocol has not been improved effectively. There is still requirement to improve the AODV-ZFA by applying several dynamic cluster head selection techniques.

In [11] the author has simulating AODV and DSDV for the dynamic wireless sensor network. Results of simulations compared DSDV protocol which is a proactive routing protocol with AODV protocol which is belong to reactive routing protocols based on end to end delay and total performance. Results conclude that the performance of AODV is better than DSDV and AODV is more suited to sensor networks applications.

In [12] the author implemented a new scheme for task dissemination in sensor networks. It uses a tree structure which is formed when the source node broadcasts the code version messages. This work proposes a prototype with a mesh topology of wireless sensor networks for analysis of various message costs and overall cost of data messages. It is applied on both static and dynamic WSNs. The source node initializes task dissemination by broadcasting a code version message. The sink nodes form a multicast group to receive the task image. A routing tree formed by the code version messages and code request messages are used to route the code data. Each sensor node keeps a node and a request table reflecting the routing tree has been implemented.

VI. PROPOSED ACTIVE ROUTE TIMEOUT – AODV

AODV is very sensitive to several default and static values of parameters such as ACTIVE_ROUTE_TIMEOUT, MY_ROUTE_TIMEOUT, HELLO_INTERVAL, NET_DIAMETER, and RREQ_RETRIES. The dynamic value of these parameters may affect the performance of the protocol. In this propose the choice of the value of the parameter ACTIVE_ROUTE_TIMEOUT where MY_ROUTE_TIMEOUT is calculated as:

*MY_ROUTE_TIMEOUT = (2*ACTIVE_ROUTE_TIMEOUT)*

A. Simulation model

In order to observe the affect of static parameter on AODV we have consider the platform's based simulation on Qualnet version 5.0 which is a standard tool set used for wired, wireless, MANETs, and sensor networks standards. The model demonstrates the data collection from ground sensor using mobile vehicle. Sensors are randomly deployed in the observation region. The sensors constantly monitor any phenomena of interest in the area. The sensory information observed by each sensor is stored locally at the sensor. The mobile vehicles are moving inside the area where sensors are deployed. The vehicles have short range communication to sensors and long distance communication to a remote site which is called fusion centre in this model. The sensors send their locally stored data packets to the vehicles which at any time are within their radio range. The vehicles then relay sensory data packets to fusion centre using long distance communication to that centre. Short range communication between sensor nodes and vehicles is have been configured as IEEE 802.15.4 standard where PHY and MAC is 802.15.4 and routing protocol is AODV. Long distance communication between vehicles and remote site (fusion centre) configured as IEEE 802.11a.

Simulation Time	30 minutes
Terrain Area	500 x 500
Number of nodes (sensor)	100
Number of mobile nodes (vehicles)	5
Remote site	1 (Base station)
Channel Frequency	2.4 GHz
Path Loss Model	Two Ray Model
Traffic type	UDP
Application type	CBR

Table 1.1 Configuration Table

B. Experiments Results

Every time route changes when link failure is occur, it confirms that the routing layer is directly affected by link failure (route disconnections). The routing operations in AODV uses stored route depending on their active route timeout. In this way we proposed to add this property to AODV and make it to new ARTO-AODV: Active Route TimeOut AODV. The following graphs show the various changes in the performance of AODV.

Average end to end delay: The result shows in Figure 3 show the average end to end delays for variable time of Active Route TimeOut. In ARTO- AODV as the Active Route TimeOut increases the end to end delay decreases [13].

Throughput: is the total packet received successfully per unit time. It is the ratio between the number of packets sends and number of packets received. Figure 4 shows the change in throughput by changing time of Active Route Timeout [13].

Total Bytes Received: Number of received bytes by all nodes in the network for finding the target information [13].

Average Jitter: is the deviation in or displacement of some aspects of the clock pulses from the source to reach the destination with different delays. In other words it can be defined as counts the number of packets from the source will reach the destination with different delays [13].

Packet Delivery Ratio: is the ratio of the total packet received by destination to the total packet send by the source. The better packet delivery ratio provides more complete and correct routing protocol [13].

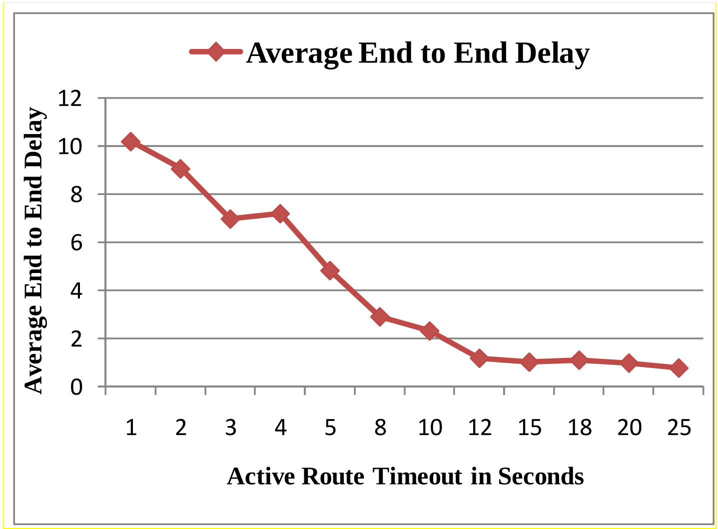

Figure 1.3 Active Route Timeout Vs Average end to end delays

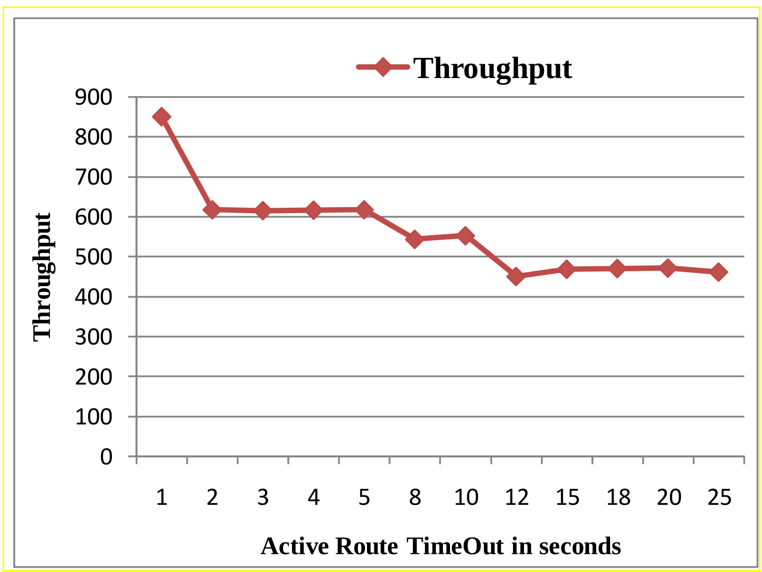

Figure 1.4 Active Route Timeout Vs Throughput

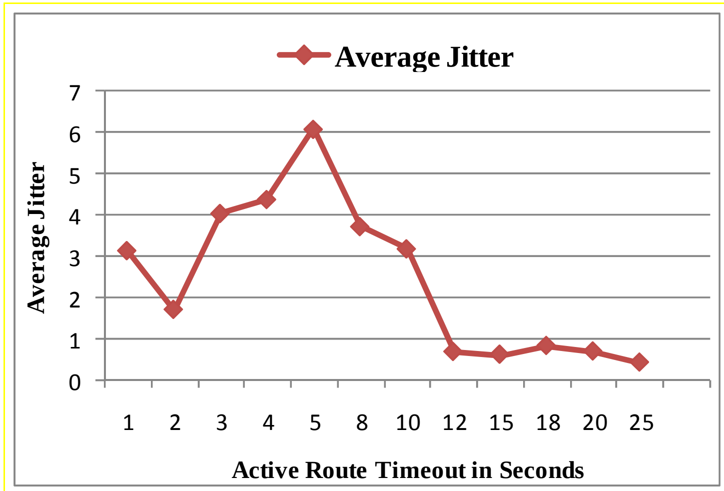

Figure 1.5 Active Route TimeOut Vs Average Jitter

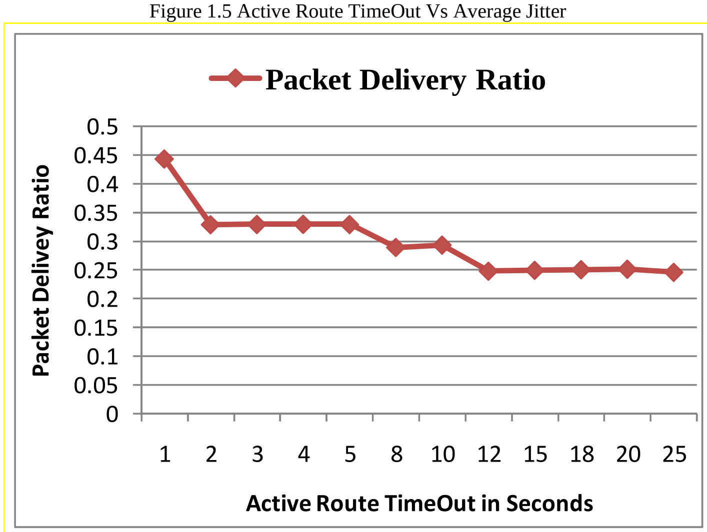

Figure 1.6 Active Route TimeOut Vs Packet Delivery Ratio

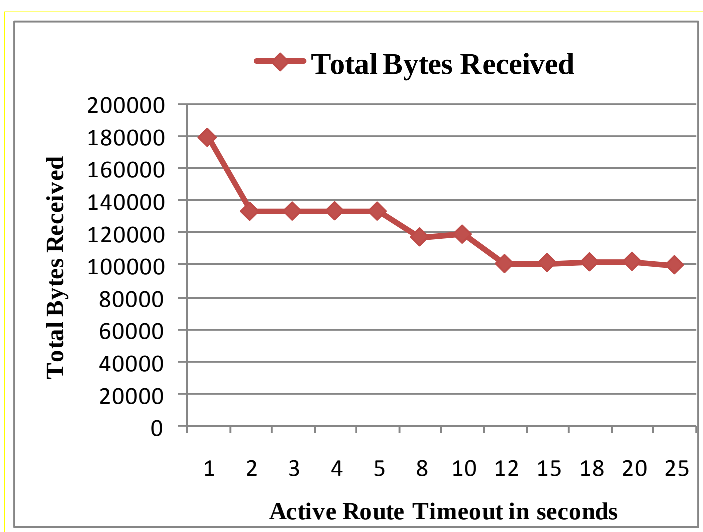

Figure 1.7 Active Route Timeout Vs Total Bytes Received

VII. CONCLUSION

In this Figure 1.3, 1.4, 1.5, 1.6, 1.7 shows the concept of variable active route timeout for various application parameters such as average end to end delay, throughput, average jitter, packet delivery ratio and total bytes received. We conclude that if the active route timeout is less or exactly 1 second then it provide maximum throughput. When the value of active route timeout increases from 1 second to few seconds then the throughput get changes accordingly. The other parameters are also get change on variable values of active route timeout. In Future we can simulate the results for other static parameters of AODV like HELLO_INTERVAL, NET_DIAMETER, and RREQ_RETRIES.

ACKNOWLEDGMENT

This work is supported by Dr. Sanjeev Sharma and all member of my Institution School of Information Technology RGPV Bhopal.

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