Analysis of Selective Routing Strategies for Fault Tolerance In Wireless Sensor Networks

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Abstract:

Wireless sensor networks are intended to have large number of sensor nodes which are widely deployed in a distributed environment. Steep increase in number of nodes, which is a deviant to WSN eventually, affects the communication capability of the network as it raises the scalability issue. This at any instance may destabilize network throughput which leads to network failure. Therefore, fault-tolerant protocol is desperately needed to stabilize the dexterity of network. In this paper, we have examined the two prominent routing protocols DSDV and AODV which has been the inception for evolution of numerous routing protocols for wireless network environments. We have summarized the execution evaluation of the significant parameters (i.e.) throughput, packet delivery ratio and end-to-end delay by varying the transmission range for different node densities to analyze which mechanism well suits for the trustworthy WSN environment.

Keywords: WSN, AODV, DSDV, node density, transmission range.

I. INTRODUCTION:

WSNs are envisioned to have wide variety of applications as it is fundamentally a new tool in wireless research community which provides limitless future potentials. It has emerged as a premier research topic since it is a significant resent perception in the area of wireless technology. They have the great enduring economic potential to transform our lives as it is significantly different with classical networks because of limitations on the simplicity of the processing power of nodes, energy consumption and possibly highly dynamic environmental [1].

It also poses several new conceptual and optimization problems since it consist of numerous diminutive sensor nodes which are deployed at high density in regions requiring surveillance and monitoring [2]. Due to limited energy provision, the energy resource of sensor networks should be wisely managed to extend the lifetime of sensors [3].

Routing mechanisms are the core part of wireless sensor networks [4].So when WSN environment changes, as its implication, performance of routing protocol tends to cause temporary or permanent failure of the network.

This failure usually are due to the fast energy depletion of the sink node i.e., energy hole, caused when the transmitting nodes are not in the range between one another in WSN [3]. In such case, they need to rely on multi-hop communications and in such constraint, routing becomes mandatory. To overcome such criteria, support of transmission range is needed because impact of the radio transmission range affects the network throughput as the number of nodes exceeds. A higher transmission range increases the distance progress of data packets towards their final destination with increased throughput [5].

Since, network routing protocols must be designed to achieve fault tolerance in the presence of individual node failure. Therefore fault-tolerant mechanism finds the significance for a successful communication in WSN. Realizing fault-tolerant operation is critical issue for a successful WSN environment. It is the ability of the system to sustain functionalities without any disturbances or interruptions [6].

Therefore to achieve a fault-tolerant environment, the main objective is to focus on the core issues of routing mechanisms like average end-to-end delay, throughput and packet delivery ratio [7][8][9].

This paper will exhibit the performance study of two types of protocol, the proactive and reactive routing protocols. AODV has chosen to study the performance of reactive routing and DSDV has chosen for the performance study of proactive routing.

AODV and DSDV are chosen, since these are the evolutionary routing strategies among the most efficient routing protocols in terms of establishing the shortest path and lowest power consumption as both are distance vector based routing.

AODV uses the concepts of path discovery and maintenance although it establishes route only when needed. DSDV keeps the simplicity of distance vector and guarantees loop freeness. It allows fast reaction to changes in topology. Both guarantees loop free path to destination despite using different mechanisms for route establishments.

II. RELATED WORKS:

In recent years there has been several research works related to routing protocols performance in WSN [10][11][12]. Mainly many of the research works are focused on WSN communication capability (i.e.) changes of network topology should not affect the consistency of WSN environment. In reference to communication capacity for a network, routing mechanism is the main issue [13][14][15]. It is focused on the analysis and enhancement of routing protocols.

Routing is the critical issue as it plays the key role in wireless sensor networks. Therefore, strategies of WSN is been proposed for analysis of various routing protocol [16].

The design of routing protocols for a fault-tolerant wireless sensor networks must consider the limitations of power and resource limitation of network nodes, quality of wireless channels stability over average time, packet loss and delays.

The exploration of several parameters such as traffic pattern, number of nodes i.e. node density and initial pattern of nodes causes remarkable changes in WSN performance [17].

At present, there are several papers related to performance evaluation of Ad-hoc On-demand Distance Vector (AODV) and Destination-Sequenced Distance Vector (DSDV). We have focused on the performance of the protocol by changing the communication range with increase in number of network nodes for analyzing the efficient fault tolerant mechanism among above mentioned two routing protocols. As the adjustable increase in transmission range will enhance the lifetime of the network [3], we compute the performance metrics such as packet delivery ratio, average end to end delay and throughput for study of suitable fault tolerant routing protocol among the reactive and proactive routing protocols. In this paper, we observed and analyzed our experiment by varying the transmission range for AODV and DSDV in wireless sensor networks with relatively scalable network size.

a. The Ad-hoc On-Demand Distance Vector Routing Protocol [AODV]:

Reactive routing protocols also known as on-demand routing protocols are which does not initiate a route discovery process until a route to a destination is required.

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is a reactive protocol which is designed for the use of ad-hoc mobile networks and wireless sensor networks [18]. The significant feature of AODV is the routes are created only when they are needed. Traditional routing tables are used i.e., only one entry per destination, and the sequence number to determine whether routing information is up-to-date to prevent routing loops [19]. RREQ (Route Request) is broadcasted from the source node to the destination node along with the source node address, destination node address and sequence number. If the node is within the network range, the destination node sends the RREP (Route Reply) to the source node. Another important feature of AODV is the maintenance of time-based states in each node i.e., a routing entry which is not recently used will be expired. And in case, when a route breaks, it will be indicated to the neighbors (i.e.) if the node is external to the network range, it sends the RRER (Route Error) message about the link failure.

The Merits of AODV protocol are that it favors the least congested route instead of the shortest route and it supports both unicast and multicast packet transmissions even for nodes in constant movement [20]. It also responds very quickly to the changes in topology that affects the active routes. AODV does not put any additional overheads with data packets as it does not make use of source routing.

b. *Destination-Sequenced Distance Vector Routing Protocol [DSDV]:*

Proactive algorithms are which finds the entire possible path to the destination and stores them in routing table ahead of time. It updates the routing table after a particular amount of time and while a new node is starting up or when old one fails.

DSDV is the successor of distance vector in routing protocol and guarantees a loop free path to each destination [8]. It uses Bellman-ford algorithm to calculate path. DSDV is the table-driven proactive protocol in which every node maintains a routing table that contains next hop entry and number of hops needed for all possible destinations. Sequence number is tagged with each route table entry to eliminate routing loops. While each node transmits information, periodic updating is done to maintain the consistency in environment by using periodic trigger update mechanism. Therefore when time entries in the list changes, the advertisement must be made to each of its current neighbor nodes often or periodically. The sequence number of normal update is made by even number. It will be incremented by 1 only when the node needs to update an expired route to the neighbors.

Merits of DSDV protocol are that it avoids fluctuations in route updates by employing "settling time" data, which is used to predict the time when route becomes stable. It detects broken links by using the layer-2 protocol or if no broadcasts have been received for a while the route may be inferred [21].

III. SIMULATION & RESULT ANALYSIS:

The performance evaluation of AODV and DSDV has been analyzed by varying number of network nodes and transmission range. We have used Network Simulator ns2 for our evaluation. In this scenario we have placed 50,100,150 and 200 nodes for observation with transmission range 50,100 and 150m which are randomly distributed in area of 1000m x 1000m terrain.

The parameters used for evaluation are:

a. Average end-to-end delay: The end-to-end-delay is averaged over all the surviving data packets from the sources to the destinations.
b. Throughput: It is the ratio of successfully received data packets by the destination to the total packets being sent from the source nodes.
c. Packet delivery ratio: It is the ratio of the number of packets has been received successfully and the total number of packets transmitted.

TABLE 1: SIMULATION PARAMETERS USED FOR ANALYSIS

Parameters	**Value**
Routing protocol	DSDV/AODV
Mac layer	802.11
Channel type	Wireless channel
Radio-propagation model	Two Ray Ground
Antenna type	Omni Antenna
Interface queue type	DropTail/PriQueue
Terrain dimension(in m^2)	1000x1000
No. of nodes	50,100,150,200
Transmission range(in m)	50,100,150
Initial energy(in joules)	10
Source type	TCP
Simulation time(in seconds)	130

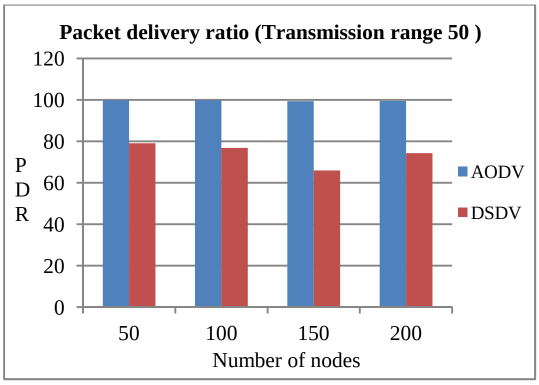

Fig 1.1 PDR analyses of AODV & DSDV with TR 50

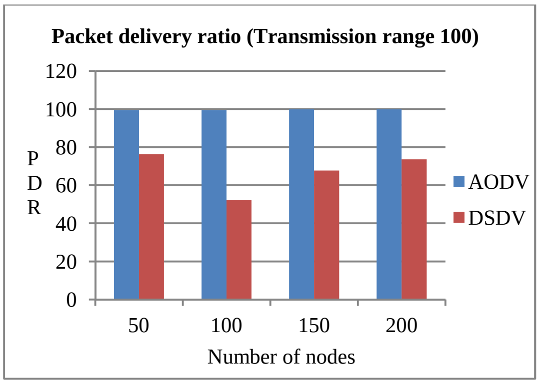

Fig 1.2 PDR analyses of AODV & DSDV with TR 100

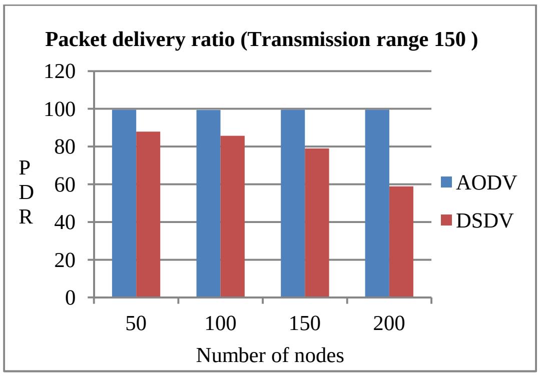

Fig 1.3 PDR analyses of AODV & DSDV with TR 150

These graphs show the performance of two different routing protocols with transmission range 50,100 and 150 in terms of PDR with node densities 50,100,150 and 200. As the number of nodes increases with change in transmission range, AODV has comparatively high and stable packet delivery ratio and DSDV gradually decreases as node density increases.

In Fig 1.1 & 1.2, at transmission range 50 and 100, the PDR remains constant for node densities 50,150 and 200 in case of DSDV and in case of AODV, PDR is high and stable. In Fig 1.3, at transmission range 150, AODV shows high PDR and for DSDV, it gradually decreases as the number of nodes increases.

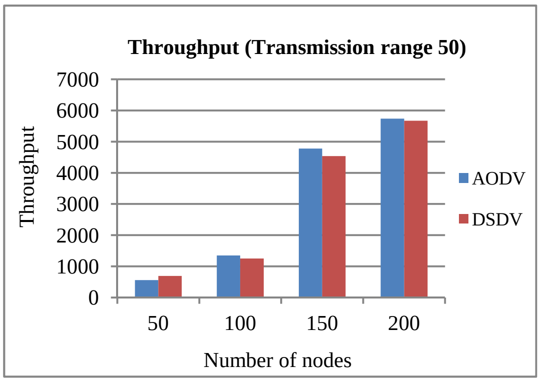

Fig 2.1 Throughput analyses of AODV & DSDV with TR 50

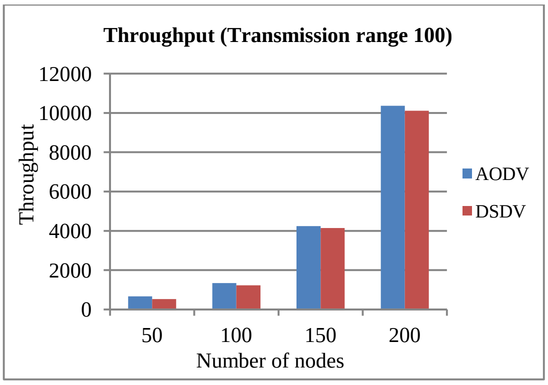

Fig 2.2 Throughput analyses of AODV & DSDV with TR 100

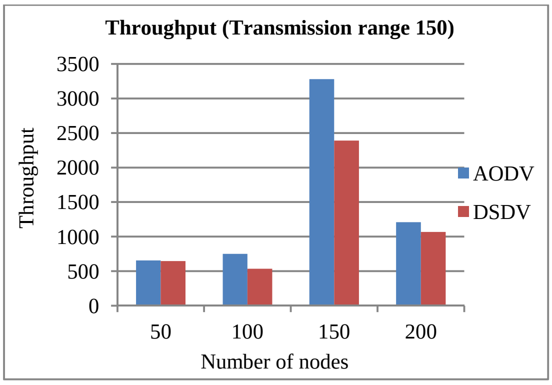

Fig 2.3 Throughput analyses of AODV & DSDV with TR 150

These graphs show the performance of throughput for the two different routing protocols with change in transmission range 50,100 and 150 along with node densities 50,100,150 and 200. As the number of nodes increases with change in transmission range, AODV has comparatively high throughput than DSDV, as DSDV shows comparatively less fluctuated throughput.

In Fig 2.1 & 2.2, at transmission range 50 and 100, the throughput gradually increases for node densities 50,150,100 and 200 in case of both DSDV and AODV. In Fig 2.3, at transmission range 150, AODV shows high throughput and for DSDV, it remains constant for node density 50 and 100 but shows fluctuation as the number of nodes increases.

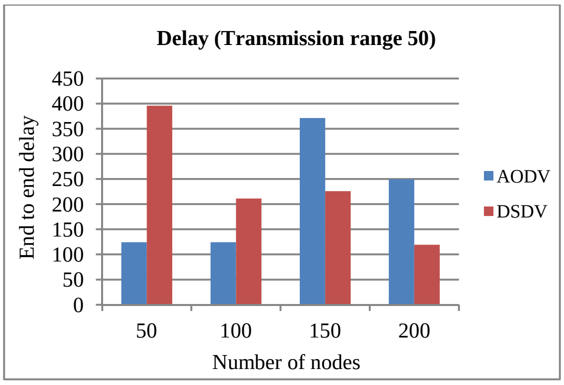

Fig 3.1 Delay analyses of AODV & DSDV with TR 50

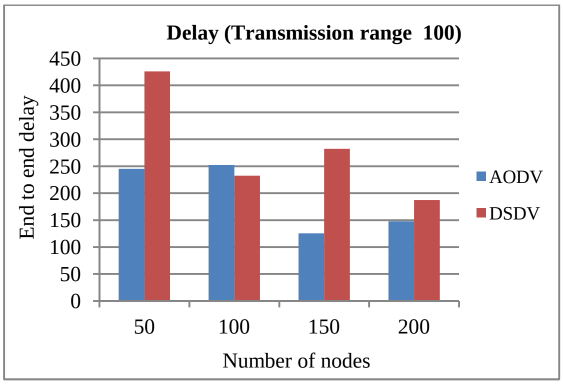

Fig 3.2 Delay analyses of AODV & DSDV with TR 100

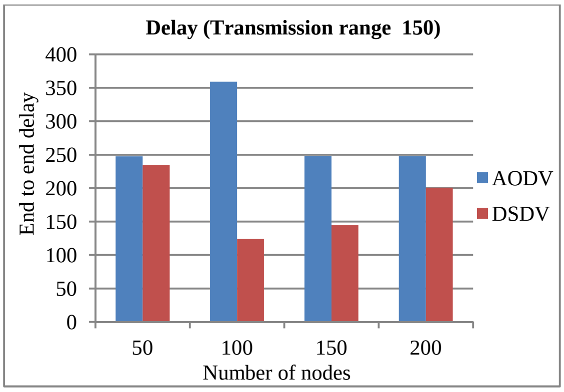

Fig 3.3 Delay analyses of AODV & DSDV with TR 150

These graphs show the performance of two different routing protocols with transmission range 50,100 and 150 in terms of end-to-end delay with node densities 50,100,150 and 200. As the number of nodes increases with change in transmission range, AODV comparatively has the high end-to-end delay than DSDV as the number of nodes increases.

In Fig 3.1, at transmission range 50, AODV shows less end-to-end delay for node density 50 and 100 but as the number of nodes increases delay also increases. In Fig 3.2 & 3.3, at transmission range 100 and 150, AODV shows high delay for node density 100 but shows comparatively less delay as the number of nodes increases. In the case of DSDV for transmission range 50 and 100, it shows high delay in case of 50 nodes but as number of nodes increases, delay decreases. For transmission range 150, DSDV has less delay when compared to AODV.

IV. CONCLUSION:

In our experimental study, we scrutinized the execution evaluation of AODV and DSDV for various node densities with varying transmission range to analyze suitable fault-tolerant mechanism for WSN. In terms of PDR, AODV performs well when compared with DSDV as AODV shows higher and constant packet delivery ratio. In terms of throughput, AODV shows highly consistent performance when compared to DSDV. In the case of end-to-end delay both protocols show its level of fluctuation. From our analysis, we conclude that both AODV and DSDV perform well but comparatively AODV is best since it gives high throughput and constant packet delivery ratio despite of high delay ratio. It would perform much better, if suitable mechanism is adapted to overcome end-to-end delay ratio.

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