UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona

MANET SIMULATION

Giacomo Calabria, Sofie Olsen
Quality of Service in Networks (QSN)
Universitat Politècnica de Catalunya (UPC)
14.06.2024

***Abstract* - Using the NS2 simulator, we explore the performance of the MANET network, providing an analysis with different configurations, varying the number of nodes and sources. Other metrics we are assessing include packet loss, delay, throughput, jitter delay and the number of received packets. Results show that with higher density of nodes we obtain better overall performance. Increasing the number of sources impacts packet losses, as more network congestion can occur. We have found a linear relationship between the MOD and the packet loss.**

***Keywords*- Mobile ad hoc network, adaptive multipath routing, video-streaming services.**

I. INTRODUCTION

A **Mobile Adhoc NETwork (MANET)** is a type of wireless network in which there is a collection of data terminals equipped with wireless transceivers that can communicate with each other without relying on any fixed networking infrastructure, hence MANETs are self-organized networks.

These networks suffer from link breakages, as the topology of the network changes frequently due to the movement of the nodes, which also have a limited transmission range. So, MANETs protocol should adapt dynamically to maintain communications. Moreover, Quality of Service (QoS) provision for multimedia services is a challenge in this type of network, as no fixed network configuration parameters can be used.

A. The MANETs simulator

We are carrying out a series of network simulations using the NS2 tool to evaluate the performance of a QoS-aware routing protocol specifically designed for video streaming services over MANETs. The simulator emulates a game-theoretic multipath and using a multipath multimedia routing protocol (MMDSR) it dynamically selects the best path to forward the video frames. The selection is done according to the QoS parameters received by feedback.

B. The MMDSR protocol

The MMDSR is a multipath routing protocol with which sources send the (I,P,B) video frames from a video flow so that: I frames are sent through the best path; P frames through the medium quality path and B frames through the worst path.

The classification of the paths is done periodically according to the QoS feedback received in the sources from destination. In Fig. 1 we can see how the MMSDR routing protocol works.

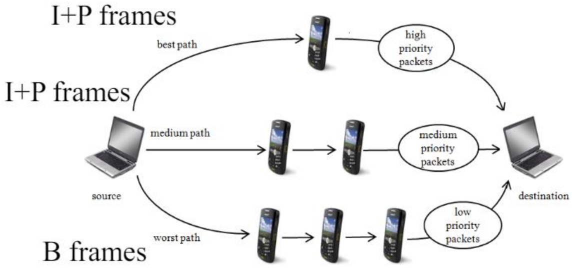


Fig.1 MMDSR routing protocol for video-streaming over MANET. From [1]

In section II we provide how we have set the simulations of our framework. Simulation results are shown and analyzed in section III. Finally, conclusions are given in section IV.

II. SIMULATION SETUP

The simulation is performed using the scripts provided in the course. The parameters that we will modify throughout the simulations are:

- The **probability *p* of sending I+P frames through the best path.** We have examined for each scenario $p = \{0.5, 0.75, 1\}$.
- The network topology by changing the number of nodes *N* and the number of sources *S*.

It's important to note that the simulator doesn't work as pure MMDSR due to the fact that there is a certain **probability 1-*p* that the sender sends I+P frames though the medium quality path.**

Three type of simulations we have performed:

1. 50 nodes and 2 sources.
2. 100 nodes and 2 sources.
3. 50 nodes and 2,3,4 sources

Each scenario/simulation is repeated three times in order to obtain good mean statistical values. In the third scenario we also notice the packet loss in order to explore the connection with the MOS (Mean Opinion Score). In Table 1 we provide the parameters of the general simulator to evaluate the performance of the MMDSR protocol over MANETs. For the mobility scenario we have used the BonnMotion tool with RandomWaypoint generator in order to generate the mobility patterns.

Area	520x520m
Number of nodes	50
Average node speed	2 m/s
Transmission range	120m
Mobility Pattern	Random Waypoint
MAC specification	IEEE 802.11e, EDCF
Nominal bandwidth	11 Mbps
Simulation time	200s
Video codification	MPEG-2 VBR
Video bit rate	150 Kbps
Video sources	2 to 5
Video	Blade Runner
Routing protocol	Game Theoretic algorithm + MMDSR
Transport protocol	RTP/RTCP/UDP
Maximum packet size	1500 Bytes
Multipath scheme	*K*=3 paths
Weighting values (equation (3))	1/7
Queue sizes	50 packets
Interfering CBR traffic	300 Kbps
Channel noise	-92 dBm
Mobility generator	Bonnmotion

Table 1: simulation settings. We have highlighted the settings we changed in the various simulations.

III. RESULTS

Concerning the first two simulation we have managed the following values, contained in the .rpt files:

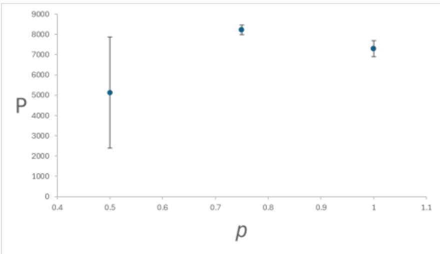
- Packets received (P)
- Packets successfully delivered (%P)
- Packet losses (%L)
- Throughput (TH) [bytes/sec]
- Delay (D) [sec]
- Jitter Delay (J) [sec]

Using Excel we have plotted the mean values between the three repetitions, including the 90% Confidence Intervals for each value of *p*, to indicate the probability that the confidence range captures the true population parameter from the samples.

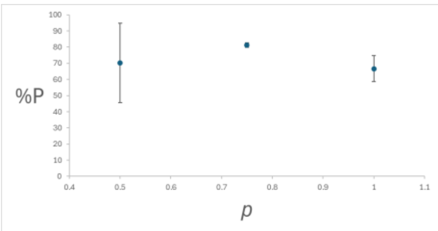
A. Simulation 1

We recall that the first simulation involves *S=2* sources, *N=50* nodes and has been analyzed with probabilities $p = \{0.5, 0.75, 1\}$ three times each.

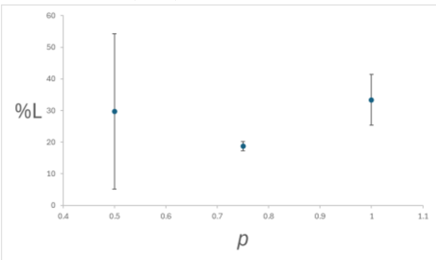
Packets received:



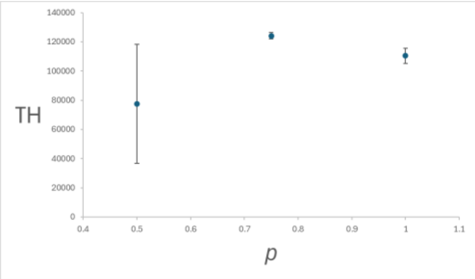
Packets successfully delivered (%P):



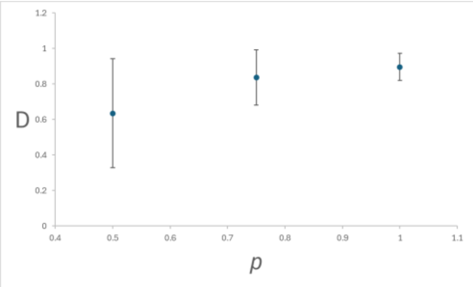
Packet loss (%L):



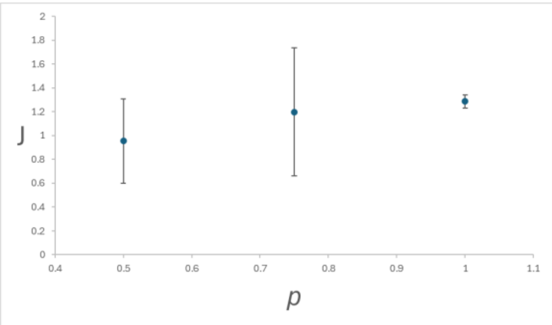
TH -Throughput (bytes/sec):



Delay (s):



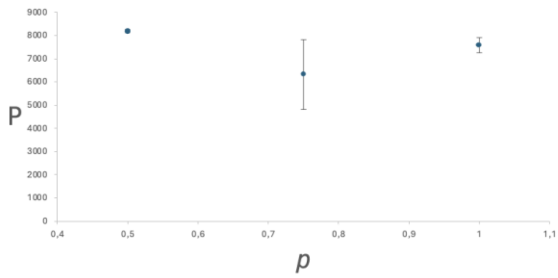
Jitter delay (s):



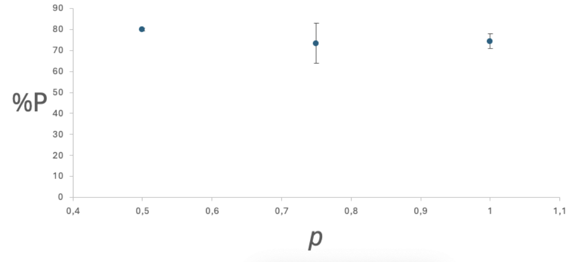
B. Simulation 2

The second simulation involves *S=2* sources, *N=100* nodes and has been analyzed with probabilities $p = \{0.5, 0.75, 1\}$ three times each.

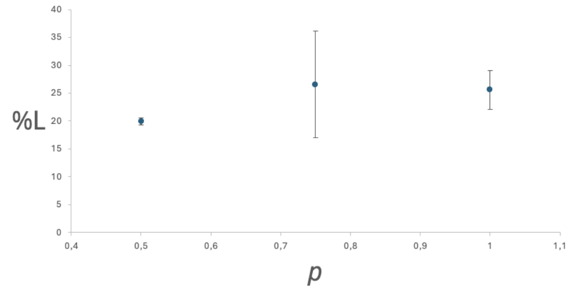
Packets received:



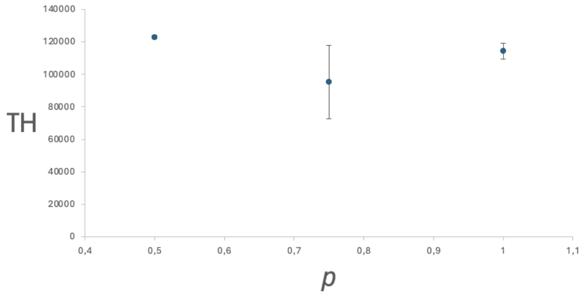
Packets successfully delivered (%):



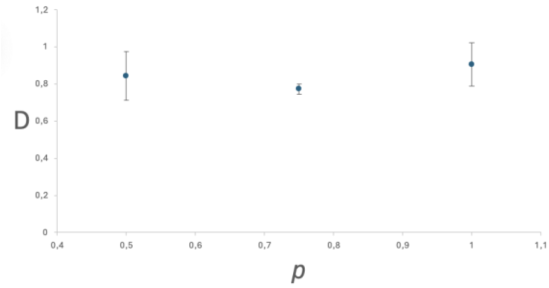
Packet loss (%):



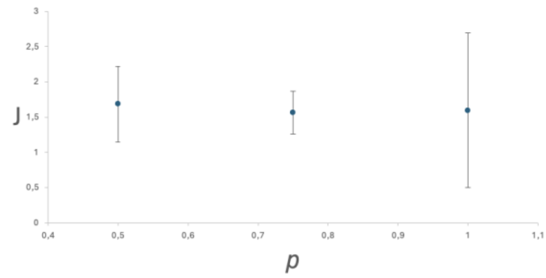
TH -Throughput (bytes/sec):



Delay (s):



Jitter delay (s):



C. Simulation 3

Using different number of sources $S = \{2,3,4\}$. In order to evaluate the quality of the received video sequence we provide our subjective QoS measure of the packet losses using a Mean Opinion Score (MOS) scale indicated from 1 to 5, where 1 is the lowest quality and 5 is the highest quality score. In Table 2 we provide the reference MOS scale that we used. Simulation performed using p=0.75.

Mean opinion score (MOS)		
MOS	**Quality**	**Impairment**
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

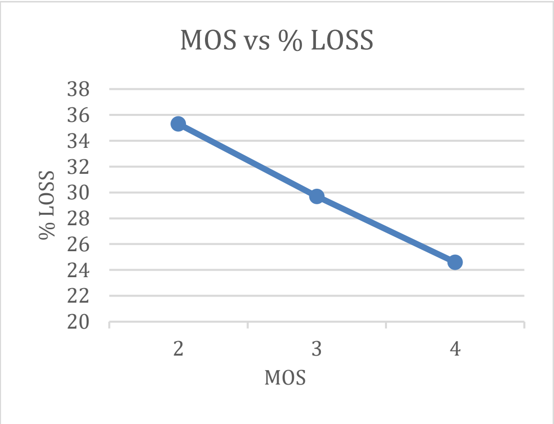
Table 2: MOS values.

In Table 3 we provide our evaluation of the received video with the MOS scale, we also compare the obtained packet losses percentage.

Number of sources	**MOS**	**% Loss**
S = 2 sources	4	24.6%
S = 3 sources	3	29.7%
S = 4 sources	2	35.3%

Table 3: Simulation 3 results

Relation between MOS and the packet loss (%) is reported in the Figure below



IV. CONCLUSIONS

From what we have observed, the two simulations with 50 and 100 nodes showed a relationship between the node density and the performance of the network. We can see that some parameters improve as the number of nodes increases, such as packet loss rate and throughput. However, for some specific probability values *p*, the results reverse; this is due to the optimal probability $p*$ [2] that produces the better results under certain network conditions.

It must be emphasised that having a limited sample of data (just three in this case), the analysis performed on the data could be biased. With a wider range of statistics, the results can be refined.

The observed MOS value aligns with what is expected from the packet loss of the transmission. The higher the number of sources, the higher packet loss and observed MOS score. This aligns with the expectation that more simultaneous sources, gives more traffic in the network and consequently, the packet loss increases. As illustrated, this increase is observed as linear decreasing.

REFERENCES

[1] Mònica Aguilar Igartua, Ahmad M. Mezher, *"Quality of Service in Networks (QSN) Lab Manual"* Departament d'Enginyeria Telemàtica, Universitat Politècnica de Catalunya. Feb 2024.

[2] Mezher, A. [et al.]. *Optimized path selection in a game-theoretic routing protocol for video-streaming services over MANETs*. A: Jornadas de Ingeniería Telemática. XI Jornadas de Ingeniería Telemática JITEL 2013: Granada: 28-30 Octubre. Granada: 2013, p. 85-92.