Exploring MANET routing with ns2

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I. Introduction

Mobile ad hoc network or MANET refers to a network of devices that communicate with each other directly, without the need for a dedicated router as in the case of a traditional local area network. In a MANET, each node must act as a router, accepting and sending packets which may not be destined for it. To accomplish routing tasks, each node must have a mechanism for calculating and updating path information. In this report we review the findings of Roshan et al. (2019) [1] and use ns2 to examine two MANET routing protocols: Ad hoc On-Demand Distance Vector (AODV) and Destination-Sequence Distance Vector (DSDV).

In a typical MANET use case, nodes move freely in relation to each other. This type of use case must handle both frequent changes to network topology and node (router) disconnections, in a graceful manner. For these reasons, MANETs have particular challenges in regards to routing procedures and scalability. MANETS have extensive applications in military communications, such as networks of drones [2], where networks must allow devices to be highly mobile and created on-demand, without the need for additional network infrastructure. Other examples of MANETs include ad hoc Bluetooth networks [3] such as Apple's AirDrop.

II. Destination-Sequence Distance Vector (DSDV) routing

DSDV is a proactive routing protocol for MANETs where each node maintains a routing table containing the shortest paths to every other node. These tables are initialized when the network is established, and routes are updated periodically. Routes are selected based on the most recent sequence number (to ensure freshness) and the fewest number of hops. If a topology change occurs, new sequence numbers are generated, and outdated entries are removed. Nodes periodically broadcast updates to ensure consistent and loop-free routes across the network.

III. Ad hoc On-Demand Distance Vector (AODV) Routing

AODV is a reactive routing protocol for MANETs which discovers routes only when it is required. When a source node wants to send data to a destination node, it broadcasts a Route Request (RREQ) packet to its neighbors. The RREQ is propagated across the network until it reaches the destination node. Upon receiving the RREQ, the destination node responds by sending a Route Reply (RREP) back to the source node, establishing a route. If a route becomes invalid or broken, a Route Error (RERR) message is sent to inform the source. AODV updates routing tables dynamically, ensuring valid paths while reducing overhead by avoiding unnecessary updates [4].

IV. Routing Loop Problem

Routing loop problems are addressed differently in AODV and DSDV. In AODV, loops are avoided using sequence numbers and hop counts during route discovery and maintenance, ensuring only fresh routes are used. DSDV prevents loops proactively by assigning sequence numbers to each route, preferring routes with higher sequence numbers and fewer hops. This eliminates outdated or incorrect paths, making both protocols efficient and loop-free in dynamic MANET environments.

V. ns2 Simulations

In the paper of Roshan et al. (2019) [1], the authors examine a MANET consisting of six nodes. The authors do not state if or how the nodes are moving, they state only that the node type is mobile, using a wireless channel with two-ray ground propagation, and an omnidirectional antenna. They calculate several metrics for their simulation, including throughput and jitter. Essentially, jitter consists of cumulative variance in packets being delivered. One could imagine a scenario where packets are delivered with a constant periodicity of one packet per second; in reality, there will be some delay for each packet being delivered. These cumulative delays are called jitter or packet delay variation [5]. We calculate jitter as $J = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(d_i - \overline{D})^2}$ such that N is the total number of packets, d_i is the delay of the the i^{th} packet, and $\overline{D}$ is the average delay of all packets.

Our goal for the simulation was to recreate and expand upon the simulations conducted by Roshan et al. We considered two scenarios. The first being a deterministic simple swapping of two moving mobile nodes back and forth between two stationary mobile (network) nodes. The second, was the well-known random waypoint model [6]. In the simulation we maintained the two stationary mobile (network) nodes, however we populated the space in between them with 6 nodes that move randomly. To give a fair comparison, we seeded the node movements so that in both AODV and DSDV, the node movements are the same. We provide screenshots of the simulations as well as the specific topology details in table I and II.

Simple Swap Scenario	
Parameters	**Value**
Number of Nodes	4 (2 moving)
Topography dimension	600x400
Channel Type	Wireless
Propagation Model	Two-Ray Ground
Network Interface Type	Phy/WirelessPhy
MAC type	MAC 802.11
Interface Queue (IFQ) Type	Queue/DropTail/PriQueue
Link Layer	LL (default)
Antenna Type	Omnidirectional
Max packets in IFQ	50
Routing Protocol	(AODV / DSDV)
Connection Type	TCP
Application Type	FTP
Packet size	1500 bytes
Simulation time	200.0

TABLE I

SIMPLE SWAP PARAMETERS

Random Waypoint Scenario	
Parameters	**Value**
Number of Nodes	8 (6 moving)
Topography dimension	600x400
Channel Type	Wireless
Propagation Model	Two-Ray Ground
Network Interface Type	Phy/WirelessPhy
MAC type	MAC 802.11
Interface Queue (IFQ) Type	Queue/DropTail/PriQueue
Link Layer	LL (default)
Antenna Type	Omnidirectional
Max packets in IFQ	50
Routing Protocol	(AODV / DSDV)
Connection Type	TCP
Application Type	FTP
Packet size	1500 bytes
Simulation time	400.0

TABLE II

RANDOM WAYPOINT PARAMETERS

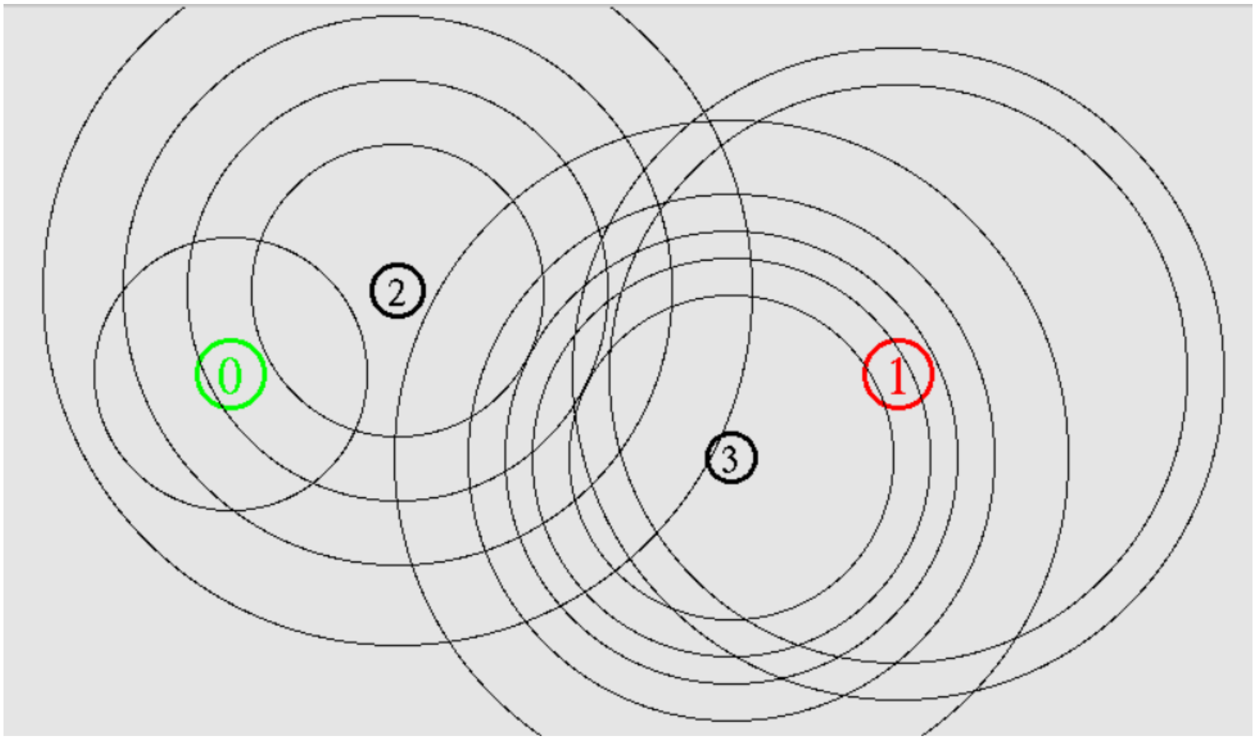

Fig. 1. Simple swap

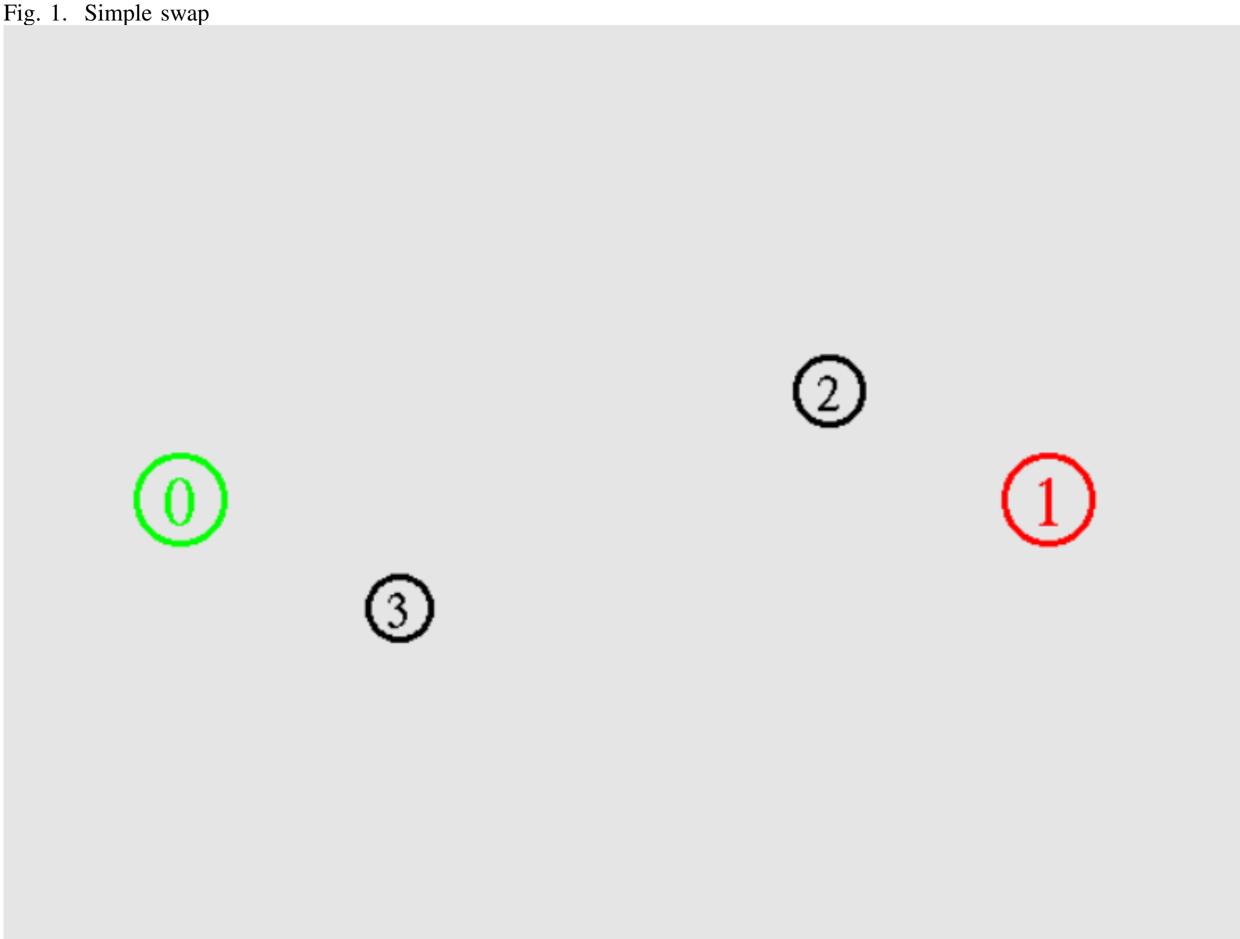

Fig. 2. Simple swap

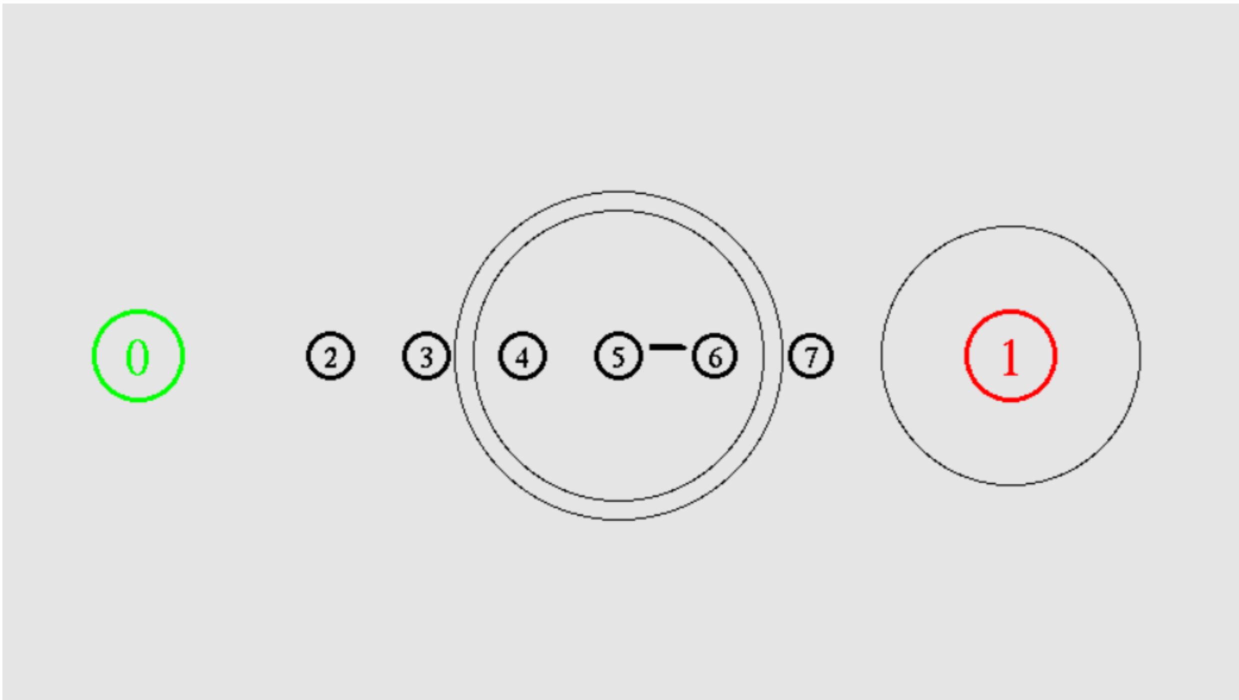

Fig. 3. Random waypoint

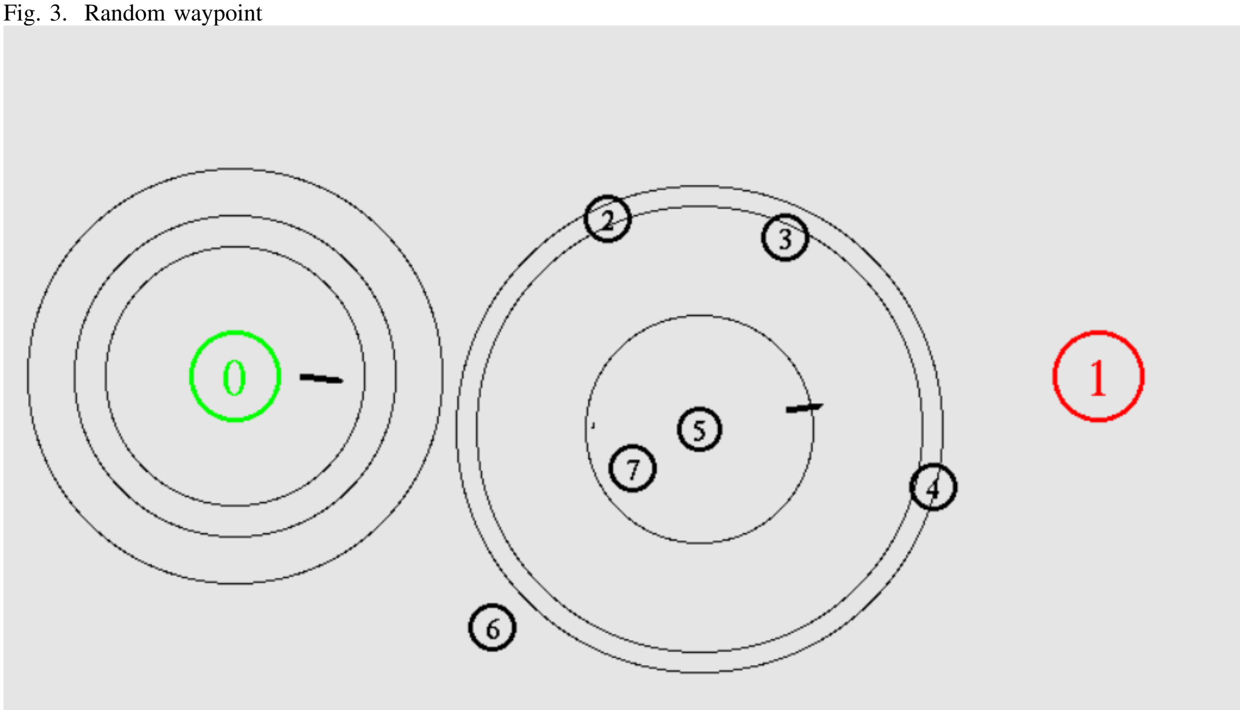

Fig. 4. Random waypoint

VI. Results and Future Considerations

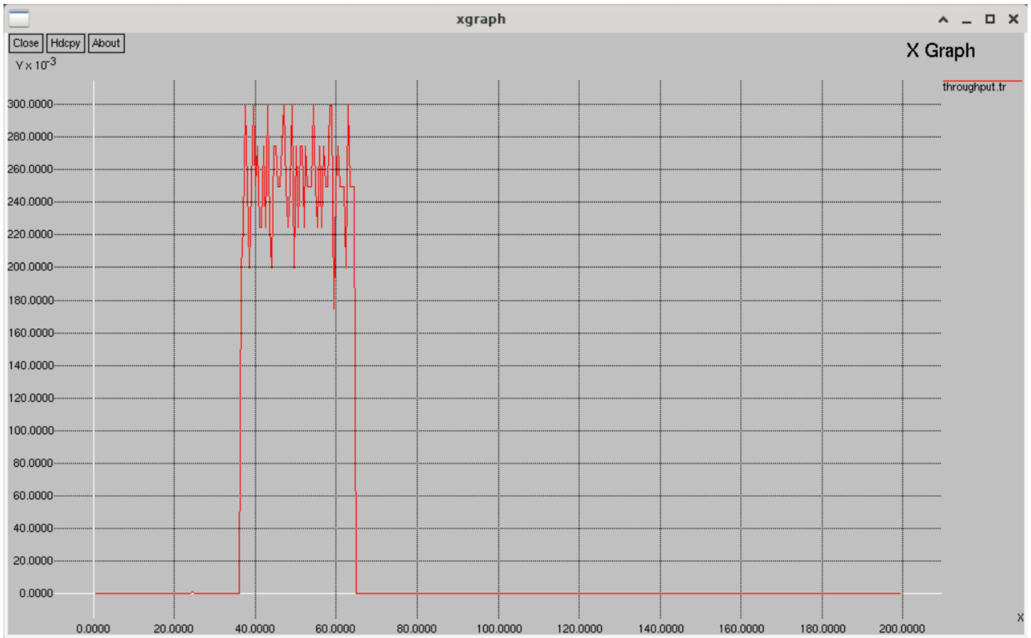

Fig. 5. Simple swap DSDV throughput

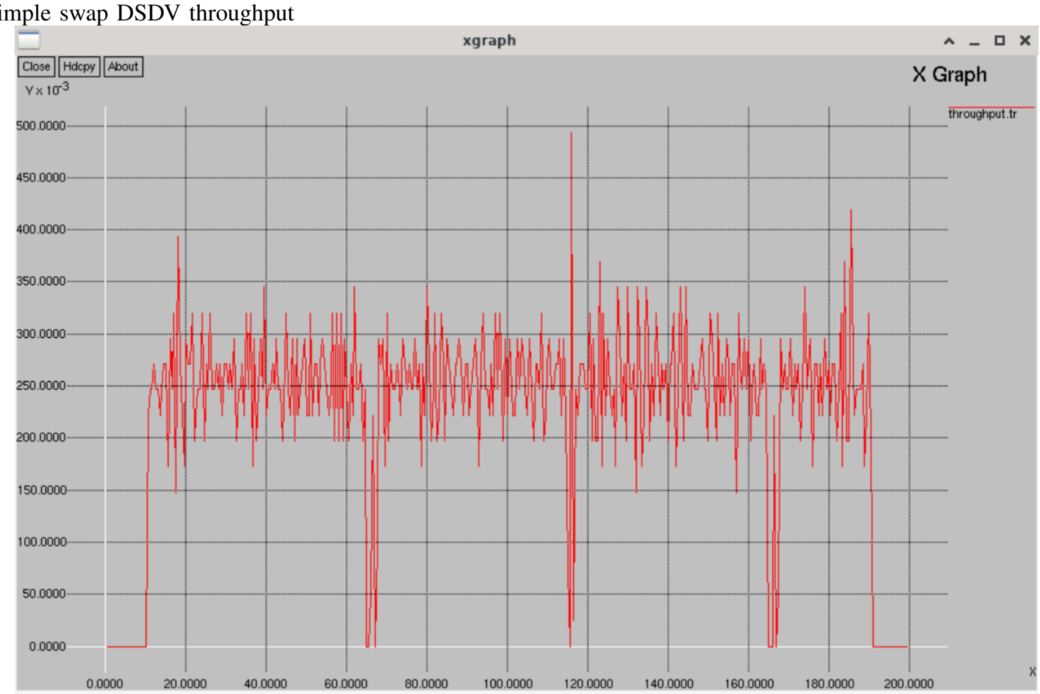

Fig. 6. Simple swap AODV throughput

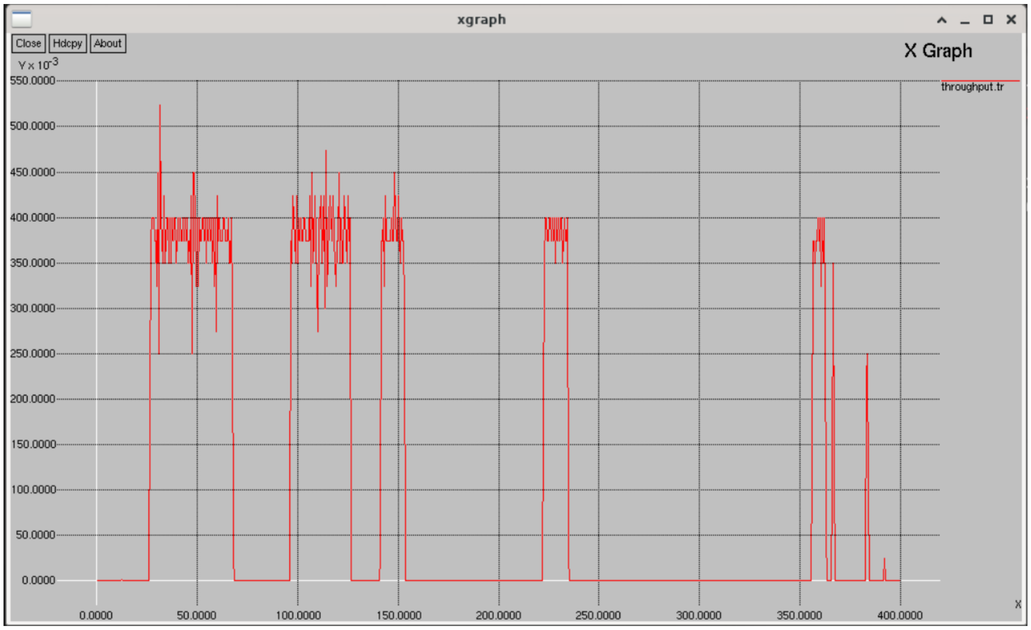

Fig. 7. Simple swap DSDV throughput

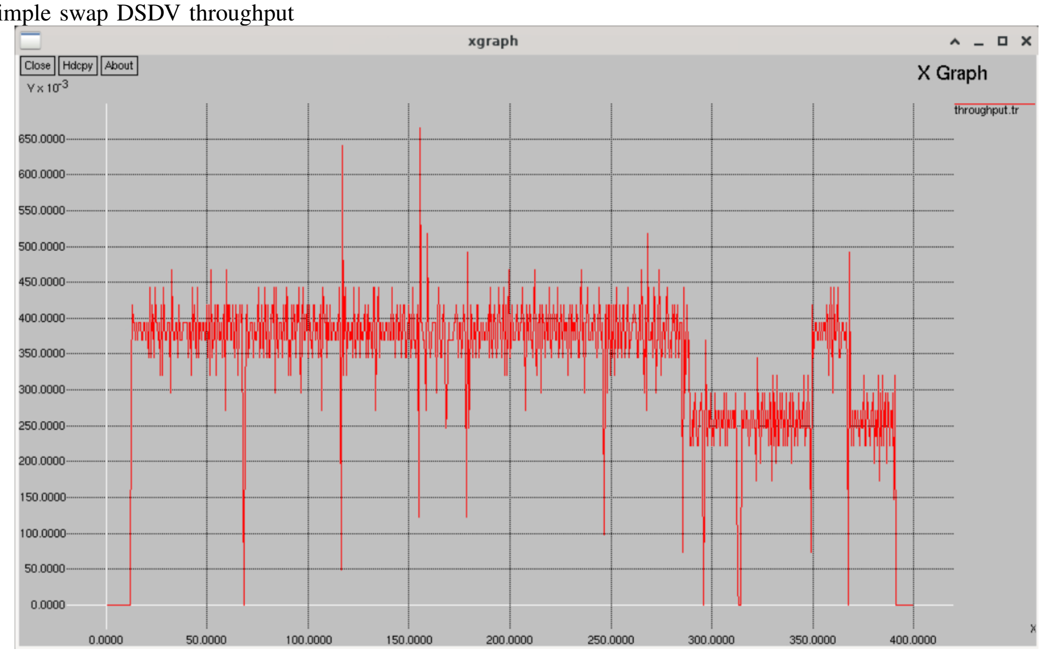

Fig. 8. Simple swap AODV throughput

Simulation Type	Jitter	Average Throughput
Simple Swap DSDV	11.74ms	0.04 Mbps
Simple Swap AODV	52.06ms	0.22 Mbps
Random Waypoint DSDV	94.05ms	0.10 Mbps
Random Waypoint AODV	109.04ms	0.33 Mbps

TABLE III

SIMULATION RESULTS

In our investigation, we ran four simulations collecting the network traffic data in order to observe their throughput. In addition, we determined the network jitter. These performances of the network in the two scenarios and different protocols are summarized in table III. Intuitively, we expected better throughput and lower levels of jitter. Throughout the varying scenarios and routing protocols, we observed low values of throughput and considerably high jitter. This could be due to the configurations of the network parameters in our simulation or an inaccurate collection and analysis of the network traffic. Since Roshan et al. did not mention whether their simulation included movement of the nodes, we took it upon ourselves to include this in our simulations. In the future, it would be of interest to analyze the network performance in relation to the amount of nodes in the network as well as their mobility. Finally, we could further explore other routing protocols and their performance.

VII. Related Work

While conducting our research, we learned about a hybrid approach proposed by Kiran and Kumar [7] combining AODV and DSDV. The result of this investigation shows a significant improvement in the packet delivery ratio when the number of nodes increased. Hybrid approaches are recommended to use, for applications for mobile commerce. AODV routing protocols perform better in mobile scenarios with high mobility, whereas DSDV performs better in more static scenarios with low mobility. They conclude an integration of a layer where both can be chosen depending on the conditions of the network leads to significant improvement.

VIII. Conclusion

In summary, we explored two prominent routing protocols - DSDV and AODV. We built upon the simulations of Roshan et al. and observed poor throughput and jitter in both a simple swapping scenario and and more complex random waypoint scenario. The two parameters indicate a poor performance of the networks in our simulations. To achieve more robust and meaningful observations, it would be crucial to refine our simulations. Moreover, it would be beneficial to research more parameters of the MANET, such as the number of nodes in the network, and node mobility. Finally, a simulation of a hybrid protocol would prove worthwhile.

REFERENCES

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