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Impact of Variations in Transmission Range, Nodes Concentration and Nodes Speed on the Performance of Shortest Path Routing Protocol

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Abstract

MANET is an infrastructure less network with no fixed topology. The nodes in such an environment are capable of receiving and forwarding packets. The task of routing data in such an ever changing environment is a tedious task to implement. AODV is a popular routing protocol in MANETs where in each node receives and broadcasts packets to attain network information. Shortest path routing based on Dijkstra algorithm utilizing AODV routing methodology can be used to determine the shortest route between source and destination in MANET. This paper is an attempt to study impact of nodes concentration, transmission range and nodes speed on the performance of the discussed routing protocol in MATLAB 7.0

Keywords- *nodes, transmission range, routing, nodes speed*

1. INTRODUCTION OF MANET

"A mobile ad-hoc network (MANET) is a self-configuring network of mobile routers and associated hosts connected by wireless link" [1, 5]. Nodes belonging to a MANET can either be end-points of a data interchange or can act as routers when the two end-points are not directly within their radio range. MANET has certain silent features such as: MANET can be formed without any preexisting infrastructure, it follows dynamic topology where nodes may join and leave the network at any time and the multi-hop routing may keep changing as nodes join and depart from the network. Besides MANETS have very limited physical security, and thus increasing security is a major concern. Every node in the MANET can assist in routing of packets in the network. There are numerous advantages and disadvantages with MANET's as listed below

Advantages

- Independence from central network administration
- Self-configuring, nodes are also routers
- Self-healing through continuous re-configuration
- Scalable: accommodates the addition of more nodes
- Flexible: similar to being able to access the Internet from many different locations

Disadvantages

- Each node must have full performance
- Throughput is affected by system loading
- Reliability requires a sufficient number of available nodes. Sparse networks can have problems
- Large networks can have excessive latency.

Routing in MANET is an indispensable requirement for data communication. Since environment in MANET is never fixed and is ever changing i.e, the topology in manet keeps changing so the link establishment is not easily achievable**.** One of the popular routing techniques for MANETS is AODV i.e, Adhoc on demand distance vector routing.

A. Adhoc on demand distance vector routing protocol (AODV)

In MANETS a node does not have to discover and maintain a route to another node until the two needs to communicate, unless the former node is offering its services as an intermediate forwarding station to maintain connectivity between two other nodes. When the local connectivity of the mobile node is of interest, each mobile node can become aware of the other nodes in its neighborhood by the use of several techniques, including local broad casts known as hello messages. The routing tables of the nodes within the neighborhood are organized to optimize response time to local movements

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and provide quick response time for requests for establishment of new routes. The algorithms primary objectives are:

- To broadcast discovery packets only when necessary
- To distinguish between local connectivity management, neighborhood detection and general topology maintenance
- To disseminate information about changes in local connectivity to those neighboring mobile nodes that are likely to need the information

AODV uses a broadcast route discovery mechanism as is also used with medications in the Dynamic Source Routing DSR algorithm. Instead of source routing, however AODV relies on dynamically establishing route table entries at intermediate nodes. This difference pays off in networks with many nodes, where a larger overhead is incurred by carrying source routes in each data packet. To maintain the most recent routing information between nodes we borrow the concept of destination sequence numbers from DSDV .Unlike in DSDV however each adhoc node maintains a monotonically increasing sequence number counter which is used to update stale cached routes. The combination of these techniques yields an algorithm that uses bandwidth efficiently by minimizing the network load for control and data traffic is responsive to changes in topology and ensures loop free routing.

Path discovery

The Path Discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. Every node maintains two separate counters a node sequence number and a broadcast id. The source node initiates path discovery by broadcasting a route request RREQ packet to its neighbors The RREQ contains
The following fields:
<source addr, source sequence #broadcast id,
#dest addr, dest sequence, #hop cnt >
The pair <source addr, broadcast id > uniquely identifies a RREQ. Broadcast id is incremented whenever the source issues a new RREQ. Each neighbor either satisfies the RREQ by sending a route reply RREP back to the source or rebroadcasts the RREQ to its own neighbors after increasing the hop count. Notice that a node may receive multiple copies of the same route broadcast packet from various neighbors. When an intermediate node receives a RREQ, if it has already received a RREQ with the same broadcast id and source address, it drops the redundant RREQ and does not rebroadcast it. If a node cannot satisfy the RREQ, it keeps track of the following information in order to implement the reverse path setup, as well as the forward path setup that will accompany the transmission of the eventual RREP Destination:

- IP address
- Source IP address
- Broadcast id
- Expiration time for reverse path route entry
- Source nodes sequence number

2. PROPOSAL

In MANETS many times the communication between the source node and destination node is achieved through the Intermediate nodes. The nodes in MANET are capable of Receiving and forwarding the date besides transmitting their own data. The network information is communicated to the reachable nodes using concepts of AODV[6,7] or the RREQ and RREP packets and also maintains table to keep the information necessary for the routing. Utilizing similar concepts of gathering network information, each router shall run Dijkstra's algorithm to compute the shortest paths and modify the forwarding table. Ultimately Dijkstra is used to obtain the path with min hops from source node to the destination node.
This paper aims to analyze the impact in variation of the following network and physical parameters in the performance of above described routing protocol.
a) Impact of change in the Transmission range of nodes.
b) Impact of increase in number of nodes in the simulation region.
c) Impact of nodes speed i.e, whether nodes is approximately same or the nodes are moving with different speeds.
The output parameters in terms of which the performance is diagnosed on changing the above discussed quantities are discussed in the section 3

3. SET UP PARAMETERS

Table 1. shows the values of Design parameters used for simulation purpose.

Table 1: Design Parameters

Set up parameter	Value
Area of simulation Region	2000x2000 sq units
Nodes position	Random
Number of nodes	Varied from 30 to 50 Step size of 10
Routing algorithm	Dijkstra's Shortest Path
Transmission Range	275,300,325
Packet transmission interval	1sec
Mobility Model	Random Walk
Number of packet sent	100
Number of iteration	Variable

A. Performance Metrics

The following metrics has been used to evaluate the performance of MANET in the idealistic and realistic ones.

Metrics used

Packet Delivery Ratio (PDR)-Defined as the ratio of total packets received by different destinations to the total number of packets transmitted by various source nodes.

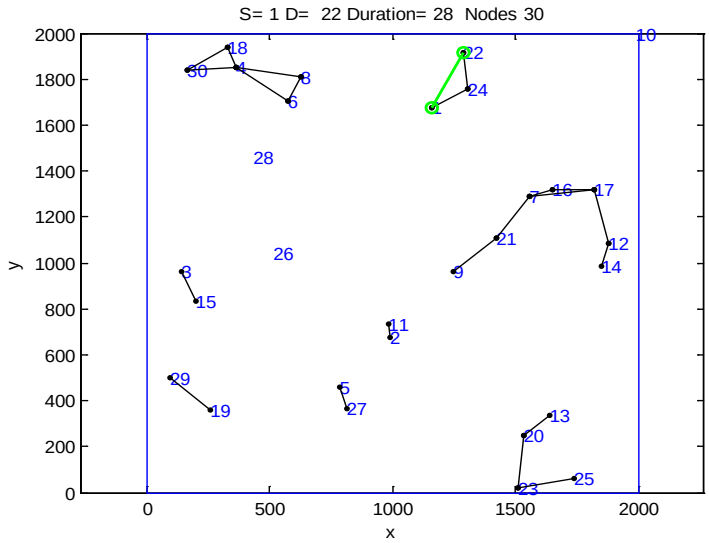
Hop Count- Defined as the number of intermediate hops from source to the destination for successful transmissions.

Probability of Reach abililty(PoR)- Defined as ratio of paths actually formed to the total number of paths that are possible for a given number of total nodes.

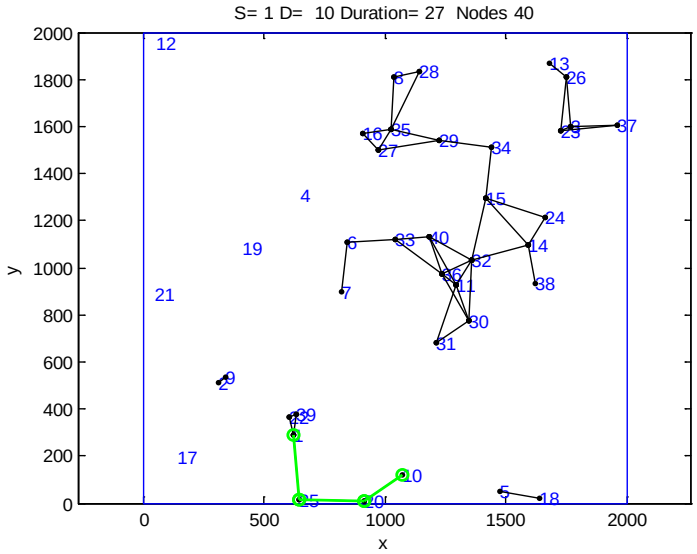
B. Simulation Setup

A Simulator has been designed in MATLAB for the analysis of the Possibilities and outcomes that are likely to be introduced by the deployment of the Primary user nodes. From the design consideration point of view a region of 2500*2500 Sq Units is chosen where in 40 Nodes are placed at random Positions. This is accomplished by the use of *Randint* function that uniformly distributes nodes in the Square region as shown in the figure1. At any instant the path between any randomly chosen source and destination pair is selected by the use of *Dijkstra's shortest path algorithm.* The intactness of path is checked for certain time duration and data counter value is incremented successively

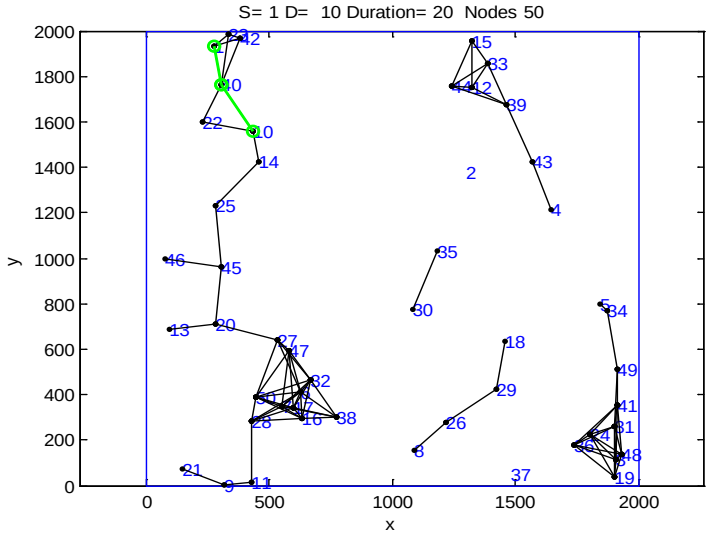
(1) When TX=275 and number of nodes=30



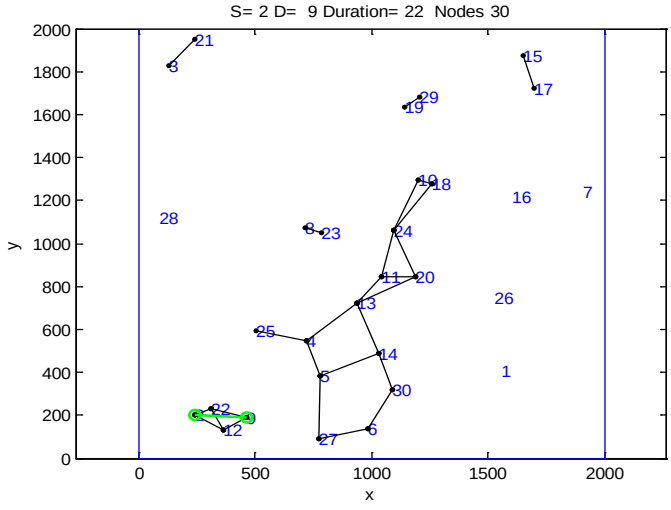
(2) When TX=275 and number of nodes=40



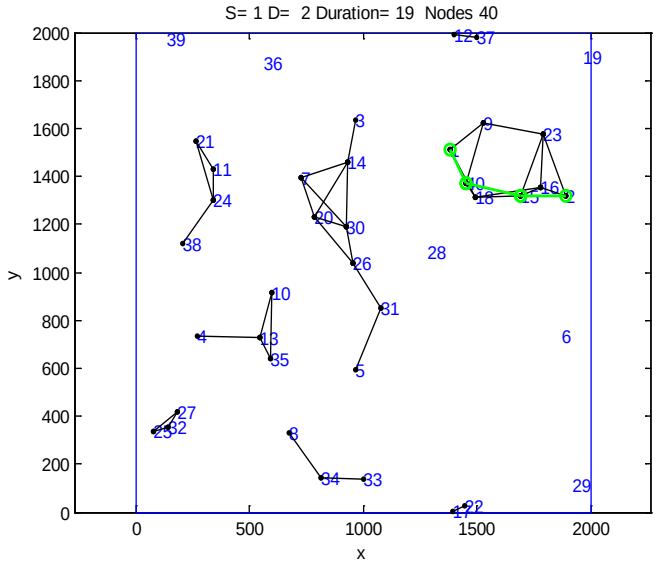
(3) When TX=275 and number of nodes=50



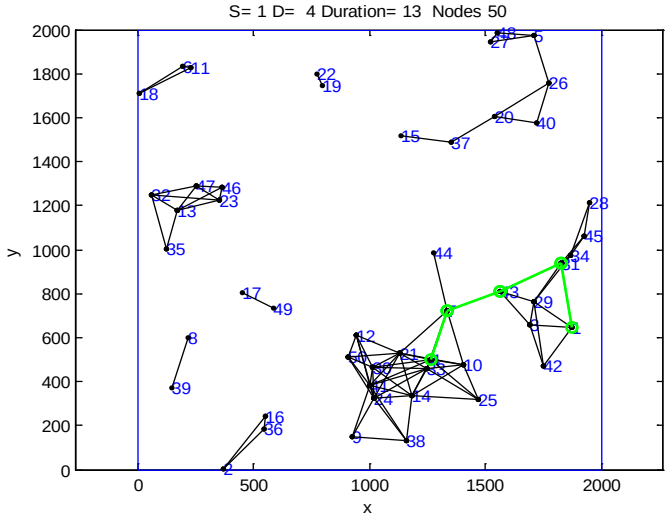
(4) When TX=300 and number of nodes=30



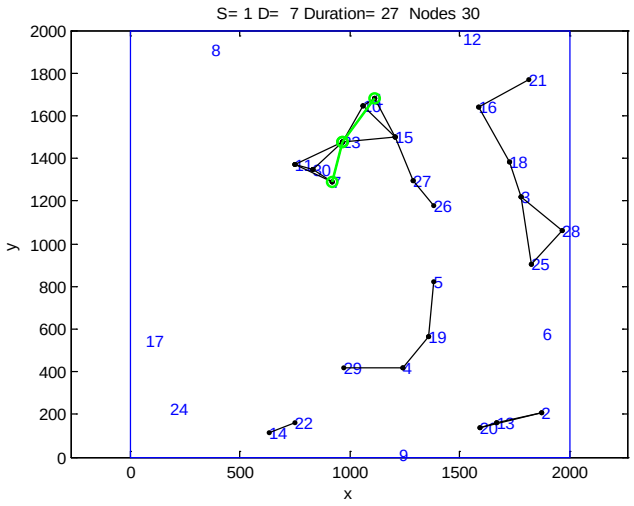
(5) When TX=300 and number of nodes=40



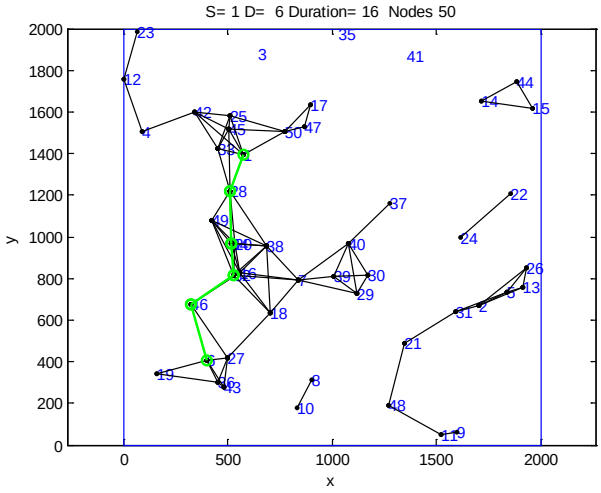
(6) When TX=300 and number of nodes=50

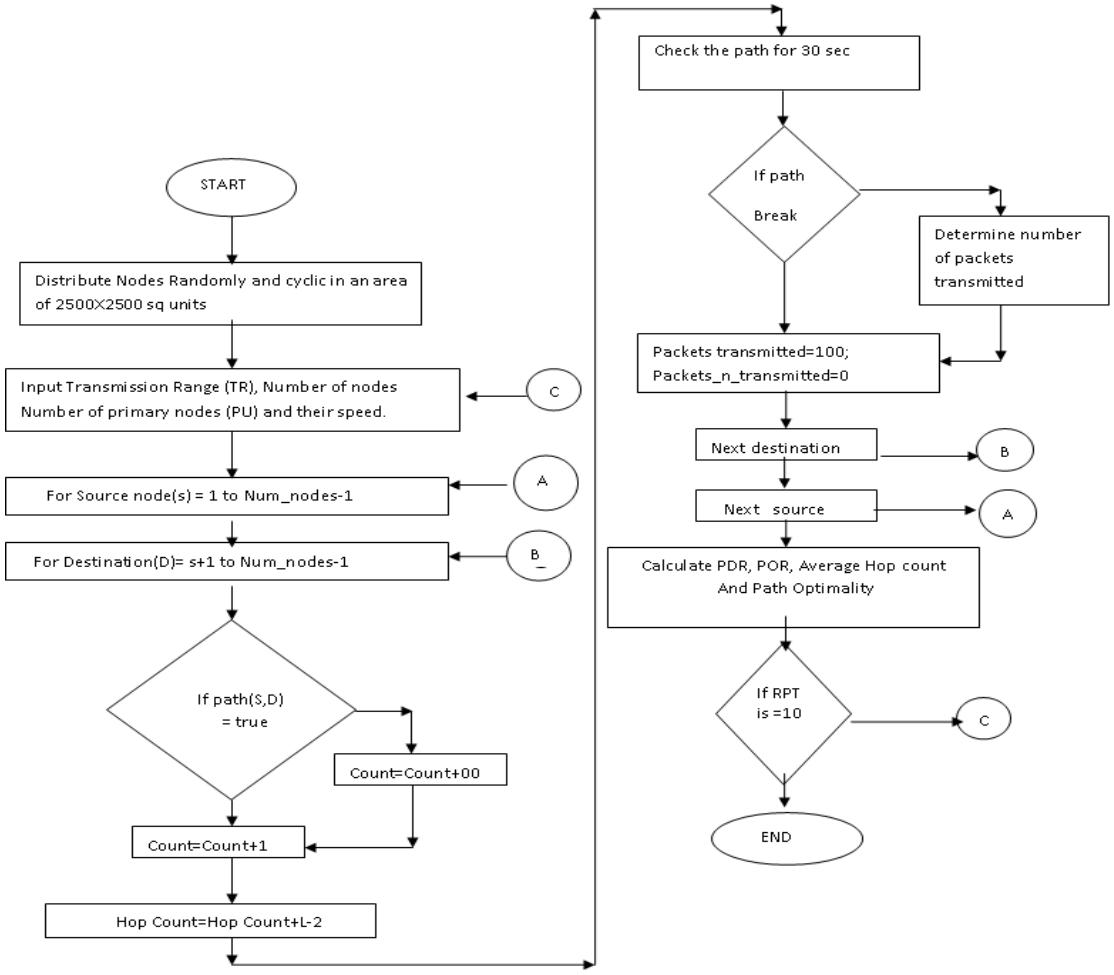


(7) When TX=325 and number of nodes=30



(8) When TX=325 and number of nodes=50





4. RESULTS (Same speed)-

The performance evaluation of the routing protocol is done under the following performance metrics, when nodes speed is approximately same.

A. Average PDR Comparison

PDR refers the Packet delivery ratio i.e, the number of packets actually transmitted to total number of packets. Average PDR is the average of PDR values obtained for different paths. The PDR under this category is measured when the mobile nodes are moving at approximately similar speeds. The PDR evaluation is done by changing

number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the PDR is plotted then for another node concentration and different values of transmission range the values of PDR are determined.

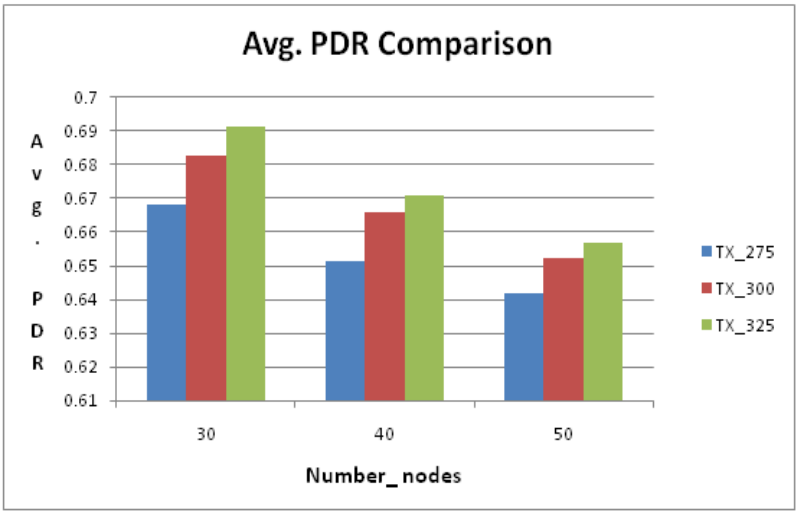


Fig 1: PDR comparison

Inferences-

- Value of Average PDR increases with the increase in the Transmission range at every node concentration.
- With increase in the value of node concentration the Average PDR decreases.
- At node concentration equal to 30 PDR is minimum and for same node concentration PDR is minimum when Tx(Transmission range) value is 275m and maximum when Tx is 325. As with the increase in Tx range more nodes reachable and even when nodes are moving they can remain under connectivity over a larger range.
- PDR characteristics follows similar pattern on each node concentration when transmission range is changed from 275 to 325.

B. Average Hop Count Comparison

The average hop count corresponds to the average of all hop counts obtained for different paths that are actually formed in the simulation run. The Hop count under this category is measured when the mobile nodes are moving at approximately similar speeds. The Hop count evaluation is done by changing number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the Hop count is plotted and similarly for another node concentration and different values of transmission range the values of hop count are determined.

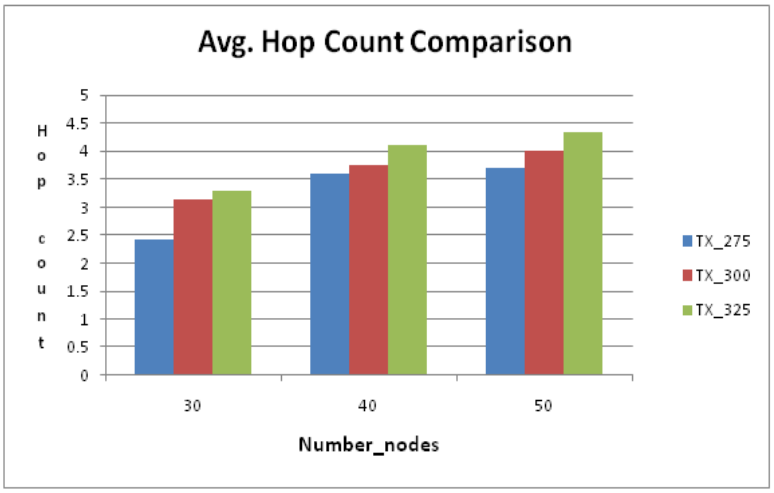


Fig 2: Avg. Hop count comparison

Inferences

- With increase in concentration of nodes the value of hop count increases. Since as the number of nodes increases paths with more number of intermediate nodes are formed.
- Increase in transmission range makes more nodes under visibility of other nodes as result paths of larger hop count are formed.
- Hop count is minimum when number of nodes is 30 and Tx range is 275.
- Hop count is maximum when number of nodes is maximum and Tx range is 325.

C. Probability of Reach ability (PoR)

The Probability of Reach ability under this category is measured when the mobile nodes are moving at approximately similar speeds. The Probability of Reach ability evaluation is done by changing number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the Probability of Reach ability is plotted then for another node concentration and different values of transmission range the values of Probability of Reach ability are determined.

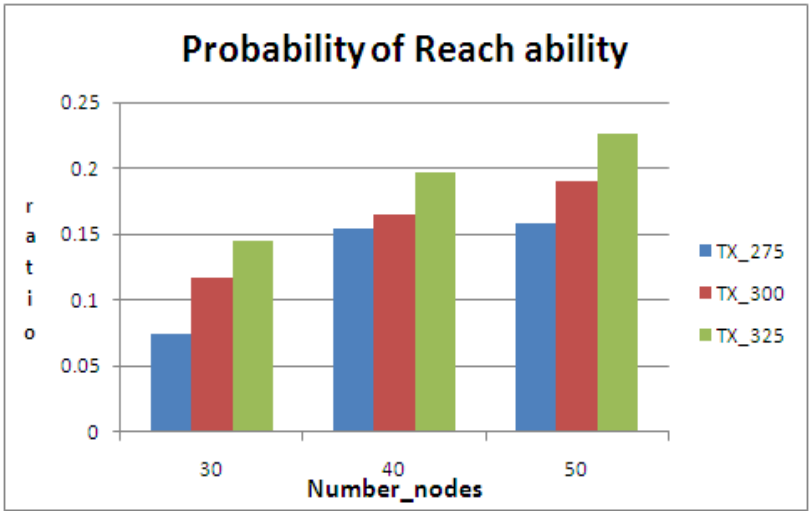


Fig 3: Path optimality comparison

Inferences-

- Path optimality is maximum at every node concentration when transmission range is 325 and minimum when transmission range is 275.
- Path optimality enhances with increase in concentration of nodes in the simulation region.
- When node concentration increases the density of nodes in the simulation region is enhanced, nodes appear closer to each other and path formation enhances. As a result

Ratio of actually forming enhances.

5. RESULTS (different speeds)- The performance metrics are measured when the different nodes move with different speeds. This section aims to measure the impact of different node speeds on performance metrics.

A. Packet Delivery Ratio

The PDR result here corresponds to the situation when all mobile nodes in the simulation region are moving with different speeds. The PDR evaluation is done by changing number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the PDR is plotted then for another node concentration and different values of transmission range the values of PDR are determined.

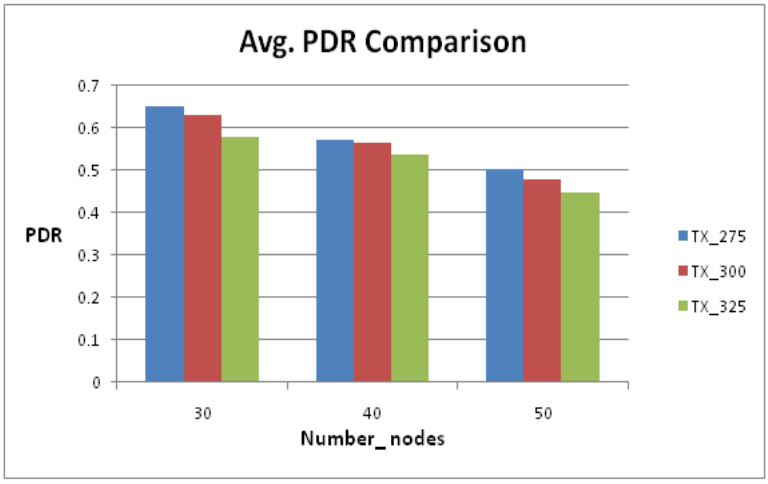


Fig 4: PDR Comparison when nodes speed is different

Inferences-

- PDR trend in this case is dissimilar with PDR trend for earlier case when all the nodes were moving with similar speeds.
- PDR values here are maximum when node concentration is 30 and minimum when concentration is 50.
- In comparison to earlier case PDR value is maximum at each node concentration when transmission range is 275 and minimum when transmission range is 325.
- Pattern of highest PDR at Tx. Range 275 and lowest PDR at Tx. Range 325 is followed at all node concentrations although their magnitude varies at each node concentration value.

B. Average Hop Count

The Hop count evaluation is done by changing number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the Hop count is plotted then for another node concentration and different values of transmission range the values of hop count are determined.

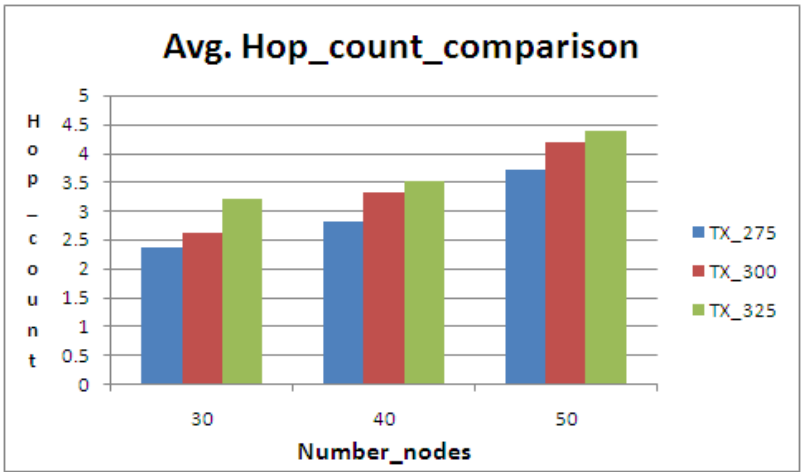


Fig 5: Avg. Hop count when nodes speed is different

Inferences-

- With increase in concentration of nodes the value of hop count increases. Since as the number of nodes increases paths with more number of intermediate nodes are formed.
- Increase in transmission range makes more nodes under visibility of other nodes as result paths of larger hop count are formed.
- Hop count is minimum when number of nodes is 30 and Tx range is 275.

- Hop count is maximum when number of nodes is maximum and Tx range is 325

C. Probability of Reach ability -The Probability of Reach ability evaluation is done by changing number of nodes and changing the transmission range. For each node concentration and different values of Transmission range the Probability of Reach ability is plotted. Then for another node concentration and different values of transmission range the values of Probability of Reach ability are determined.

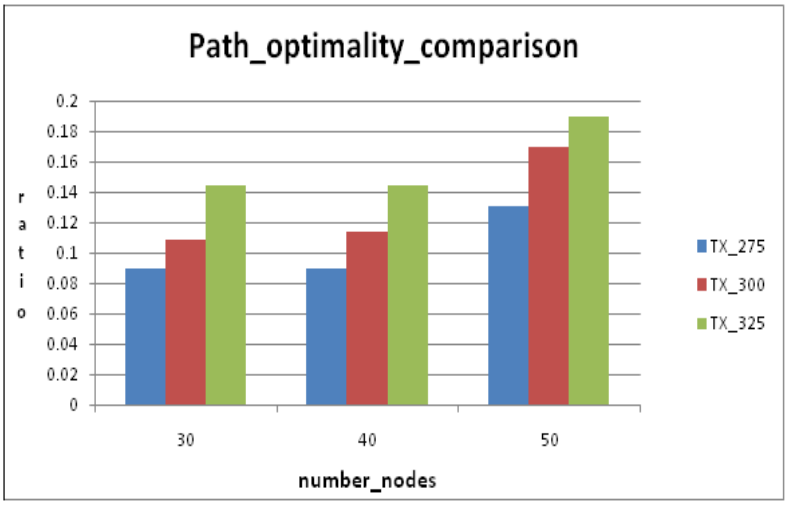


Fig 6: Path optimality comparison when nodes speed is different

Inferences-

- Path optimality is maximum for every node concentration when transmission range is 325 and minimum when transmission range is 275.
- Path optimality enhances with increase in concentration of nodes in the simulation region.
- When node concentration increases the density of nodes in the simulation region is enhanced, nodes appear closer to each other and path formation enhances. As a result ratio of actually forming enhances.

6. CONCLUSION

- In the study of the routing protocol the network and physical parameters of nodes play a significant role in performance.
- The PoR increases significantly with the increase in the nodes concentration. Although nodes speed does not induces a significant impact on PoR.
- Variation in nodes speed produces a huge impact on packet delivery ratio. The trend for PDR is dissimilar when nodes move at approximately similar speeds and when nodes move at different and randomly chosen speeds

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