S2RP: A Self –Heal Stable Routing Protocol for Disaster Scenario

Arun kumar Yadav[a], Ashwani Kush[b]

[a] Department of Computer Sci. & App., K.U., Kurukshetra, Haryana, INDIA
[b] Department of Comp. Sci., IIHS, K.U., Kurukshetra, Haryana, INDIA
[a] arunkumar9429@gmail.com, [b] akush20@gmail.com

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 10 May 2021

Abstract: As population is increasing day by day, mobile nodes are being incremented in smart cities. Due to limited battery power, many nodes in the network become inactive during data transfer which leads to route breakage. Energy is a basic requirement for mobile ad-hoc network. Energy utilization is the critical part. The aim of this paper is to design a protocol i.e. S2RP, which finds stable, secure and energy efficient route. The proposed protocol avoids frequent link breakage and allows fast data transfer with low energy Consumption..

Keywords: AODV, RSTV, NSTV, PDR, Delay, Throughput, Energy.

1. Introduction

MANETs (Mobile ad hoc networks) are categories of wireless networks that use multi-hop relaying through radio links. These networks are also referred to as infrastructure less networks. MANETs are collegiums of autonomous mobile hosts [1][2]. Communication between two hosts can be direct if they are within the radio range of each other otherwise intermediate hosts take the responsibility of forwarding packets to the destination. Due to mobility of nodes, the network topology keeps changing therefore there cannot be a permanent route from a source to sink node. To overcome this, every node has an additional responsibility of being a router as well. Since the radio links are used and open air communication follows, the nature of communication is broadcast, it means every packet transmitted would be received by all the nodes in the vicinity i.e. nodes that come in range of the transmitter of a transmitting node. Nodes therefore are presumed to be trustworthy so that if the received packet is not meant for them they must discard them and not misuse by utilizing the information in such packets. Process of routing is forwarding of packets from source to destination which requires establishing a path through which packets would move from one hop to another to reach the destination in considerable time. Due to dynamic nature of topology every node is suppose to keep track of neighbors and this information is to be updated after regular interval of time. Routing protocols for MANETs are different from those employed for wired networks as the scenario is different in both the cases. MANETs have the property of being self organizing and maintenance of paths is inbuilt because the unreliability of the communication medium and dynamic change of topology [3][4]. Generally the nodes forming a MANET are devices which have limited power supply, limited computational resources and limited bandwidth for communication. Energy utilization is a critical part of MANET's unwavering quality. In MANET, hubs are versatile and can move in various ways. It prompts successive route breakage during information correspondence. For efficient network construction, an energy-protected scheme is needed that guarantees the longer life of nodes in the organization and aggregately build the organization's reliability. Population explosion is acting as a catalyst for recourses depletion. In Future there may be chance that we have less or only limited energy resources. The idea of S2RP i.e. self –Heal Stable Routing Protocol for Smart City helps in that disaster situation. This paper is the extended version of my previous paper [5]. Literature Review and Energy model for this work has been already discussed in my previous paper [5].

2. Research Methodology

NS2(Network simulator) has been used in this proposed work for getting results. Firstly TCL files are created for proposed algorithm and traditional AODV protocol. Then run these TCL scripts on NS2 simulator to generate corresponding Trace and Nam files. After that awk files are executed on these trace files to get the values of different metrics i.e PDR, Delay, Throughput, Energy. At last graphs are prepared on the basis of value provided by awk files. Then results are analyzed. Figure 1 describes the whole activities which are to be carried out to achieve desired result.

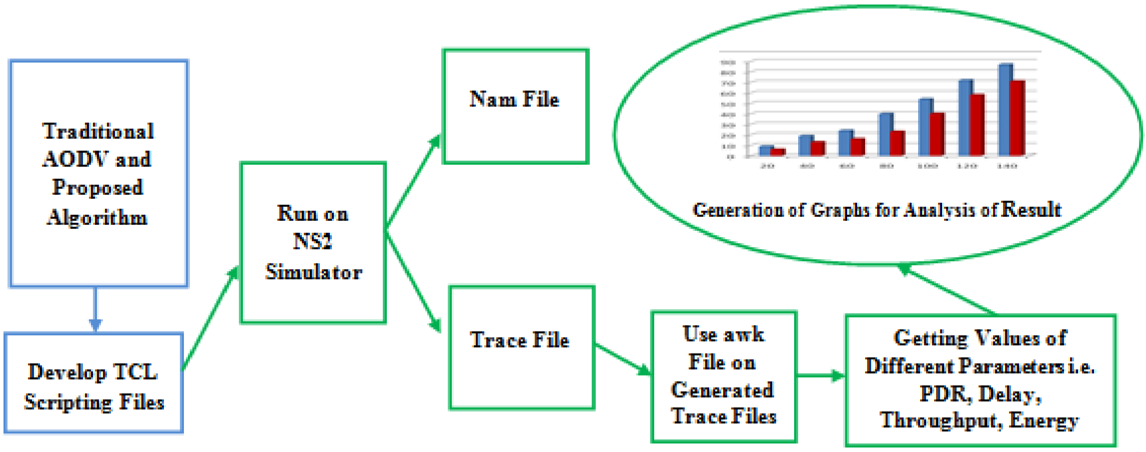
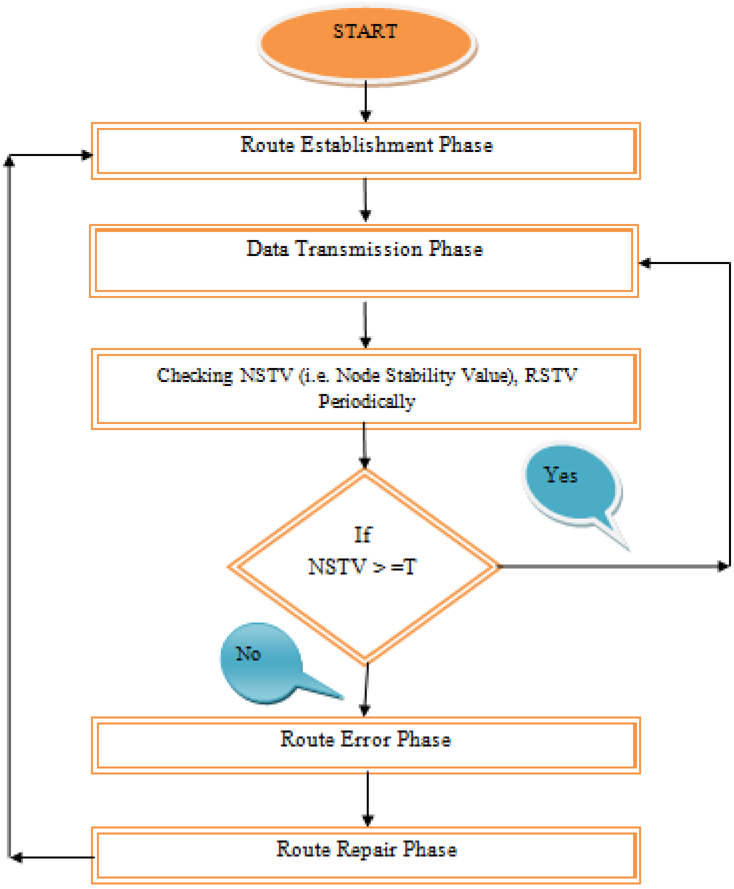


Figure 1: Research Methodology for proposed S^{2}RP

3. Proposed Work

These section discuses about the flowchart and algorithms that have been proposed and implemented for identifying stable and secure route in a MANET. Implementation has been done using NS2 simulator which is one of the most prominent tool used for implementation amongst researchers. The algorithms proposed in this section are standalone i.e. they do not need any collaborative efforts, they are able to identify stable route while route discovery process is in progress so that bandwidth is not consumed for the purpose of finding stable route separately



The above flowchart illustrates the process which is to be carried out in proposed work. There are mainly 4 phases carried out in proposed work i.e. Route Establishment Phase, Data Transmission Phase, Route Error Phase and Route Repair Phase. The activities which are to be carried out in each phase are described in below algorithms.

Algorithm for Route Establishment Phase

1. Source node broadcast Route Request Message to Network.
2. Each node in the network calculates NSTV, which based on the Residual Energy, Mobility of Node and Traffic load.
3. Destination Node sends Route Reply Message to source node.
4. Calculate RSTV value for all Routes available. RSTV value of route is the minimum NSTV value of node in that Route.
5. Source node selects the route which has largest RSTV value.

Algorithm for Data Transmission Phase

1. Source node sends the packets to destination node through path which is decided in Route Establishment Phase.

Algorithm for Route Error Phase

1. During Data Transmission, if any node in the selected route has minimum NSTV than threshold T (T=0.20*Initial Energy), then Unstable Node sends Route Error Message to its upper node.
2. If upper node has less NSTV value than threshold T (T=0.20*Initial Energy),then it send route error message to its upper node and so on.

Algorithm for Route Repair Phase

1. The Upper node calls local route discovery process to find new route if it has greater or equal NSTV value than threshold T (T=0.20*Initial Energy).

NSTV and RSTV in proposed work can be calculated by using some mathematical equations. NSTV value is directly proportional to the residual energy or available energy i.e. $E_{a.}$ it is also observed that NSTV value is inversely proportional to the mobility of node i.e. M and traffic load TL. So NSTV is totally based on the above three parameters [6]

- Now NSTV of node N can be calculated as:

$NSTV(N)=E_a(N) + (1+M_N)^{-1}+(1+TL_N)^{-1}$ ---------------------(1)

Here Node N's Available Energy is $E_a(N)$, M_N is average mobility of node N, TL_N is traffic load of Node N.

- $E_a(N)$ can be calculated as:

$E_a(N)=E_i(N)-E_C(N)$ -------------------(2)

Here Node N's initial energy is $E_i(N)$ and the consumed energy is $E_c(N)$.

- $E_c(N)$ i.e consumed energy is depends on the energy used in receiving and transmitting of a packet by a node N. so it is calculated as:

$E_c(N)=E_T(N)+E_R(N)$ -------------------(3)

Here $E_T(N)$ is packet transmitting energy and $E_R(N)$ is packet receiving energy of node N.

- $E_T(N)$ and $E_R(N)$ can be calculated as:

$E_T(N)=P_T(N)*T_D$ ---------------------(4)

$E_R(N)=P_R(N)*T_D$ ---------------------(5)

Here $P_T(N)$, $P_R(N)$ and T_D are power used in transmitting of one packet, receiving of one packet and time required during transmission of a packet respectively.

- Node mobility (average) of node N i.e M_N can be calculated as:

$M_N=\sum \frac{S(N)}{T}$ ------------------------(6)

Here S(N) is the node's speed in time interval T. Node's speed is calculated by using following equation i.e.

$S(N)=D_{\Delta T}(N)/\Delta T$ -----------------------(7)

Here $D_{\Delta T}(N)$ is the distance travel by the node N in interval ΔT.

- Distance/Path covered by node N in time t i.e. from t1 to t2 is calculated as:

$D(N) = \sqrt{(X(N)_{t2} - X(N)_{t1})^2 + (Y(N)_{t2} - Y(N)_{t1})^2}$ ------------------(8)

- Traffic load of node N i.e. $T_L(N)$ is calculated as :

$T_L(N)=P_S/\Delta T$ -------------------------(9)

Here P_S is packet size in bits and ΔT is time consumed by node during sending/ receiving of packet.

- NSTV value must follow following condition:

$NSTV<=0.20*E_i$ ------------------------(10)

Here NSTV is node stability value and E_i is intial energy of node.

4. Simulation Environment Setup

To execute the proposed plan, NS2 simulator has been used by taking parameters as shown in table1. Here Numbers of nodes are 20 with 6 TCP Connection, 40 with 12 TCP Connection, 60 with 18 TCP Connection, 80 with 24 TCP Connection, 100 with 30 TCP Connection, 120 with 36 TCP Connection, 140 with 42 TCP Connection and 150 with 45 TCP Connection taken for different simulation scenarios. 500m x 500 m Area for the simulation is considered. All nodes in the Simulation area are placed at random location using Random Way Point model[6]. Pause time and speed of mobile nodes are kept constant i.e. 100 s pause time and 1.0 m/s speed. Initial energy of all nodes is set to 100 joules. PDR, End to End delay, Throughput metrics has been used to analyze the outcome of the proposed work.

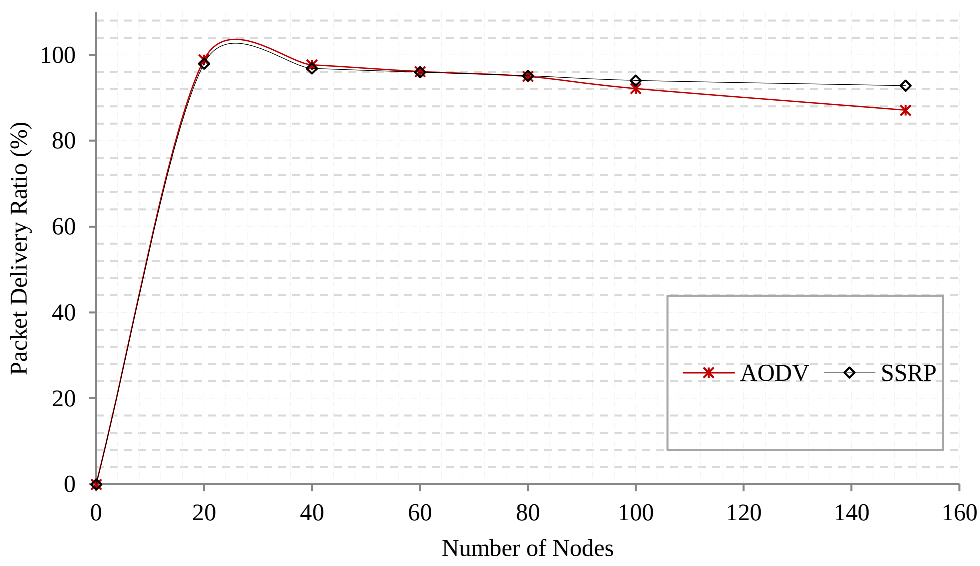
Table 1: Simulation Scenarios

Simulation Parameters	Parameter Value
Simulator	NS-2.34
Channel	Wireless Channel
MAC Type	802.11
Antenna Type	Omni
Interface Queue Type	DropTailPriQueue
Radio Propagation	TwoRay Ground
Simulation Area	500m x 500m
Mobile Nodes	20,40,60,80,100,120,140 and 50

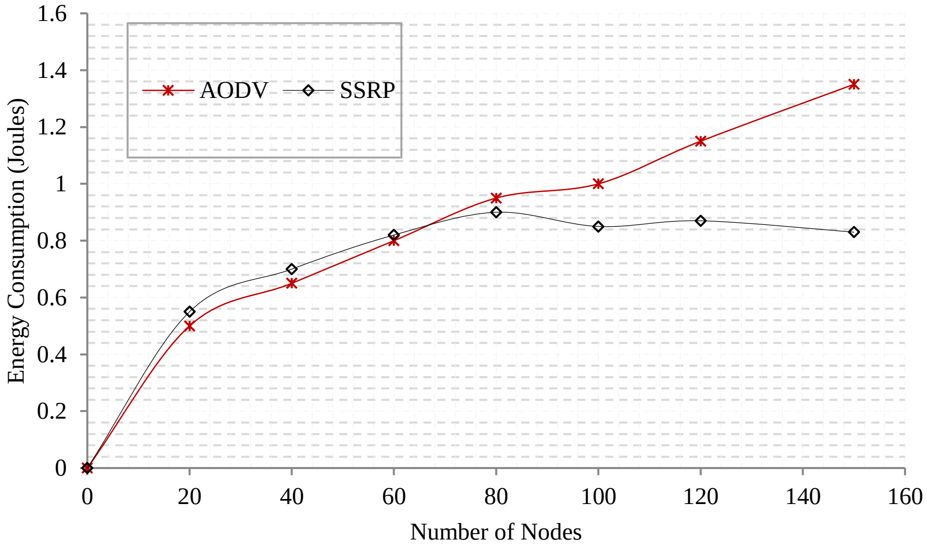
Pause Time	100
Speed	1.0m/s
No. of Connections	06 (for 20 nodes), 12 (for 40 nodes), 18 (for 60 nodes), 24 (for 80 nodes), 30 (for 100 nodes), 36 (for 120 nodes), 42 (for 140 nodes), 45 (for 150 nodes).
Routing Protocols	AODV , SSRP
Traffic Sources	TCP
Simulation Time	500 Sec.
Initial Energy	100 joule
Transmitting Power (T_X)	0.9 watt
Receiving Power (R_X)	0.7 watt
Idle Power (I_X)	0.6 watt
Sleep Power (S_X)	0.1 watt
Packet Size	960bytes
Performance Metrics	Packet Delivery Ratio, End to End Delay, Throughput, Energy

5. Simulation Results And Analysis

Proposed S^2RP is evaluated and compared with traditional AODV. Results are obtained by using the simulator (NS-2.34). Comparable findings are noticed while working with many QoS like PDR[7,8], End To End Delay, Throughput and Energy Utilization[5]. Graphs are plotted for these QoS when network mobility speed is 1m/s and pause time is 100s.



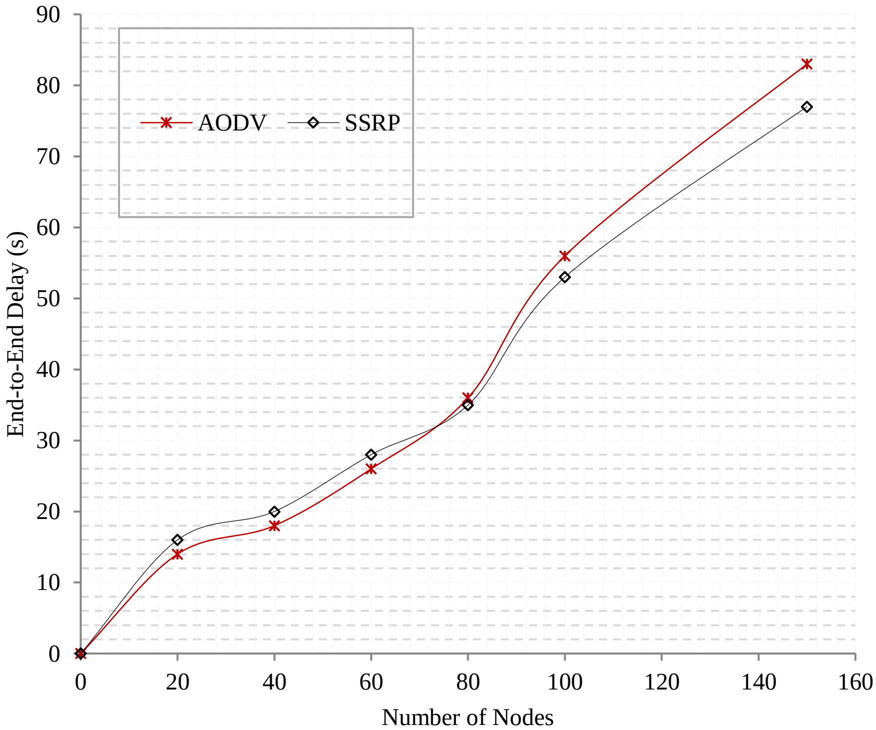
Graph 1: Packet Delivery Ratio Vs. number of nodes



Graph 2: Energy Consumption vs. Numbers of Nodes

In graph 1, it is observed that at initial points PDR of AODV and proposed S^2RP is approximately same but as we move forward to denser medium the PDR ratio of S^2RP is increasing.

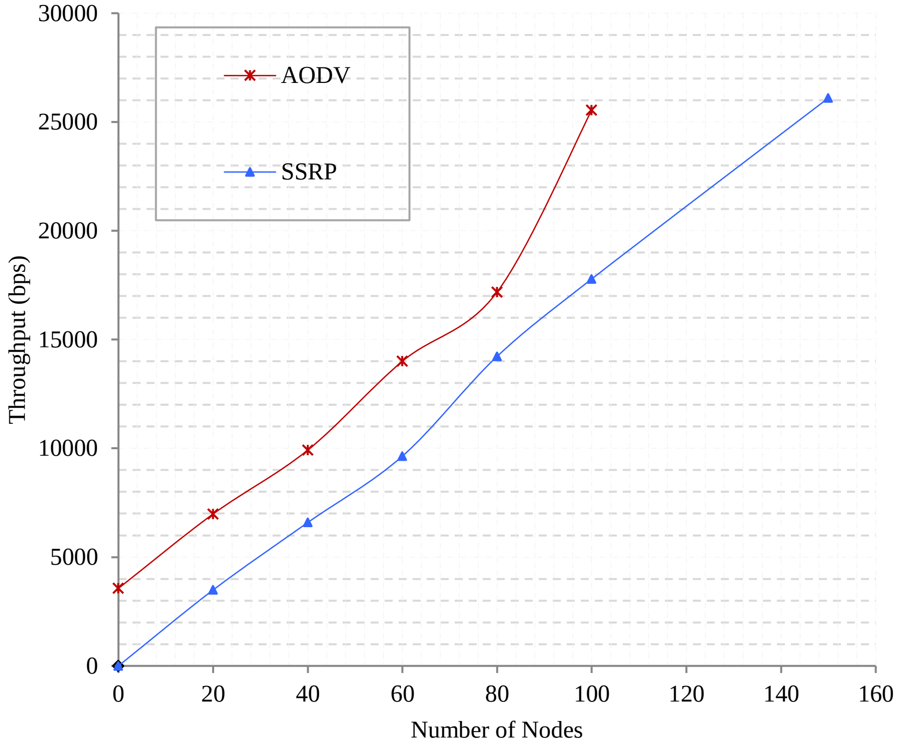
Graph 2 shows that up to 60 nodes the energy consumption of S^2RP is greater than AODV but after 60 nodes the energy consumption of S^2RP steadily declined. S^2RP conserve the energy.



Graph 3: End-to-end delay vs. number of nodes

Trends of Graph 3 depict that in sparse medium, the end to end delay by S^2RP is greater that AODV, but as we go in denser medium the end to end delay become less. There is slightly declined in end to end delay.

In graph 4, it is observed that initially the throughput of AODV are greater than S^2RP then we notice that at 80 nodes the throughput of both are approximately same but after that as we moves in denser medium there is sharp increase in throughput by S^2RP than AODV.



Graph 4: Throughput Vs. number of nodes

6. Conclusion

In this work, an experiment has been performed to analyze the performance evaluation of S^2RP and AODV. Network simulator NS2 has been used for TCP based network traffic. On the basis of Packet Delivery Ratio, it has been found that the performance of S^2RP is approximately similar to AODV. But as the network becomes denser the S^2RP outperforms AODV. On the basis of End to End delay, there is more delay in S^2RP than AODV in Sparse medium. But as the network moves towards denser medium, S^2RP performs better than AODV. Energy utilization of S^2RP over AODV in Sparse medium is more. But as the number of nodes in network increases, the Energy Consumption of S^2RP become lesser than AODV. According to Throughput metric, as the number of nodes increases the S^2RP outperforms AODV. So, in all metrics, S^2RP outperforms AODV.

References

1. Blazevic L., Buttyan L., Capkun S., Giordano S., Hubaux J.P., Le Boudec J.Y., "Self organization in mobile ad hoc networks: the approach of terminodes", IEEE Communications Magazine, 2001,volume 39, issue 6, pages 166–174.
2. Bose S., Bharathimurugan S., Kannan A., "Multi-layer integrated anomaly intrusion detection system for mobile adhoc networks", Proceedings of IEEE International Conference on Signal Processing, Communications and Networking (ICSCN'07), India, 2007, pages 360–365.
3. Buchegger S., Le Boudec J.Y., "Performance analysis of the CONFIDANT protocol", Proceedings of the 3rd ACM international symposium on Mobile ad hoc networking & computing, Lausanne, Switzerland, 2002, pages 226–236.
4. Chandola V., Banerjee A., Kumar V., "Anomaly detection: a survey, ACM Computing Surveys (CSUR)", 2009, volume 41, issue 3, pages 1–15.

5. Vishal Dattan et. al., " Manet for Stable Data flow in Smart home and Smart city", 2019 4th MEC International Conference on Big Data and Smart City (ICBDSC), 2019, doi: 10.1109/ICBDSC.2019.8645605, pages 1-4.
6. S. A. Helal et. al., "On optimal scheduling for smart homes and their integration in smart grids",2017 IEEE 30th Canadian Conference on Electrical and Computer Engineering(CCECE), 2017,doi:10.1109/CCECE.2017.7946833, pages 1-4.
7. Arun Kumar Yadav and Ashwani Kush, "TCP and UDP Based Performance Evaluation of AODV and DSR Routing Protocol on Varying Speed and Pause Time in Mobile Ad-hoc Networks" published in CSI 2015 conference proceeding, Next-Generation Networks, Advances in Intelligent Systems and Computing 638, https://doi.org/10.1007/978-981-10-6005-2_34, pages 323-332
8. Arun Kumar Yadav and Ashwani Kush, "E2-SCRP: An Energgy Efficient Secure Cluster-Based Routing Protocol for 3D Underwater Acoustic MANET (UWMANET)", published in IJITEE, ISSN : 2278-3075, 2019, Volume-8, Issue -11, pages 2430-2442.