

ENSC 894 COMMUNICATION NETWORKS

SPRING 2014

Final Project Report

SDP Implementation in MANET using OPNET

Modeler 17.5

SUBMITTED BY: VIJAYARAGHAVAN RAVI

SFU ID: 301229846

Website: www.sfu.ca/~vravi

Email: vravi@sfu.ca

TABLE OF CONTENTS

LIST OF FIGURES	ii
LIST OF TABLES	iii
GLOSSARY.....	iii
Acknowledgement	1
Abstract.....	2
Introduction.....	3
Mobile Ad hoc Networks MANETs.....	3
Application of MANETs.....	4
Mechanism of Service Distribution Protocol.....	4
Replication Mechanism.....	5
Hibernation Mechanism	5
Restoration Mechanism.....	6
Necessary steps before creating a project.....	7
Project Implementation in OPNET.....	8
Wireless Mobile Node.....	9
Process Model.....	6
Mobility Configurator	12
Repository Node.....	12
Process Model.....	13
Setting the Required Statistics	15
Simulation Results	15
SDP Availability vs Simulation Time.....	16
Service Prevalence vs Simulation Time.....	16
Partition vs Simulation Time.....	17
SDP Success Ratio vs Simulation Time.....	18
Conclusion	20
References	21

LIST OF FIGURES

Figure 1: Black dots Represents nodes in MANETs.....	5
Figure 2: Pink dots Represents nodes in replication.....	6
Figure 3: Green Cross Represents nodes in Restoration.....	7
Figure 4: Model developed using OPNET	9
Figure 5: The process model of the wireless mobile node.	10
Figure 6: Repository process model.	13
Figure 7: SDP Availability ratio vs Simulation time.....	16
Figure 8: Allocation Prevalence ratio vs Simulation time.....	17
Figure 9: Partition vs Simulation time	18
Figure 10: Success Ratio vs Simulation time.....	19

LIST OF TABLES

Table 1: States and their functions in the wireless mobile node	11
Table 2: States and its Functions of the Repository process model.....	14

GLOSSARY

MANET – Mobile Ad-hoc Networks

SDP – Service Distribution Protocol

SIR – Susceptible Infectious and Recovery

Success ratio – Is the ratio of the number of successful service requests to the overall number of requests generated in the entire network.

Partition – The most weighted network partition in terms of the partition sizes in a given network at a given time

Prevalence – Is the ratio of the size of the active replica set to the network size.

ACKNOWLEDGEMENT

I would like to thank Professor Ljiljana Trajkovic for teaching this course and providing guidance and criticism during each phase of the project. I would also like to thank the Teaching Assistants Soroush Haeri and Majid Arianezhad for their timely assistance.

I would also like to thank Mr. Chao for his help with technical issues and providing the necessary software and tools.

ABSTRACT

Mobile Ad-hoc Networks also called MANETs is an infrastructure-less dynamic network with mobile nodes moving at random. The nodes move at random and communicate with nearby nodes at random. The very nature of MANETs introduces many challenges. It can't be said definitely that all the members of network remain connected at all times. SDP (the Service Distribution Protocol for MANETS) [1] has been introduced as an approach with many innovative mechanisms to increase the mobile service availability. SDP can achieve a very efficient service distribution of the generated replicas over the MANET. In this project we analyse the SDP Implementation using OPNET Modeler 17.5 and verify our results.

INTRODUCTION

SDP has been introduced as an approach with many innovative mechanisms to increase the mobile service availability. It is mainly based on a new technique in service replication called “replication-hibernation-restoration”. The Replication hibernation restoration mechanism is very similar to SIR algorithm for Service Distribution. In this project, we implement our own Mobile-Ad hoc network from the models in OPNET Modeler 17.5 and verify our results by analysing the Obtained statistics.

MOBILE AD-HOC NETWORKS

MANETs as we know are infrastructure-less networks. They have a number of mobile nodes that communicate with one another without the need for an authority devices like routers. The biggest advantage of a mobile ad-hoc network is it can be deployed quickly in any environment. All the nodes share the same medium and a network of nodes has partitions. Each partition is made of a smaller group of nodes.

MANETs are Scalable and flexible. Depending on the application we can increase the number of the nodes and the range of each node. However the greatest challenge in MANETs is communicating between two nodes. As all the nodes are mobile. Data from Node A has to find its path to Node B which is moving at random. Another challenge is the availability of the network also called service availability. The Service Distribution protocol overcomes these challenges and ensures efficient data delivery in MANETs.

APPLICATIONS OF MANETS

Before we learn about SDP let's see some of the applications of MANETs. MANETs find many applications especially in areas which require fast deployment. Some of the Common applications of MANETs are:

- Military
- Collaborative Work in New Environment
- Emergency Operations
- Mining and other Industrial uses.

MECHANISM OF SERVICE DISTRIBUTION PROTOCOL

The important parameter of SDP is the service interest or popularity. Many criteria can be used to identify the service interest like the requesting frequency, opened sessions (load), service publishing time, service prerequisites, last time of requesting, and context. In this project we observe the Replication Restoration and Hibernation mechanism by studying the statistics such as SDP availability, prevalence, and partition and success ratio.

REPLICATION MECHANISM

Upon a replica request of a client which achieved the required replication threshold during a certain time interval, the service replication mechanism is triggered. A service provider is responsible to copy (forward) a replica to the interested clients. Therefore main functionalities of the replication mechanism take place on both service provider and client sides.

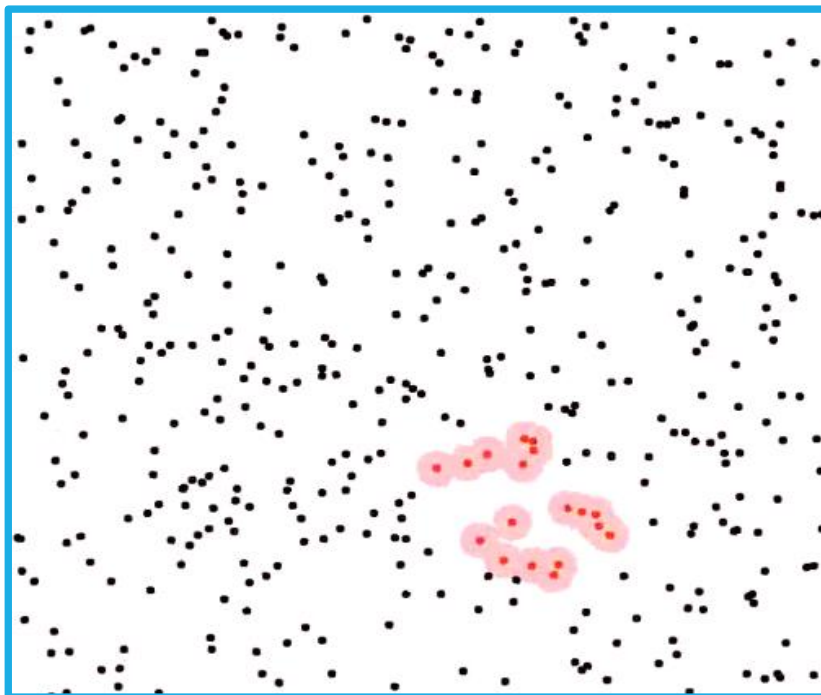


Figure 1: Black dots Represents nodes in MANETs

HIBERNATION MECHANISM

The hibernation process complements the replication process. It prevents the network from having many unnecessary concurrently running replicas. The replica

is hibernated once its provider does not receive client interest in it by the participating clients over a certain time interval.

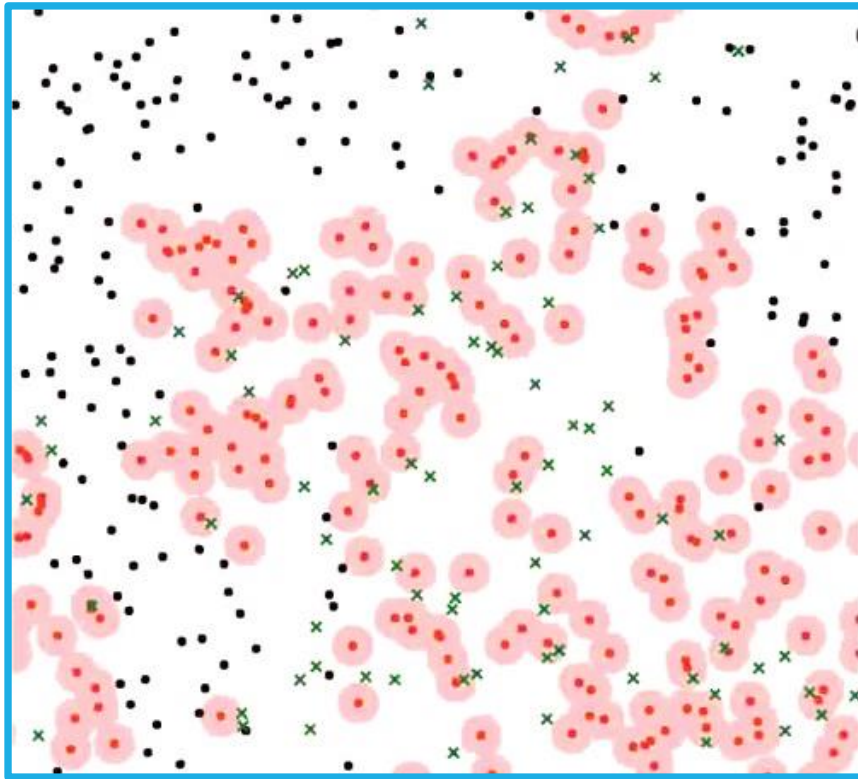


Figure 2: Pink dots Represents nodes in replication

RESTORATION MECHANISM

Based on the core functionalities of the replication mechanism, the mobile host can restore a previously hibernated service. In case of restoring a cached replica, the local and remote resources required by the service should be mounted. Then, a new service for the restored service should be published. Basically restoration readies the node to receive new data.

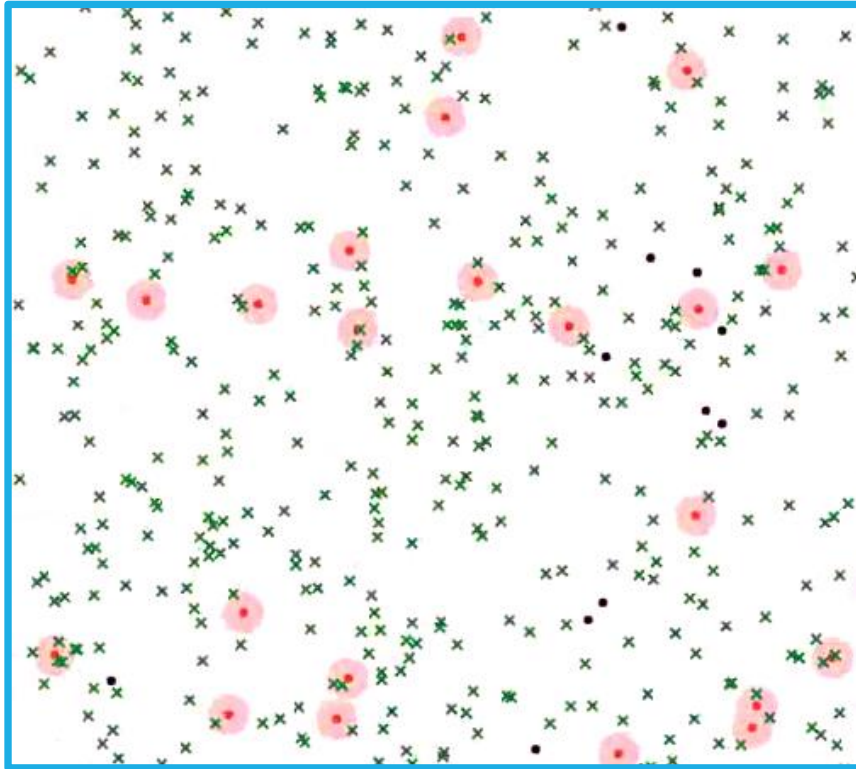


Figure 3: Green Cross Represents nodes in Restoration

NECESSARY STEPS BEFORE CREATING A PROJECT

After a successful install of an Opnet® Modeler 17.5 with the MANET library, we need to perform the following steps to be able to run SDP simulations safely and correctly.

- Install visual studio and set the environment variables for more information refer [6].
- Set the preferences in Opnet to run and execute using Visual studio
- After creating the project ensure all the models in the project are compiling successfully.

PROJECT IMPLEMENTATION IN OPNET

This project uses the nodes from the Contributed models website. However the complete set of models required for this project is not available. The other necessary node models were obtained from the OPNET model directory and changes were made to them for Compilation and successful simulation of this project. The nodes downloaded from the contributed models are referenced by model id 944.

The project was by implemented by deploying a wireless network on an area of 600 x 600. The mobile nodes inside the wireless network are deployed at random to simulate the truly mobile infrastructure of MANETs. For this case of the Simulation I deployed around 50 nodes in the network environment. However any number of nodes can be deployed. The repository node collects the statistics. However, the mobile nodes move at random and their mobility is determined by the Mobility Configurator Module. The list of models available and its functionalities are discussed below.

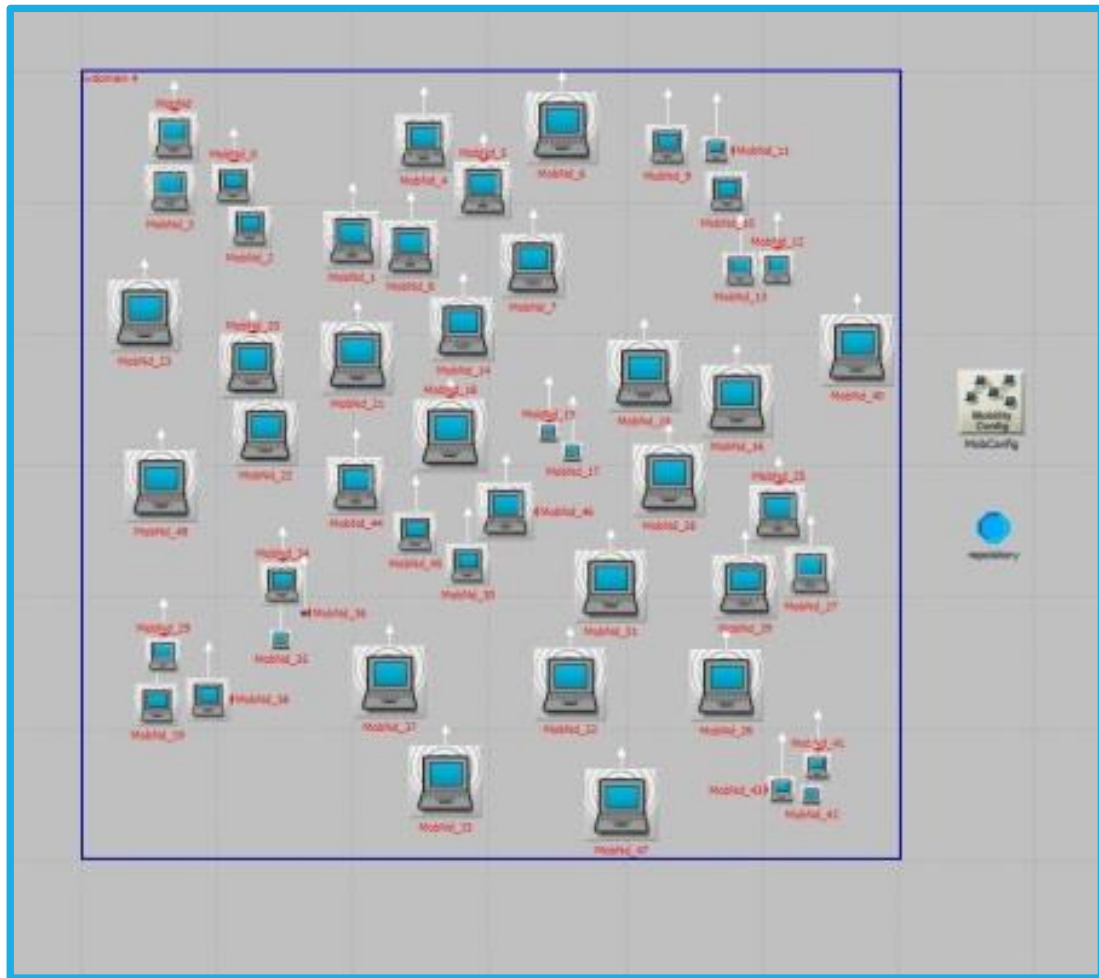


Figure 4: Model developed using OPNET

WIRELESS MOBILE NODE

This node is the network participant which may be a client or a server. It is the Manet_station_adv module of the mobile node. The nodes are deployed in a wireless domain at random trajectory. Since in a Mobile Ad-hoc environment the nodes are mobile and at any given time they are found at random.

PROCESS MODEL

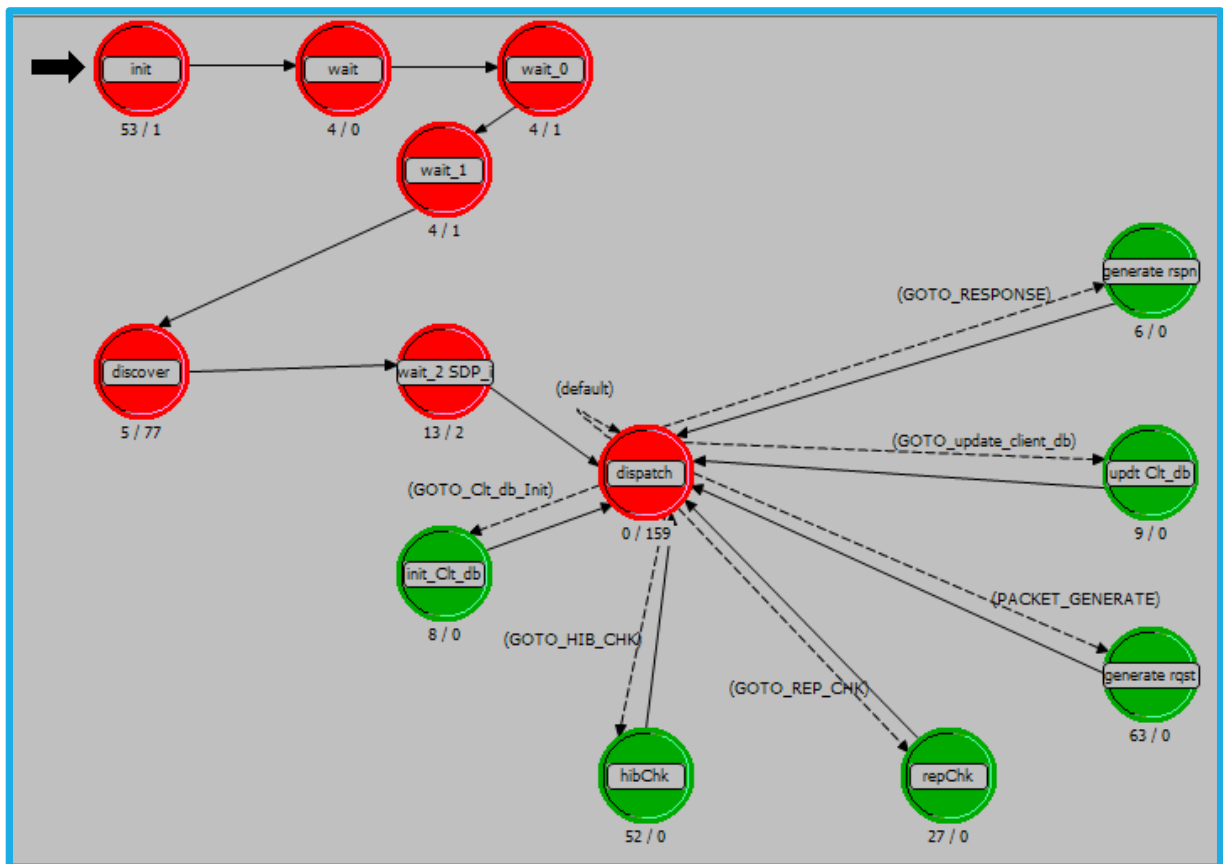


Figure 5: The process model of the wireless mobile node.

The process model of SDP application processor is presented in Figure 5. The states are described in the Table 1 below:

STATE	FUNCTION
init	Used to initiate both “client” and “provider” databases
wait, wait_0, wait_1	Used to organize the node address registration for all mobile nodes.
Discover	At enter next transition to “wait_2 SDP_init” is scheduled and at exit the IP Module is registered for the current mobile node
wait_2 SDP_init	It is used to trigger the function block.
Dispatch	It handles the arrived SDP messages
init_Clt_db	It initiates the client database list
hibChk and repChk	Is activated based on the hibernation and replication threshold specified.
Generate_rqst	Is activated when a client service makes a request.
Update_Clt_db	Activated periodically to update the client provider db
generate_rspns	Is activated when the provider gives a response to a request

Table 1: States and their functions in the wireless mobile node

MOBILITY CONFIGURATOR

The mobility config specifies the mobility model and its characteristics. The mobility configurator associates the random mobility of the mobile nodes.

REPOSITORY NODE

The repository is the virtual node in the simulation. It represents the repository module found over the mobile nodes. It performs the functions of publishing, holding and updating the service replicas. The required statistics of the SDP performance are processed and stored in this module. Moreover, it enables the user to set the specifications of the original service required to be deployed in the network. The process model of the Repository Node is described below.

PROCESS MODEL

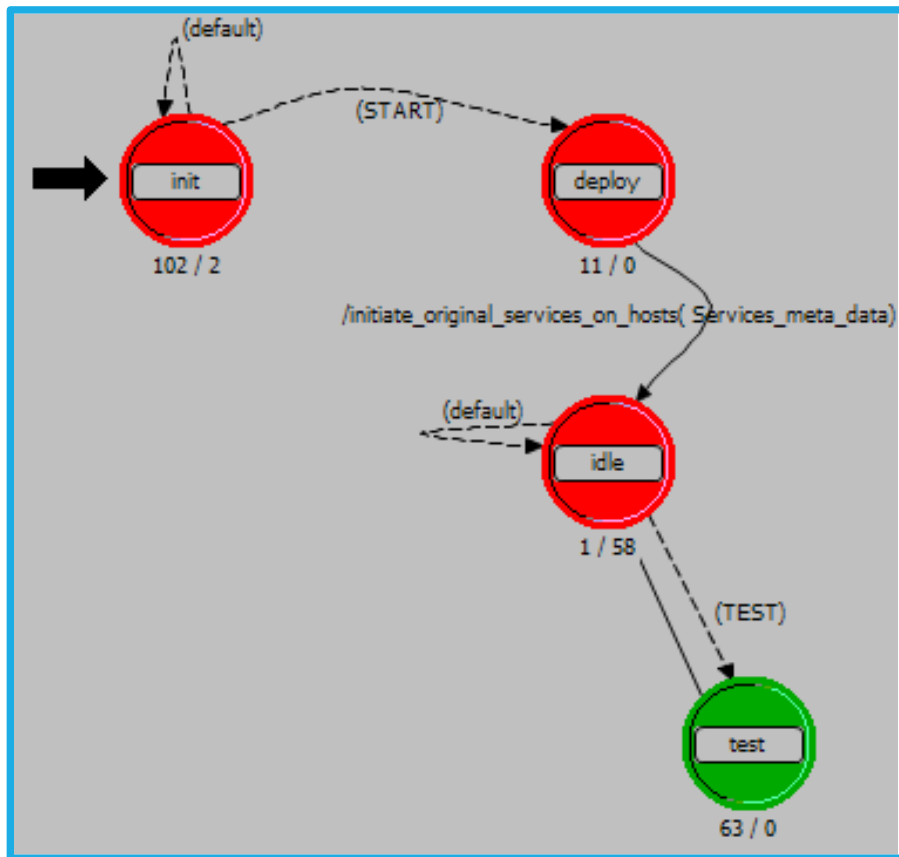


Figure 6: Repository process model.

The presented process model of the repository node processor in Figure 6 shows the states which are described below in Table 2.

STATE	FUNCTION
init	Used to initiate the repository node.
deploy	Triggered when the transition from the “deploy” state to “idle” state takes place.
idle	It either hosts the repository node listener or triggers the “test” state
test	The statistics are performed and collected here.

Table 2: States and its Functions of the Repository process model

SELECTING THE REQUIRED STATISTICS

As mentioned before, the main statistics for evaluating the SDP performance are stored in the repository model. We select them by:

1. Right click on the “repository” node.
2. Choose “Choose individual DES Statistics”.
3. Navigate in the “Module Statistics” to “Repository”
4. Select our desired matrix from the delivered different categories of SDP statistics.

The statistics collected and analysed in this project are.

1. SDP Availability
2. SDP Replica Allocation Prevalence
3. SDP Partition Analysis
4. SDP Success Ratio

SIMULATION RESULTS

The project had to be run multiple times with different seed values. To reduce the simulation time. All the multiple seed values were provided in a single simulation run also the Project was simulated using concurrent simulation. This reduced the simulation time to 2 hours. The Simulation results obtained were satisfactory and is similar to the SDP results obtained in [1] and [2].

SDP AVAILABILITY VS SIMULATION TIME

In this graph the SDP Availability is denoted vs time. Service Availability is the average ratio of the summation of time intervals that the service or one of its replicas was active somewhere in the network to the overall lifetime of the network. A value of “1” indicates that the service was active and a value of “0” indicates that neither the service nor one of its replicas was active.

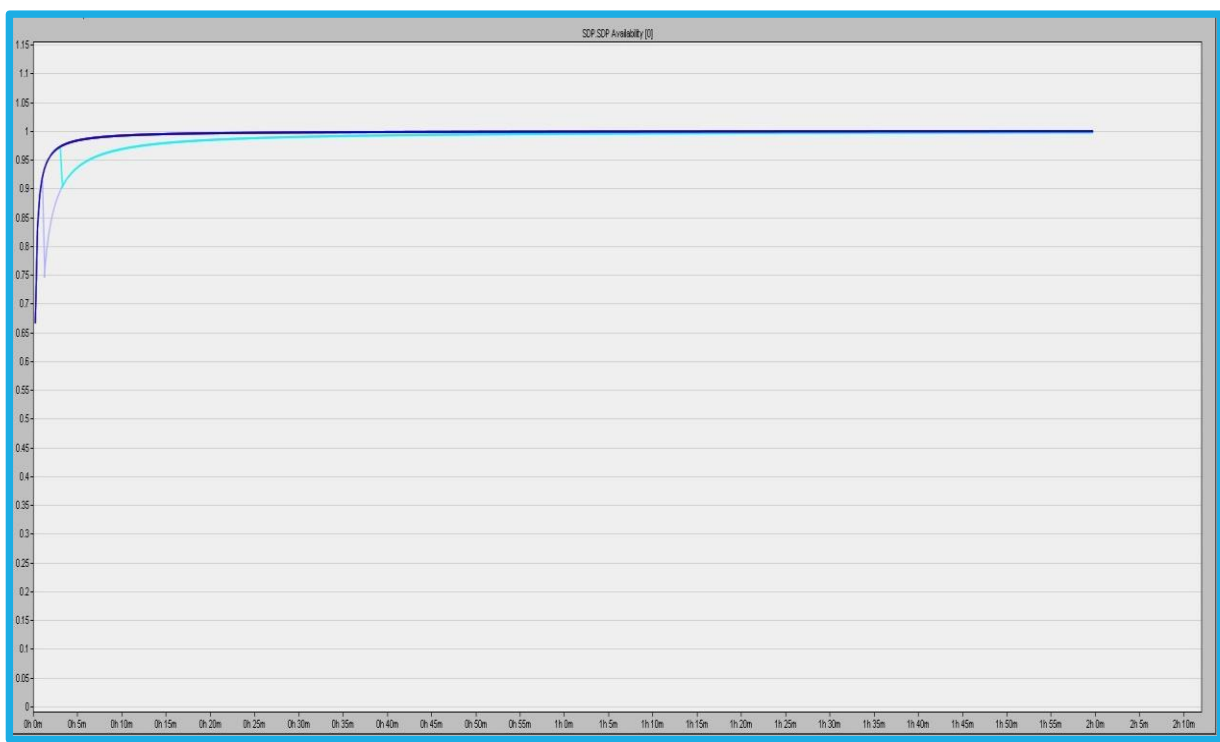


Figure 7: SDP Availability ratio vs Simulation time

SERVICE PREVALENCE VS SIMULATION TIME

The Service Prevalence is the Ratio of the number of mobile nodes having an active replica to the total number of the network participants. In this graph the service prevalence is denoted vs Simulation time. The statistics such as Service prevalence replication degree and the replica allocation correctness ratio are

closely related and can be used to indicate the number of running replicas in the network. The Service Prevalence ratio obtained is between 0.17 to 0.28 which denotes that the number of nodes that had active replicas was greater than 1 and less than 3 when the total number of participants were 10.

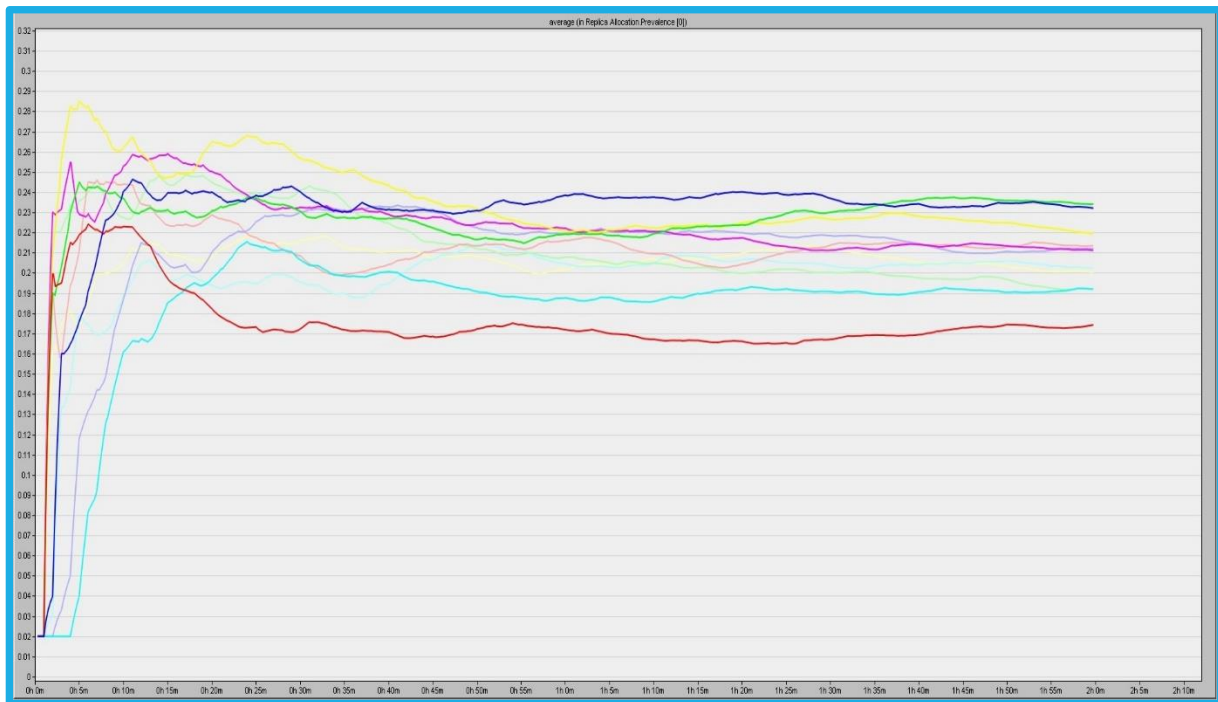


Figure 8: Allocation Prevalence ratio vs Simulation time

PARTITION VS SIMULATION TIME

Network partition gives the most weighted network partition in terms of the partition sizes in a given network at a given time. It denotes the number of active

partitions at any given time. The number of partition at any given time is around 15 to 20 as given in the simulation.

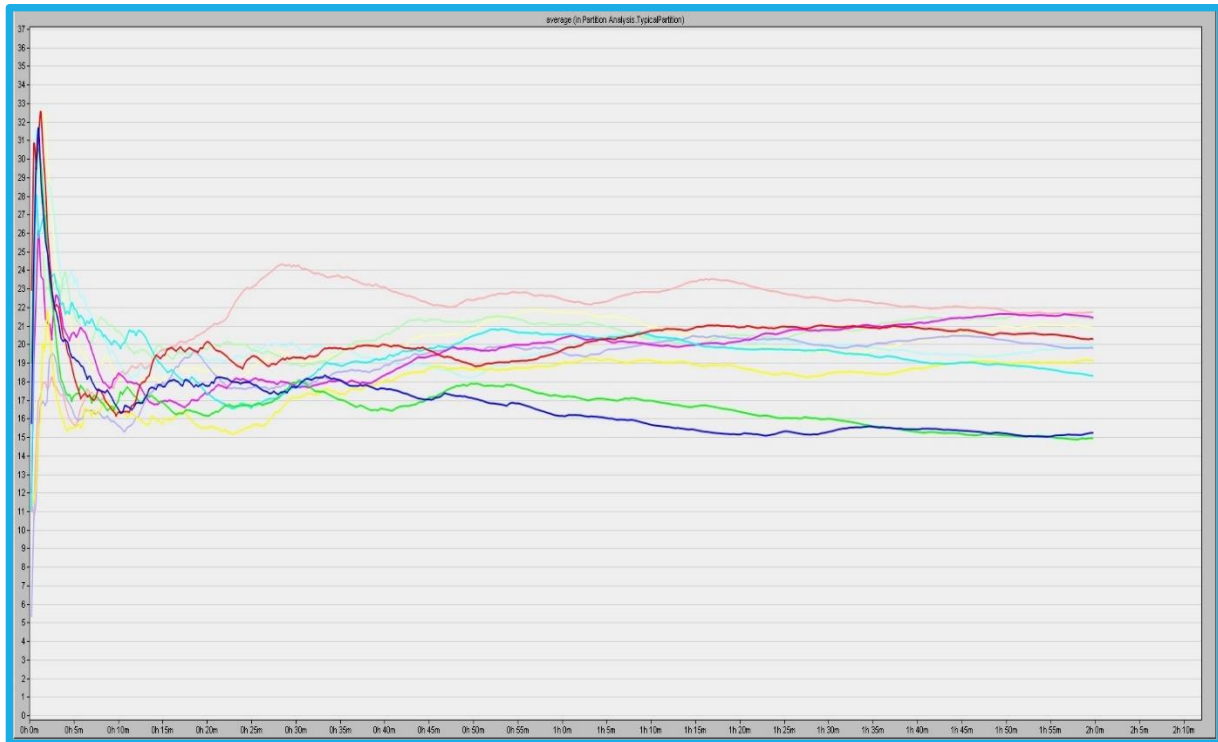


Figure 9: Partition vs Simulation time

SDP SUCCESS RATIO VS SIMULATION TIME

SDP Success ratio is the ratio of the number of successful service requests to the overall number of requests generated in the entire network. The Success ratio is observed to slowly increase in time. Which shows that the number of successful

service requests increases with time. It also shows that the longer the service lasts the more successful the network.

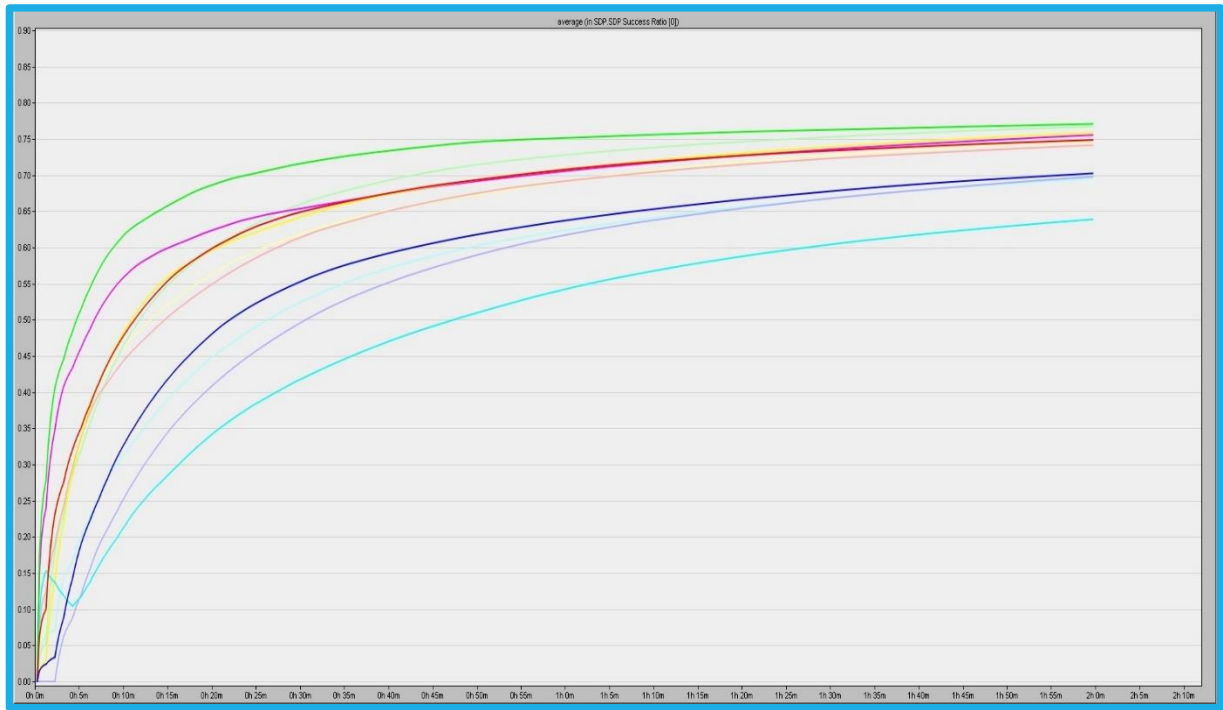


Figure 10: Success Ratio vs Simulation time

CONCLUSION

Thus, Service Distribution Protocol is mainly based on a new technique in service replication called “replication-hibernation-restoration”. In this project the SDP implementation in MANETs was successfully tested using OPNET Modeler 17.5. Also by random deployment of the nodes I made an interest based and topology independent comparison. The simulation results obtained shows that the project was successful in implementing SDP in a truly mobile environment.

As a future work the code could be optimised to make the simulations more efficient. Also that alternative models could be developed which could give out better results.

REFERENCES

- [1] Mohamed Hamdy and Birgitta König-Ries. Book of Communications in Computer and Information Science, Book of the selected papers of the ICETE 2008, volume 48 of CCIS 48, chapter: The Service Distribution Protocol for MANETs- Criteria and Performance Analysis, pages 467-479. Springer Berlin Heidelberg, 2009.
- [2] Mohamed Hamdy and Birgitta König-Ries, "Service Availability, Success Ratio, Prevalence, Replica Allocation Correctness, Replication Degree, and Effects of Different Replication/Hibernation Behaviour Effects of the Service Distribution Protocol for Mobile Ad Hoc Networks -A Detailed Study-," JENAER SCHRIFTEN ZUR MATHEMATIK UND INFORMATIK, Technical Report: Math/Inf/08/08, Friedrich-Schiller-University Jena, December 2008.
- [3] Dipanjan Chakraborty, Anupam Joshi, Yelena Yesha, Tim Finin, "A Novel Group-based Service Discovery Protocol for MANETS," University of Maryland, Baltimore County.
- [4] Chen et al, "A Dynamic Execution Path Selection Approach for Composite Services in MANETs," The 4th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM 08), Chengdu, China, 2008.
- [5] Ebtisam Amar and Selma Boumerdassi. A location service for position based routing in mobile ad hoc networks. In Proceedings of the 8th international conference on new technologies in distributed systems (NOTERE 08), pages 1-4, New York, NY, USA, 2008. ACM.
- [6] Zheng Lu, University of Essex and Hongji Yang, De Montfort University, Leicester, "Unlocking the power of OPNET Modeler", pages 11-20, Cambridge, Feb 2012.