Project Review 1: Comparison of TCP Variants over Routing Protocols in MANET

Team Members

Under the guidance of Dr. P. Varalakshmi

BATCH 1

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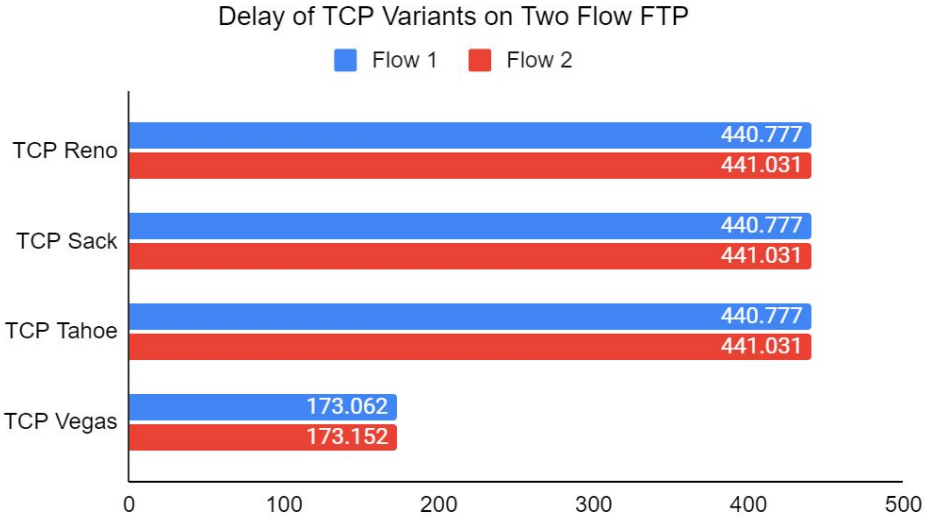
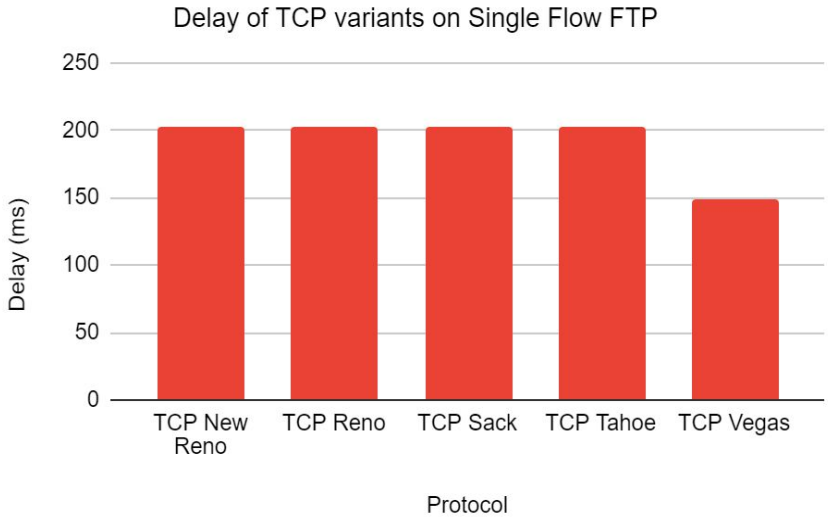
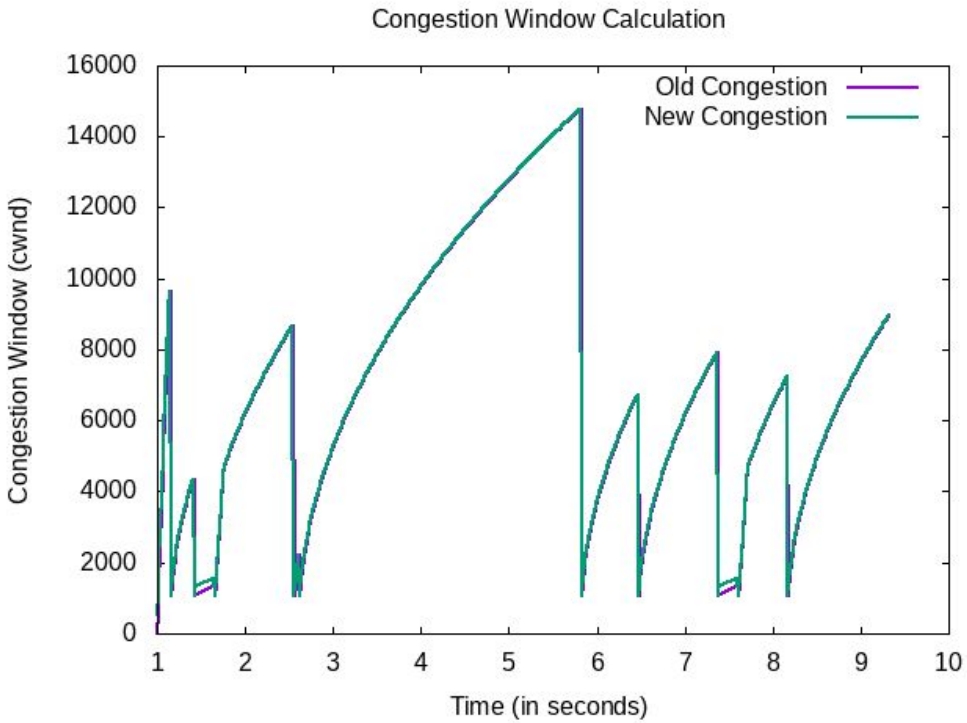
TCP SIMULATIONS

FTP traffic has been run on single and multiple flows and results are recorded. Average delay of all the variants is more or less alike and TCP Vegas shows 25% lesser average delay than other variants. In other words, TCP Vegas performs superior on two flows than other variants keeping average delay under discussion. It is evident that as loss rate increases, throughput decreases. Similarly congestion window size also decreased.







From this Congestion Window Graph generated using NS3 we understand the following

- The Congestion reaches a maximum of more that 14000 and drops.
- After the major drop the congestion goes through increase.
- This increase reaches maximum and drops back. This occurs multiple times.
- The network stabilises over time.
- Old and New congestion don't vary massively.

Conclusion on TCPs

We have calculated the performance of TCP variants; TCP Tahoe, TCP Reno, TCP New Reno and TCP Vegas. After analyzing the performance from simulated data, we have found that TCP Vegas is better than other TCP variants for sending data and information. In essence, TCP Vegas dynamically increases or decreases transmission of data according to the window size of sending packets of observed RTTs, whereas TCP Tahoe and Reno continue to increase their window size until packet loss is detected. Simulation, implementation and experimentation conclude that TCP Vegas can provide higher throughput than any other TCP variants. The accuracy of our analysis is validated by comparing the simulation results. We conclude stating that the performance of TCP Vegas is much better than any other TCP variants where congestion is occurred in two point junction. Comparison of TCP variants with respect to other remaining network parameters would be an important future attempt. Such type of analysis is very helpful for selecting the appropriate TCP in ad hoc networks.

The drawback of simulation is that inherently runs the risk of oversimplification. It is not possible to exactly replicate the entire world inside a computer model, so when creating a simulation some factors must be statistically or otherwise approximated

MANET ROUTING PROTOCOL SIMULATIONS

INTRODUCTION TO MANET SIMULATION

An ad hoc network is a group of wireless mobile computers (or nodes) in which nodes cooperate by forwarding packets for each other to allow a node to communicate beyond its direct wireless transmission range. a multi-hop scenario occurs, where several intermediate hosts relay the packets sent by the source host before they reach the destination host. The network topology may change with time as the nodes move or adjust their transmission and reception parameters. Routing protocols for ad hoc networks must deal with limitations such as high error rates, scalability, security, quality of service, energy efficiency, multicast, aggregation and node cooperation etc. Routing Protocols for wireless adhoc networks - **Table Driven (Proactive) and On-demand (Reactive)** **Proactive**: Destination Sequenced Distance Vector (DSDV) , OLSR (Optimized Link State Routing) **Reactive:** Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR)

Performance comparison of AODV, DSDV, OLSR and DSR routing protocols in a constrained situation is done and results are tabulated, graphs are drawn and conclusion have been drawn from them
Performance and Simulation setup:
Simulator: NS2 and NS3
No of nodes used in network creation: 17 (NS2 suffers if nodes>100)
Antenna height: 1.5
Propagation Model: Two ray ground
Packet size and Traffic sources identified.
Routing Protocols: AODV, DSDV, OLSR, DSR.

NAM VISUALIZATION

After setting up the network using NSG2.1 , TCL scripts are generated, using which the network animator shows how the network behaves during different intervals.

Visualization of the same has been done with NAM, for AODV, DSR and DSDV routing protocols, whose results are pasted in the slides to follow. The residual energy and instant throughput of the routing protocols are compared after writing the AWK scripts for the same, and the graphs are also plotted. For plotting the graph, gnuplot is used, which is very effective for visualizing the tabulated data in a graphical plot.

SIMULATION PARAMETERS

Throughout the simulation, every node starts its journey from random spot to a random chosen destination. Once the destination is reached, the node takes a rest of your time in second and another random destination is chosen subsequently pause time. This repeats throughout inflicting continuous changes within the topology of the underlying network, totally different network state of affairs for varieties of nodes and pause times square measure generated

Packet Delivery Ratio (PDR): The packet delivery ratio is the ratio of packets successfully received to the total sent.

Average End-to-End Delay : Average amount of time taken by the packets to reach to the destination in seconds.

Throughput: Total Range of packets received by the destination. It is a live of effectiveness of a routing protocol

Energy Consumption: Energy consumption of a node is mainly due to the transmission and the reception of data or controlling packets.

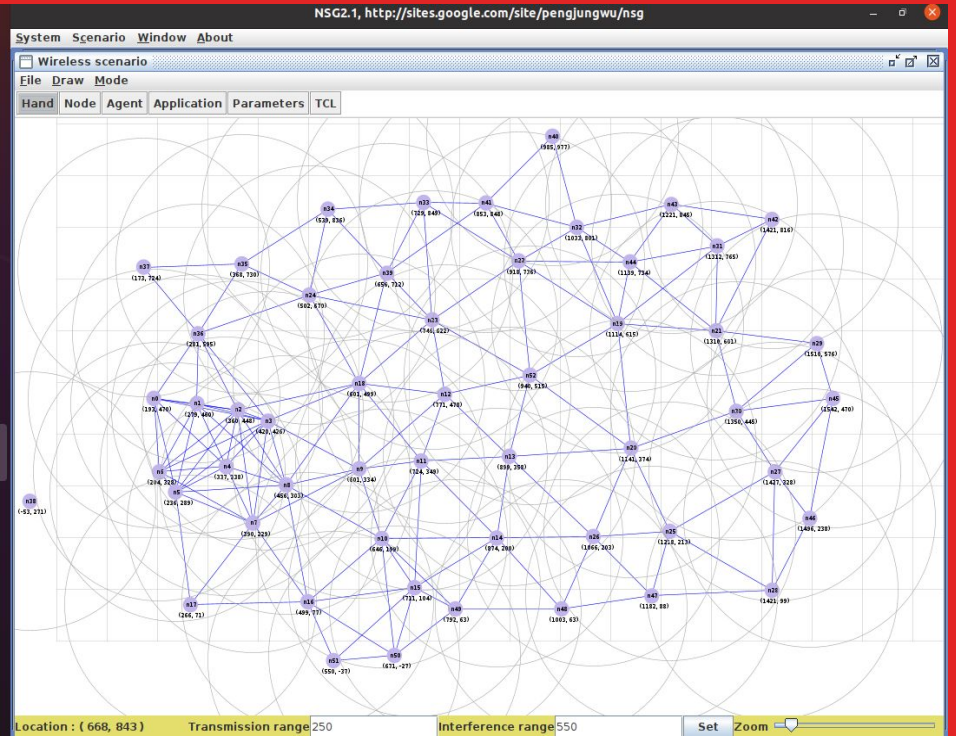
USING NAM AND TCL SCRIPTS:

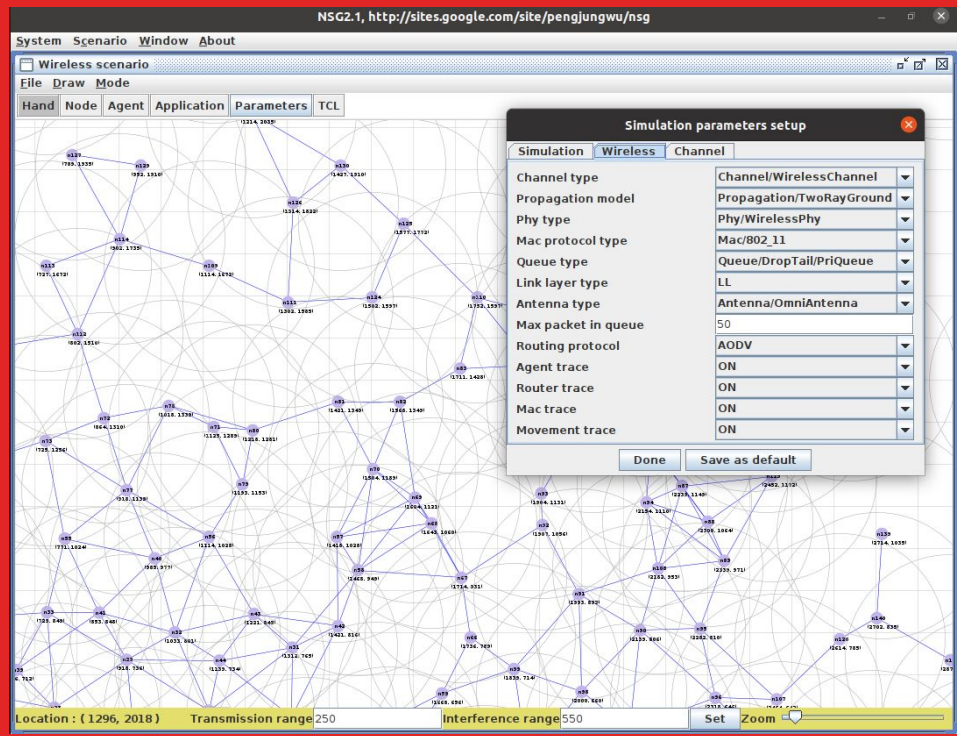
Nam (Network Animator) is an animation tool to graphically represent the network and packet traces. To be able to run a simulation scenario, a network topology must first be created. In ns2, the topology consists of a collection of nodes and links. The simulator object has member functions which enables to create the nodes and define the links between them. The class simulator contains all the basic functions. Since ns was defined to handle the Simulator object, the command $ns is used for using the functions belonging to the simulator class.

Traffic agents (TCP, UDP etc.) and traffic sources (FTP, CBR etc.) must be set up if the node is not a router. It enables to create CBR traffic source using UDP as transport protocol or an FTP traffic source using TCP as a transport protocol. These are done using the NSG2.1 (Network Scenario Generator) Jar file.

Once the Network has been generated using NSG2.1, we can view the TCL script in the GUI available over there. Queue/DropTail/PriQueue is not supported by DSR, we have to go for CMUPriQueue. DSR does not obey the queue model as specified for AODV. DSR supports this queue called CMUPriQueue, it should reflect in the tcl code.

As seen in the GUI, Create a network with varying number of mobile nodes and the nodes are moving with a interference of certain meters and transmission range is defined, and other parameters are defined in the interface itself. Initially (25 nodes), OLSR outperforms AODV because it is proactive in nature and creates routes in advance, whereas AODV wastes some time in creating routes. The overhead of OLSR is small for smaller topologies, however, for larger topologies the significantly large routing overhead of OLSR degrades performance, creating interference in the network and causing loss of packets. These are detailed in the graphs in the below slides.

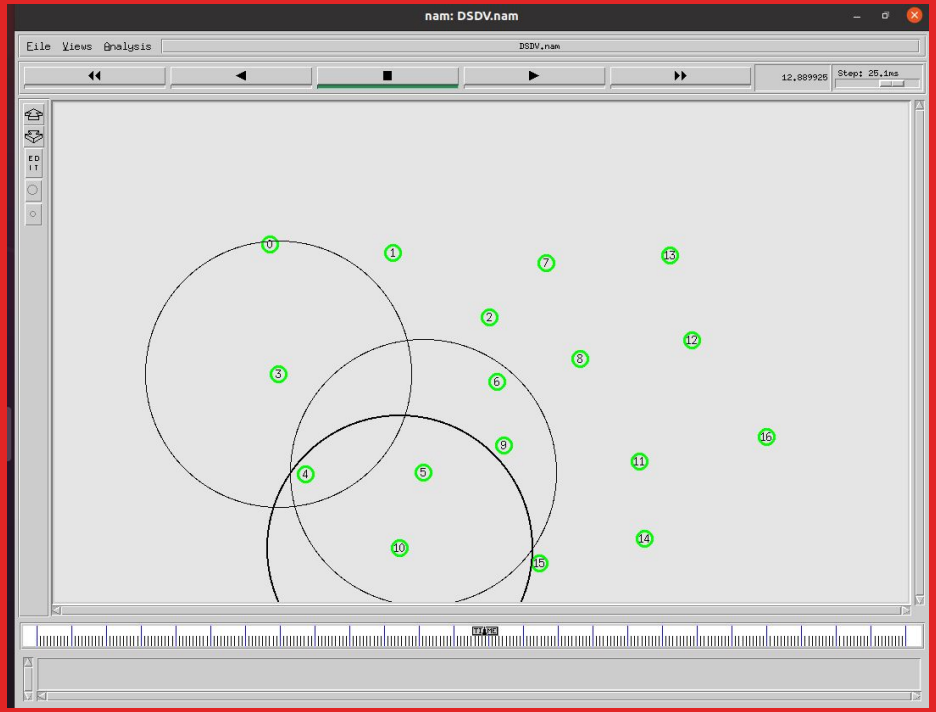




A Snapshot of the Simulation of AODV in NAM for 17 Mobile Nodes (Small number, to analyze the performance of AODV)

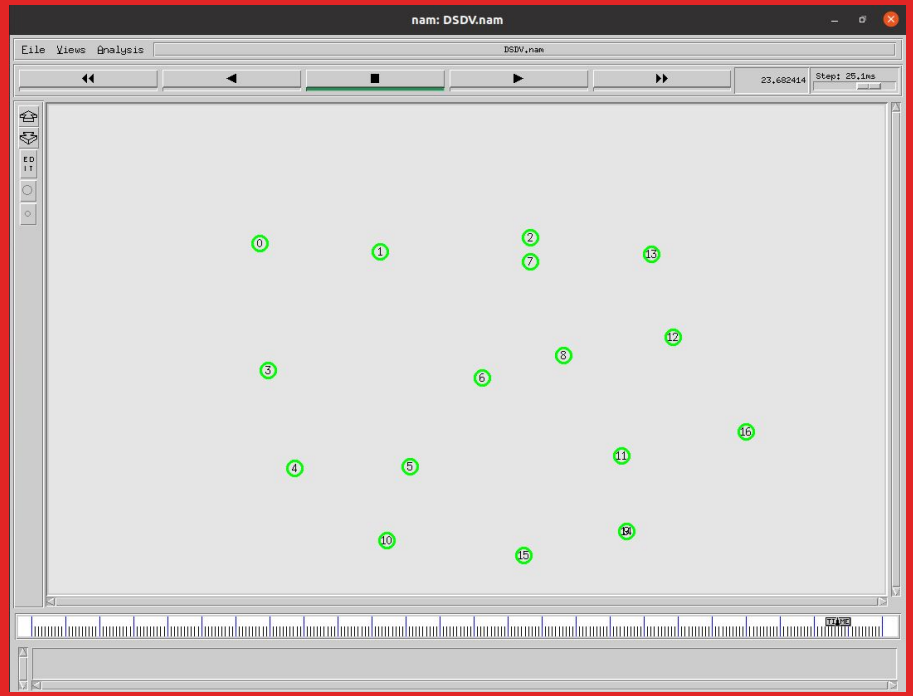
The popular Two-Ray Ground radio propagation model is used to model the wireless communication. An Omni directional antenna transmits and receives signals equally, in all directions. That is, an Omnidirectional antenna transmits signals in a 360^{o} angle. The source, destination and next hop nodes are addressed by using IP addressing, and each nodes in the network maintains a routing table that consists the information about neighboring nodes. AODV supports multicasting as well as unicasting within a uniform framework. Each route has a lifetime after which the route expires if it is not used.

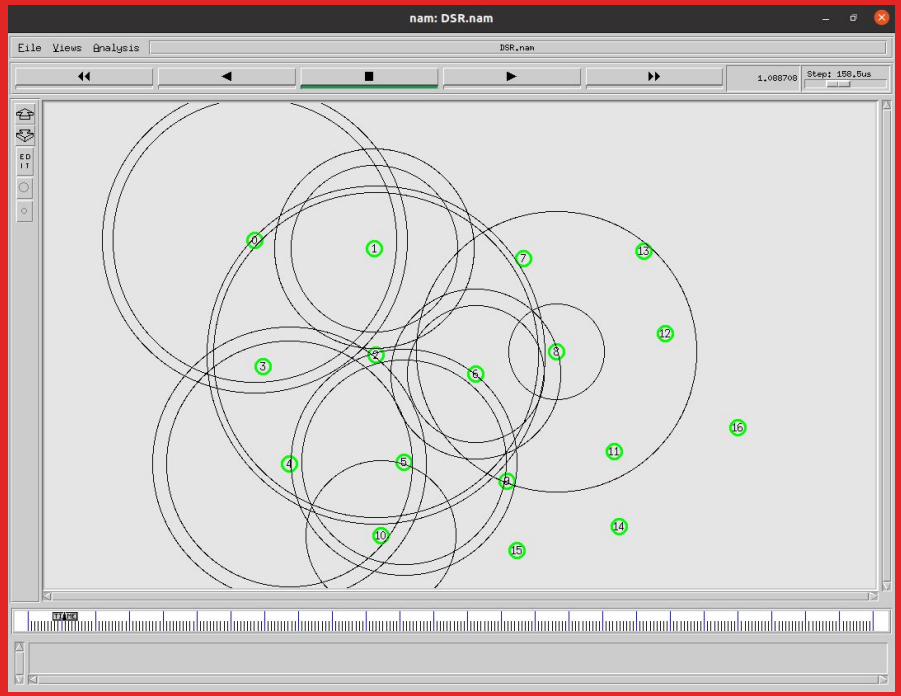
A Snapshot of the Simulation of DSDV in NAM for 17 Mobile Nodes (Small number, to analyze the performance of DSDV)



Mobility models are used describe the movement pattern of mobile nodes in an ad hoc network. As the location, velocity and acceleration change over time with the change in movement of the nodes. Since mobility patterns play a vital role in determining the protocol performance, it is important for mobility models to simulate the movement pattern of targeted network in a reasonable way. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent.

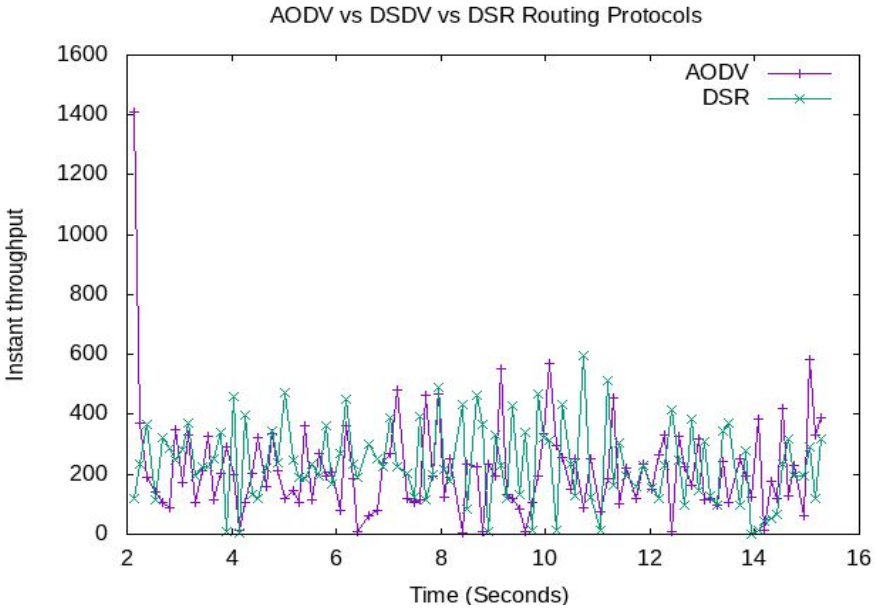
A Snapshot of the Simulation of DSRin NAM for 17 Mobile Nodes . Consider a source node that does not have a route to the destination. When it has data packets to be sent to that destination, it initiates a RouteRequest packet. This RouteRequest is flooded throughout the network. Each node, upon receiving a RouteRequest packet, rebroadcasts the packet to its neighbors if it has not forwarded it already, provided that the node is not the destination node and that the packet's time to live (TTL) counter has not been exceeded.

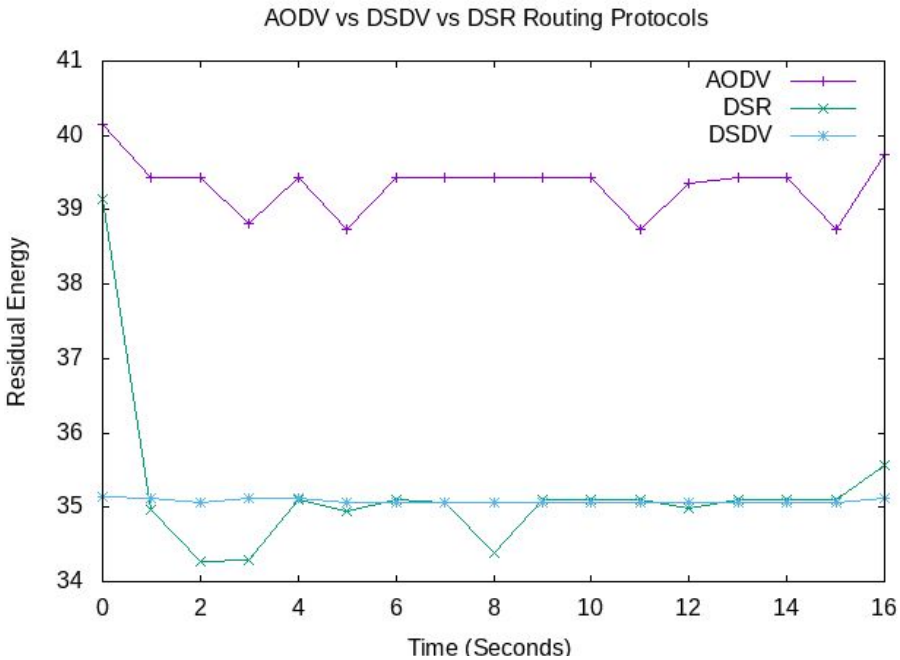




MANET ROUTING PROTOCOL COMPARISON

Residual Energy=Total Energy-energy consumed and Total energy consumed(ith node)=energy consumed(ith node). In case of DSDV, even though network is idle it requires a continuous update of its routing table which consumes battery power and little amount of bandwidth. Energy consumption is less in AODV than DSDV protocol, as observed since Residual energy for AODV is the highest. The performance of AODV is better than DSR in terms of throughput, which is the rate of successfully transmitted data per second in the network during the simulation. For Corresponding Data Click here.

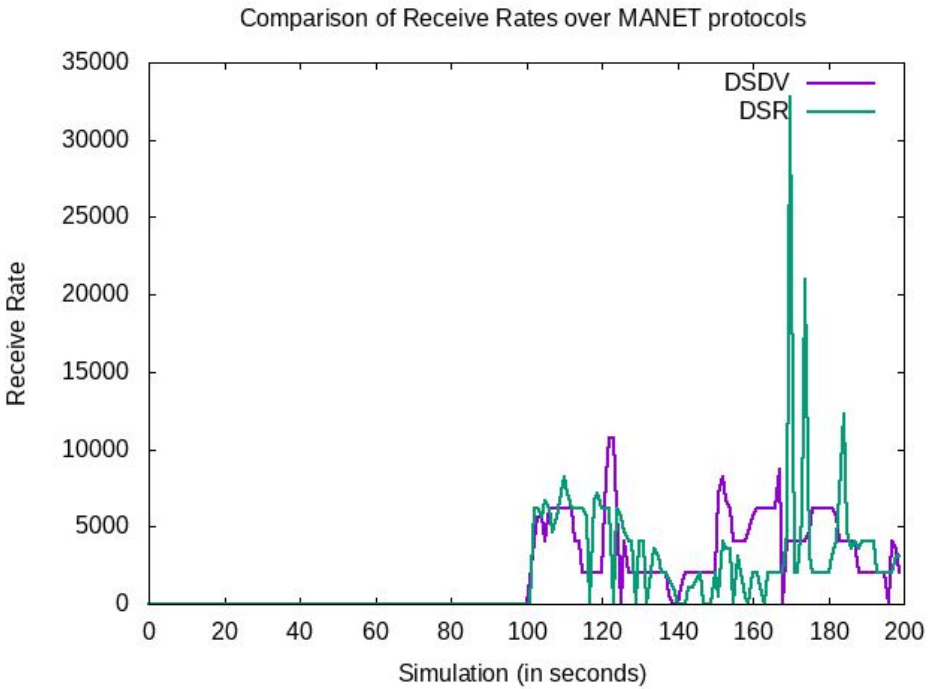




DSDV VS DSR

Packet receiving statistic were performed for several propagation delays in case of DSDV AND DSR protocols, whose nature of packet variation becomes as in shown graph.

DSR perform better when the propagation delay of nodes increases because nodes become more stationary will lead to more stable path from source to destination. DSR is superior to DSDV especially when the node's propagation delay begins to rise.



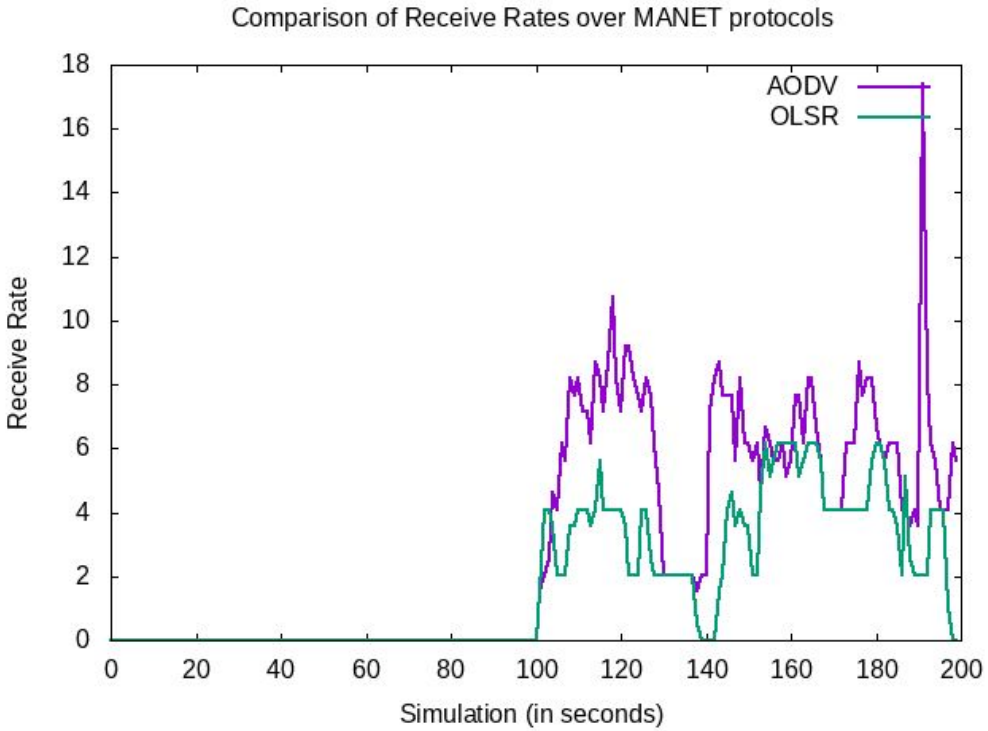
For Corresponding Data Click here.

AODV VS OLSR

The packet receive rate of AODV is greater than OLSR. But as observed, at high mobility both behave the same.

Protocol which has high receive rate is considered to be a better protocol as it denotes the number of packets received by a destination.

As OLSR must maintain up-to-date information at anytime, it decreases the network performance as more network overhead is needed.



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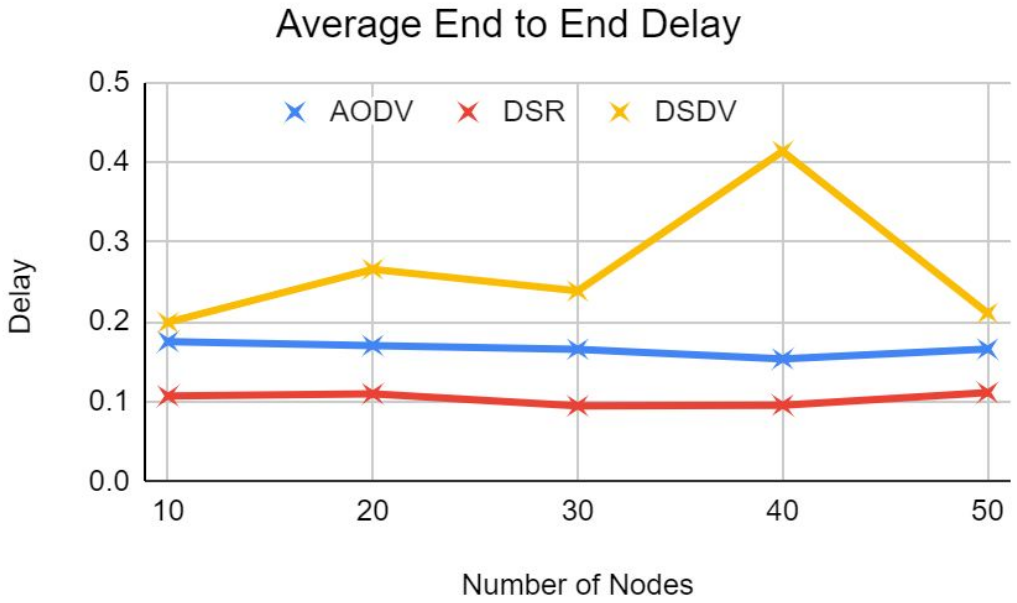

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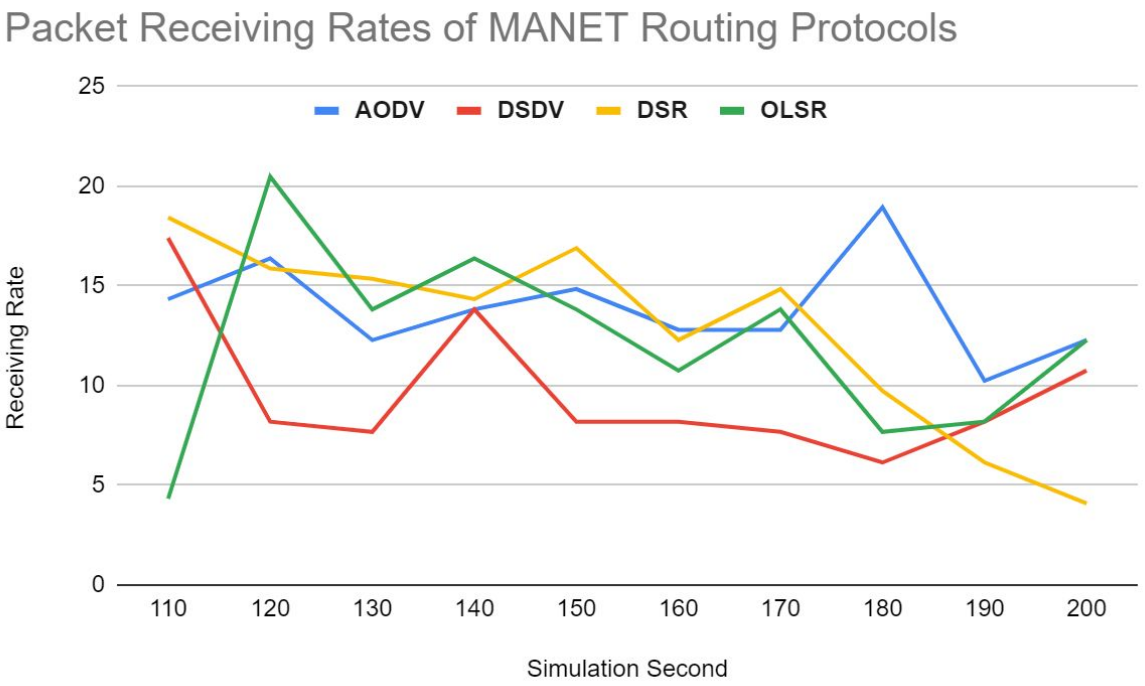
As we see the graph given here , we can infer that DSDV has high average end to end delay followed by AODV and then DSR which has the least. The performance of DSDV is degrading due to increase in the number of nodes the load of exchange of routing tables becomes high and the frequency of exchange also increases due to the mobility of nodes.

Analysing Packet Loss Ratio, Packet Delivery Ratio, Average Throughput, End to End delay, Total Jitter Delay of different MANET Routing Protocols in NS3 and obtained the results, tabulated here.

```
sudharsan@sudharsan-VirtualBox:~/Downloads/ns-allinone-3.31/ns-3.31$ ./waf --run scratch/manet-routing-compare
Waf: Entering directory `/home/sudharsan/Downloads/ns-allinone-3.31/ns-3.31/build'
[2674/2727] Compiling scratch/manet-routing-compare.cc
[2676/2727] Linking build/scratch/scratch-simulator
[2678/2727] Linking build/scratch/seventh
[2680/2727] Linking build/scratch/subdir/subdir
[2688/2727] Linking build/scratch/manet-routing-compare
Waf: Leaving directory `/home/sudharsan/Downloads/ns-allinone-3.31/ns-3.31/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (10.632s)
100.326 3 received one packet from 10.1.1.14
100.565 3 received one packet from 10.1.1.14
100.612 2 received one packet from 10.1.1.13
100.613 2 received one packet from 10.1.1.13
100.815 3 received one packet from 10.1.1.14
100.823 2 received one packet from 10.1.1.13
101.065 3 received one packet from 10.1.1.14
101.073 2 received one packet from 10.1.1.13
101.123 8 received one packet from 10.1.1.19
101.248 9 received one packet from 10.1.1.20
101.315 3 received one packet from 10.1.1.14
101.323 2 received one packet from 10.1.1.13
101.37 8 received one packet from 10.1.1.19
101.498 9 received one packet from 10.1.1.20
101.565 3 received one packet from 10.1.1.14
101.573 2 received one packet from 10.1.1.13
101.62 8 received one packet from 10.1.1.19
101.748 9 received one packet from 10.1.1.20
101.815 3 received one packet from 10.1.1.14
101.823 2 received one packet from 10.1.1.13
101.87 8 received one packet from 10.1.1.19
101.998 9 received one packet from 10.1.1.20
102.065 3 received one packet from 10.1.1.14
102.073 2 received one packet from 10.1.1.13
102.12 8 received one packet from 10.1.1.19
102.248 9 received one packet from 10.1.1.20
102.315 3 received one packet from 10.1.1.14
102.323 2 received one packet from 10.1.1.13
102.37 8 received one packet from 10.1.1.19
102.498 9 received one packet from 10.1.1.20
102.565 3 received one packet from 10.1.1.14
Throughput =52.5756Kbps
----Flow ID:60
Src Addr10.1.1.8Dst Addr 10.1.1.10
Sent Packets=1
Received Packets =1
Lost Packets =0
Packet delivery ratio =100%
Packet loss ratio =0%
Delay =+4000277.0ns
Jitter =+0.0ns
Throughput =93.7435Kbps
----Flow ID:61
Src Addr10.1.1.10Dst Addr 10.1.1.8
Sent Packets=1
Received Packets =1
Lost Packets =0
Packet delivery ratio =100%
Packet loss ratio =0%
Delay =+10939615.0ns
Jitter =+0.0ns
Throughput =21.4244Kbps
----Flow ID:62
Src Addr10.1.1.5Dst Addr 10.1.1.1
Sent Packets=1
Received Packets =1
Lost Packets =0
Packet delivery ratio =100%
Packet loss ratio =0%
Delay =+10006434.0ns
Jitter =+0.0ns
Throughput =23.4224Kbps
--------Total Results of the simulation----------

Total sent packets  =944
Total Received Packets =424
Total Lost Packets =520
Packet Loss ratio =55%
Packet delivery ratio =44%
Average Throughput =22.4946Kbps
End to End Delay =+7165819590.0ns
End to End Jitter delay =+3424798306.0ns
Total Flod id 62
sudharsan@sudharsan-VirtualBox:~/Downloads/ns-allinone-3.31/ns-3.31$
```



We calculated the packet receiving rate of MANET network based protocols such as AODV, DSDV, DSR and OLSR. . We simulated these protocols in NS-3 and evaluated the performance characteristics like number of packets per sec, transmission power and receiving rate. Graphs are also plotted for the same and the results show that the OLSR protocol has the maximum packet receiving rate compared to other routing protocols.

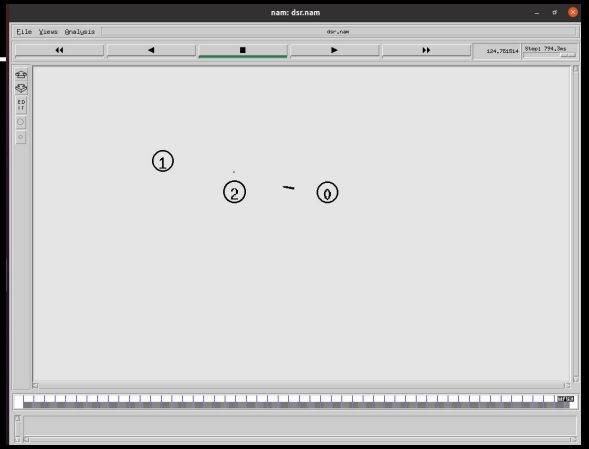
Corresponding data here

Conclusion on MANETs

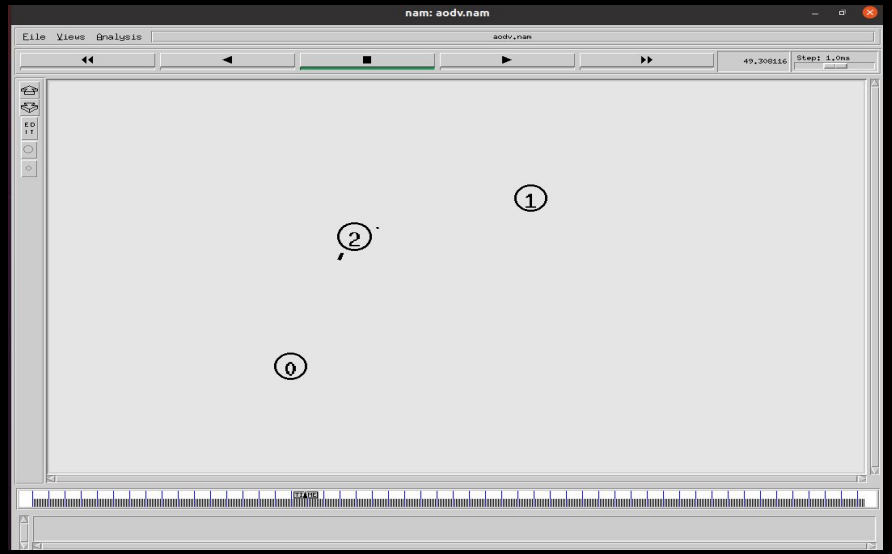
The significant observation is, simulation results agree with expected results based on theoretical analysis. We took the same set of mobility scenarios for each variation of node speed and variation of the number of nodes while changing the routing protocol.. We find that the performance varies widely across different number of nodes and different types of speed in node mobility. AODV performance is better, considering its ability to maintain connection by periodic exchange of information, which is required for TCP, based traffic. DSR as observed in the NAM, performs well in all mobility rates, and we observed that DSR requires the transmission of many routing overhead packets. DSDV performs quite predictably, delivering nearly all knowledge packets once node quality rate and movement speed area unit low, and failing to converge as node quality will increase. Average End-to-End Delay is the least for DSDV and does not change if the no of nodes are increased. OLSR and DSDV are best suited for networks with high density and low latency, as the average end-to-end delay was significantly lower than other protocols and the throughput did not decrease with increase in number of nodes.

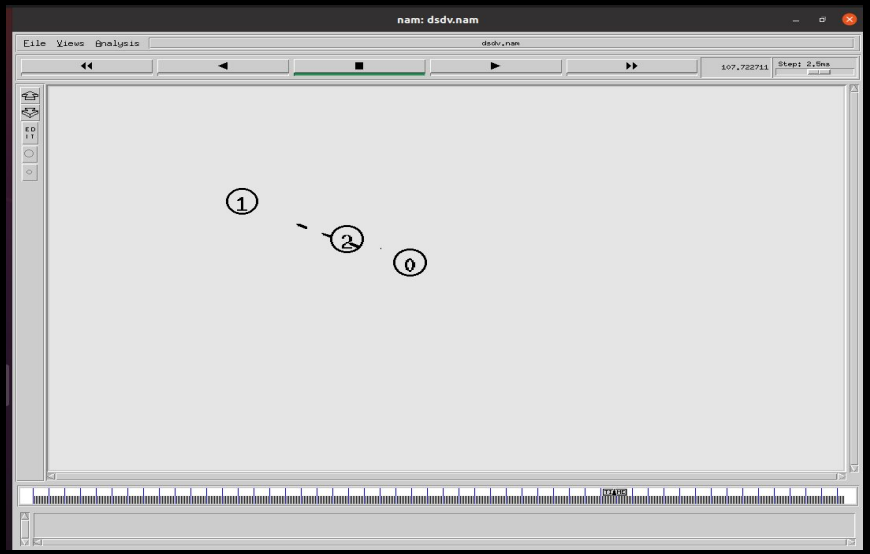
TCP VARIANTS OVER ROUTING PROTOCOLS

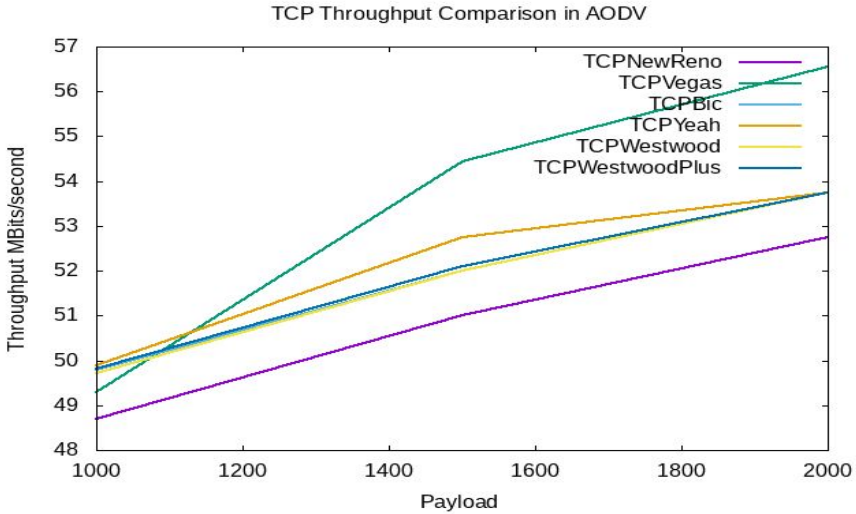
Despite the fact that considerable simulation work has been done, still more investigation is needed in the fairness of the TCP traffic and mobility models. Difficulty exists to analyze fairness of TCP flows using TCP variants over routing protocols based only on mathematical and theoretical calculations.
There are a lot of different parameters that need to be considered. Implementation of wireless network topology using simulators helps to overcome these difficulties. That is why, we simulated the MANET routing protocols prior to moving on to this one.The interaction of MANET with the TCP protocol structure may lead to impulsive phenomena like severe unfairness problem between simultaneous TCP flows.



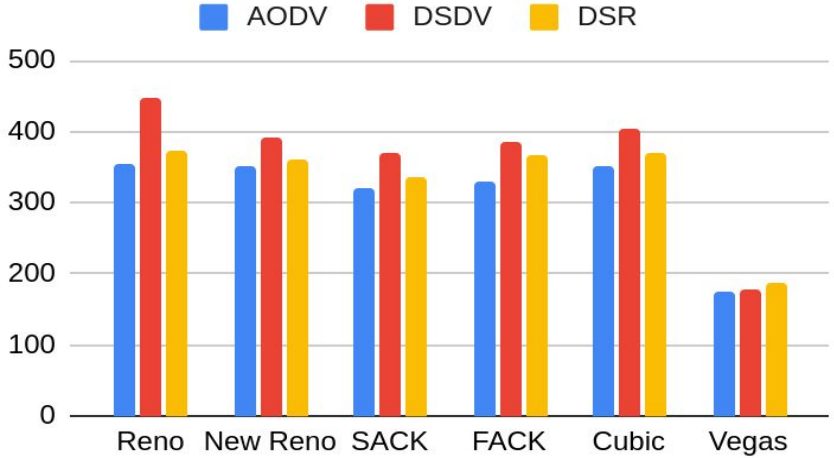
TCP Variants are simulated over AODV, DSDV and DSR routing protocols and the topology and the results are to be seen here. The tabulation results for the same can be found The performance of TCP is largely dependent on the underlying routing protocols. From the scenario generated, it is seen that , since TCP variants do not have mechanism to know the route re-establishment period; the throughput can degrade because of the large delay to transmit packets.

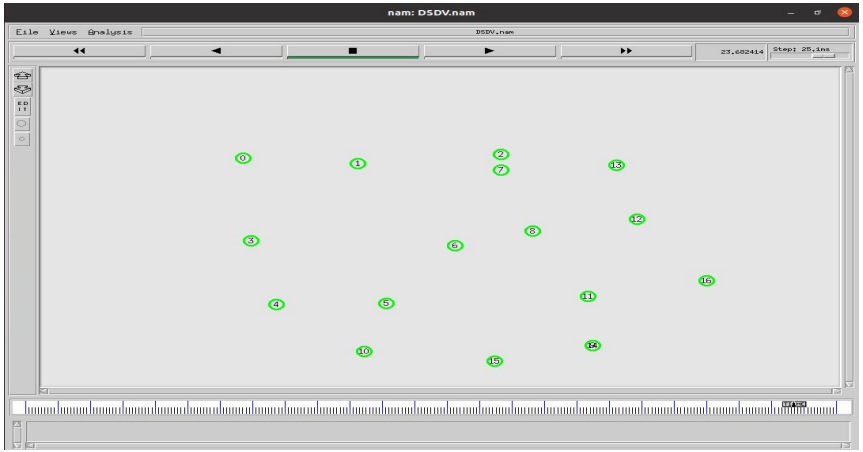






Here AODV, DSR and DSR are simulated with different TCP algorithms for analyzing the throughput . In the adjacent topology, for constant movement of nodes throughout the simulation we set the pause time to 0. ll mobile nodes in the network are configured to run AODV,
AOMDV, DSDV and DSR protocols and multiple FTP sessions using six TCP variants namely TCP Vegas, TCP Reno, TCP New Reno, TCP SACK, TCP FACK and TCP Cubic. The fairness of TCP Variants in wireless mobile network is evaluated in our simulation experiment and graphs are shown as below.





CONCLUSION

The fairness of TCP Variants in wireless mobile network is evaluated in our simulation experiment, using six TCP variants on four routing protocol of which each node share FTP connections randomly. Sender and receiver are chosen randomly by calculating shortest possible path.By measuring throughput fairness and packet drop behavior of TCP flows we can understand how TCP Variants reacts to the mobile ad hoc network conditions which will help us to understand how reactive and proactive routing protocol has facilitated TCP Variants operation. As throughput is a positive value, the throughput fairness of a set of TCP flows will always lie between 0 and 1. TCP Vegas received the most unfair throughput over four routing protocol. In our simulation, eight senders try to send packet at a time, as a consequence collisions occur so frequently which indicate congestion in mobile ad hoc network. As Reno flows are more aggressive, as a result, can achieve higher throughput comparing with other TCP Variant. As shown in the data,

From our analysis, we have found that TCP Vegas achieves unfair throughput comparing with other TCP variants over four of the routing protocol named AODV, DSDV, and DSR. It also showed an inconsistent performance for all four routing protocols as an average. From TCP variants, TCP Reno outperforms other TCP variants under DSDV routing protocol.. As DSR responds quickly to link failure which circumvents TCP's deployment acknowledge at low pause time. The generic investigation from the simulation is that for throughput fairness of TCP flows and packet drop behavior existing DSDV, outperforms AODV, and DSR in more "stressful" topology like for an increased number of nodes and high mobility pattern. After DSDV, it is DSR that performs well with TCP variants.

Goals for next meeting

1. Document simulation and finish conclusion
2. Do more research to come up with a novel idea

Check out all experimental data (csv) ***here***

Thank you