

Fuzzified Swarm Intelligence Framework Using Fpsor Algorithm for High-Speed Manet

Harihara Gopalan (✉ urshari@gmail.com)

Sri Ramakrishna Engineering College <https://orcid.org/0000-0003-0830-9742>

Research Article

Keywords: Network-centric, Fuzzification, Load Balancing, Arbitrary Trip Time, Mobility, and Convergence Speed

Posted Date: March 16th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-288901/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

FUZZIFIED SWARM INTELLIGENCE FRAMEWORK USING FPSOR ALGORITHM FOR HIGH-SPEED MANET

Dr.S.Harihara Gopalan

Associate professor, Department of CSE, Sri Ramakrishna Engineering College, Coimbatore

urshari@gmail.com

Abstract

Ad-hoc routing protocols may be dispersed and involve every node in the route discovery process by making routing data more reliable. Mobile-Adhoc-Networks (MANETs) consist of many portable nodes that can commune directly with each other or through intermediate nodes. Repeatedly, nodes in MANETs operate with batteries and can roam freely, and thus, a node may exhaust its energy or move away without providing any notice to its cooperative nodes. In MANETs, a route consists of numerous links in sequence, and so, its lifetime is based on the lifetime of every node and also the wireless links among adjacent nodes. In this research work Fuzzified Particle Swarm Optimization oriented Routing (FPSOR) algorithm is planned to minimize data loss and computational overhead, which in turn maximizes the lifetime of MANETs. Particle Swarm Optimization oriented Routing protocol (PSOR) has taken energy competence as a significant criterion for processing routing and driving optimised path for the data accelerating and processing to the source node. The PSOR produces a fresh route for routing by considering the fitness value of energy to evaluate diverse paths and to choose the best-optimised path whose energy consumption is less as compared to ant colony optimization routing paths. This algorithm utilizes a good approach focusing energy levels/status of the nodes through fuzzification and the lengths of the routed ways. NS2 simulator is cast for performance evaluation.

Keywords: Network-centric, Fuzzification, Load Balancing, Arbitrary Trip Time, Mobility, and Convergence Speed.

Introduction

The wire-less era has been undergoing exponential development in the previous decade. The significant advances in network infrastructure, the growing availability of wireless applications, and the emergence of universal wireless devices are as moveable or handheld computers, Personal Digital Assistant (PDA), and cell phones, all getting more powerful in their capabilities [1]. Also, wireless devices are now playing an ever-increasingly important role in our lives, and mobile users can rely on their cellular phones to check e-mail and browse the Internet data [2]. Remote Networks, in the current situation, gives answers for outline and improvement of several continuous remote applications. In wireless sensor networks, Generic and Gateway are the two main types of sensors. First, based on the Wireless Sensor Network (WSN) scenario, the Generic sensors are to take the data from the environment. Multi-purpose sensor nodes mainly undertaking is to catch information from the condition and are furnished with different gadgets that can quantify different characteristics such as Temperature, Humidity, Acceleration, Acoustics, and so forth [3]. Second, Gateway nodes play out the requirement of get-together the information from non-specific nodes and transmit back to sink nodes/base stations. Gateway

nodes when contrasted with generic nodes are all capable of handling, vitality, remote transmission run [4], and so on.

In recent years, Mobile Ad hoc Networks (MANETs) have received attention due to self-design, self-protection self- prearranged, and accommodating environments. In Mobile ad-hoc networks, all the nodes are mobile, and the topology is adjusted speedily exclusive of any predefined infrastructure. Each node in the MANETs can be palmtops, laptops, cellphones, and so on. Figure 1 shows the basic interlink of Mobile Ad Hoc Networks (MANETs) with Wireless Local Area Network (WLAN). Each device can act as both a host and a router to forward packets for other nodes [5].

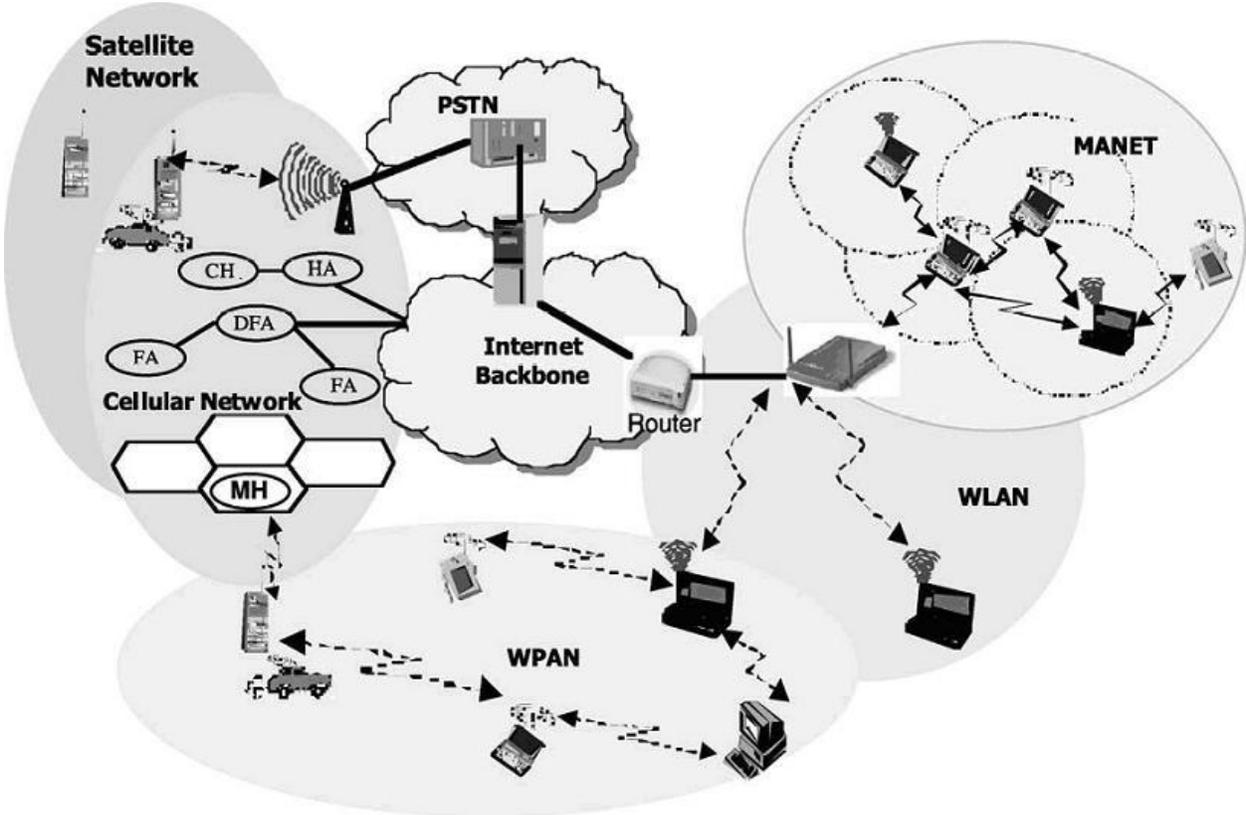


Fig. 1: Basic interlink between MANET and WLAN

The MANETs are an essential key component in the 4G and Fifth Generation (5G) structural design, and ad-hoc networking potential is estimated to become an essential part of overall next-generation wireless network functionalities. In general, MANETs is a self-directed system of mobile nodes that are linked via wireless links exclusive of using an existing network infrastructure or centralised administration. The nodes are free to move arbitrarily and arrange themselves randomly. As a result, the network’s wireless topology may adjust fast and unpredictably. MANETs may operate in a standalone method, or it is connected to the more extensive Internet [6]. MANETs are infrastructure-less networks because they do not require any fixed infrastructure of a base station for processing. Second, multihop wireless ad hoc network

paths support the multi-hops network calls. Though there are numerous advantages, the user population increase does not influence the required number of mobile mesh nodes. An excessively large number of user groups could influence the performance; it requires much work to improve the parameters relating to the dynamic nature of nodes viz. energy drain rate, relative mobility estimation to predict the route lifetime. This has given a set of problems such as a lifetime of sensor nodes is low, maintenance cost is high for overall system performance while routing, energy efficiency is low across the routing network, consumption of sensor energy is high, and best routing path selection with least distance is hard to achieve [7]. Hence this work contributes a framework with the FPSOR approach which provides a better lifetime with a reduction in data loss, energy consumption, and computational overhead. The upcoming section of this paper is systematized as, section 2 describes the related work concerning MANET routing strategy, section 3 describes rule generation to find out the node status with fuzzification, section 4 implements fuzzy integrated node estimation procedures with PSOR. This position-related data is circulated among the nodes present inside the range after proper verification procedure. The route recovering is achieved by insisting on a mechanism of re-routing to the strong nature node to ignore the provision of a weak node, section 5 offers the performance-computation outcomes. Finally, section 6 reveals the conclusion and future direction.

Related Works

A lot of investigations have been directed on the streamlining issue to accomplish an energy-effective MANET. A portion of the strategies depends on the idea of utilizing the energy to a base expand and subsequently expanding the existence season of the organization. Different techniques are depending on the routing advancement that decreases the energy usage when a specific hub is in utilization and so expands the life of the overall MANET. A portion of the strategies that guarantee to accomplish energy effectiveness in a Mobile Ad-hoc network is portrayed in this section.

The routing of MPLS-based MANET is made Ambika et al. [8] by the mixture of FuzzyLogicControllerBased Routing Scheme (FLCR) which is enhanced by PSO. By enhancing the FLC in PSO, the perfect vertex is chosen for creating the successful transmission route. This proposed technique is named as FLCR--MPLS--MANET strategy. The presentation of this strategy is investigated as alive vertices, dead vertices, energy utilization, throughput, and capacity of bandwidth. The proposed technique is contrasted and the current strategy Dist-MANET and the BECIT. This Dist-MANET thought about just the distance while producing the transmission path in the whole network. The transmission capacity of the technique expanded at 43% and 95% against the Dist-MANET and the BECIT separately.

Chander et al. [9] a viable planning calculation Cross-layer directing for multicast was acquainted with upgrade the nature of administration utilizing a tree-based multicast steering convention which furnishes a three route improvement with snappy pivot time, decreases the energy and temperature than in separation. The investigation on Ad Hoc On-Demand Vector and Dynamic Manet On-Demand steering conventions are performed utilizing the Qualnet test system

under the IPv4 and IPv6 guidelines. A careful assessment of the ease of use and usefulness of the test system programming is done. The measurements for execution are; Throughput, End-to-End Delay, and Average jitter. A while later, investigations Majeed et al. [10] and synopsis of the outcomes are directed and summed up to make accessible an evaluation of their exhibitions.

Alappatt et al. [11] framed a hybridized method of ACO-BPSO which associates, Ant Colony Optimization (ACO) and the Binary Particle Swarm Optimization for the increment of a lifetime of the overall network. The ACO supports switching between the LIVE mode and SLEEP mode in the nodes. This method is simulated with NS2-simulator and the outcomes look remarkably worthy in measures such as overall throughput, Packet Delivery Ratio (PDR), and energy in residual when equated with other existing techniques. One more research work utilized the FOA (Fruit fly Optimized Algorithm) Omran et al. [12] to control the issue and find a fitting guiding as opposed to the briefest method. The results found are differentiated and the particle swarm smoothing out (PSO) approach and ordinary AODV directing show, the proposed (FOA) method offers the snappiest and most exact pathway. The numerical diversions show that the suggested approach achieved better displays by delay time and improve the capability of the structure.

Sindhuja et al. [13] described that the ongoing issues in a versatile organization are load awkwardness, more correspondence delay, discovering the best way is troublesome and energy utilization for the particular directing way. Terminal dependability doesn't consider this multitude of improvement measures, by using diverse pointless ways between the source and the objective, which restricts the authority of this issue. This lessens the organization's lifetime, productivity and expands the postponement. The Proposed Extensible Particle Swarm improvement (EPSO) strategy is executed to acquire the dependable steering way, which has a better attainable solid lifetime since hubs are prepared to advance information bundle ceaselessly. The course set picking calculation is intended to find the effective hub sets and fixes the heap adjusting way. This deals with the hefty burden during the correspondence period by streamlining proficient ways. This improves the organization's lifetime, productivity and diminishes the start to finish delay. Numerous strength-based route predicting algorithms are found around how to find a reasonable course for moving packets through halfway hubs, however, little consideration is given to finding a steady course that overflows just the base number of overhead control packets. In the previous few years, a few fuzzy-based conventions for MANETs have been anticipated, driving to another side of research. The upcoming sections will portrait the working of the proposed research and its performance evaluation with remarkable parameters.

Methodology:

Basic PSOR is a population-based method in which the discovery of the optimal solution is not guaranteed. Likewise, it may be stuck in nearby optima when managing complex multimodal capacities. This is the reason quickening the union speed just as keeping away from the nearby optima issue are two essential objectives in this FPSOR research. The proposed optimization model is segregated into three phases such as,

- Initialization phase with fuzzy for a rule set generation to predict the status of the nodes

- Appending swarm with fuzzy (fuzzified PSO) to compute values for fitness of the nodes
- Optimal route deciding by comparing fitness and status of the nodes

Phase 1: Node status predictor model:

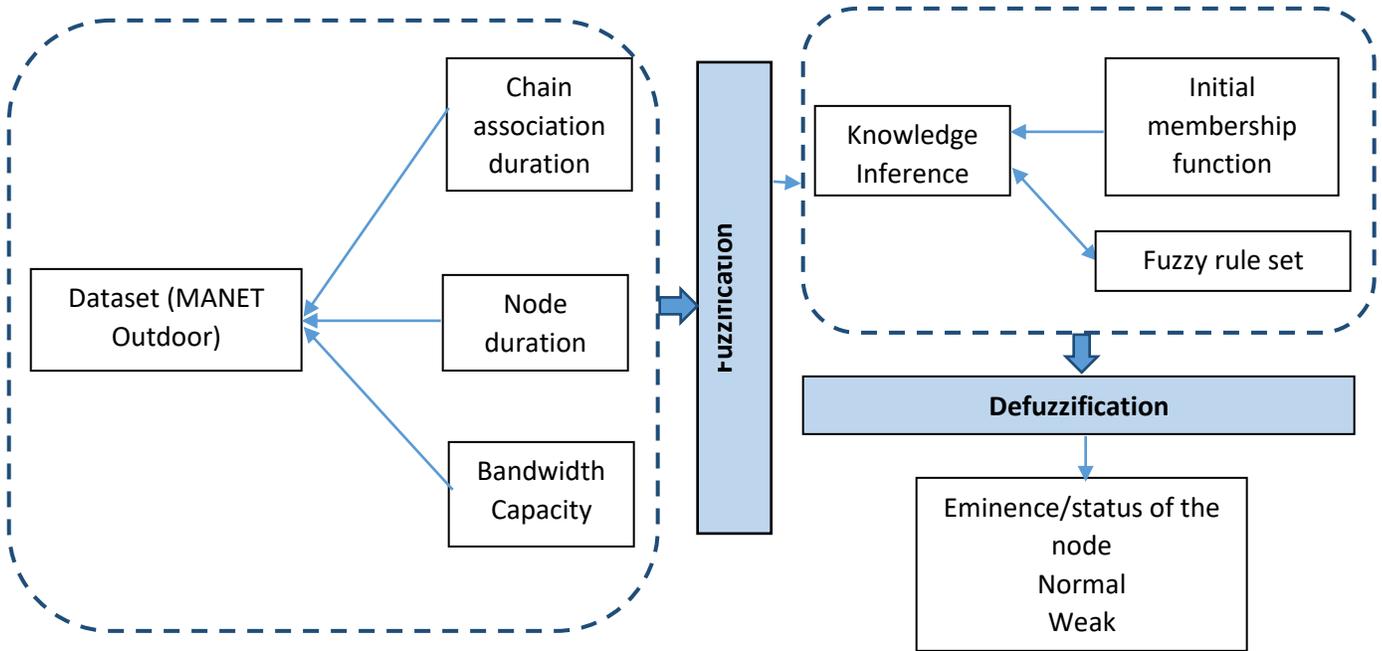


Fig. 2: Fuzzified node predictor framework

This technique involves the detection of the node's status by fuzzy logic technique as shown in Figure 2. The steps to determine the fuzzy rule set generation with knowledge-based inference are as follows:

- Fuzzification: The crisp inputs are obtained from the selected input variables and then the degrees to which the inputs belong to each of the suitable fuzzy set are estimated.
- Aggregation of the rule outputs: This involves merging the output of all rules.
- Rule evaluation: Fuzzified inputs are taken and applied to the antecedents of the fuzzy rules. It is then applied to the consequent membership function.
- Defuzzification: The merged output of the aggregate output fuzzy set is the input for the defuzzification process and a single crisp number is obtained as output.

Initially, the fuzzy logic engine analyzes each node for the detection of the node status such as Medium (M) weak (W) and strong (S) based on predicted parameters such as link lifetime (LTM), node lifetime (LTN), and available bandwidth (β).

Process of Fuzzification:

This includes fuzzification of information factors, for example, connect lifetime (M), hub lifetime (N), and accessible data transfer capacity (AB), and these sources of info are given a degree to

fitting fluffy sets. The yield fresh information sources are the blend of M, N, and B. We take two prospects, high and low, for M, N, and AB.

Process of Defuzzification:

The technique by which the crisp values are extracted from a fuzzy set as a representative value is referred to as defuzzification. The centroid of the area scheme is taken into consideration for defuzzification during the fuzzy decision-making process. Figure 3 depicts the status of nodes after the fuzzification process.

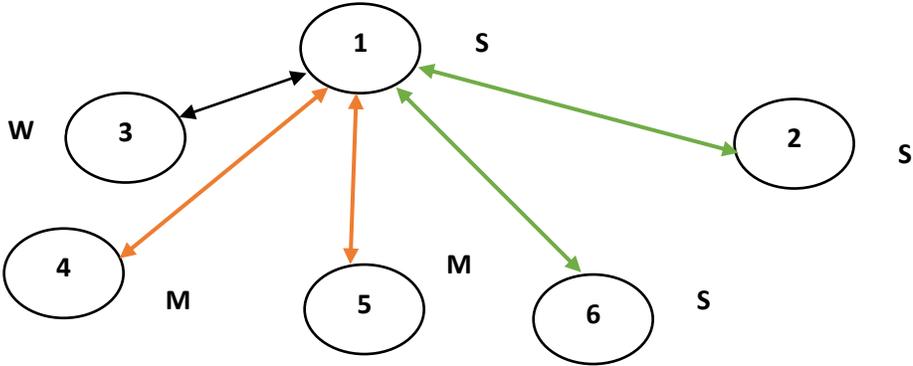


Fig. 3: Node priority based on a fuzzified rule

Table 1: Status of nodes after fuzzy set generation

Node No.	Status
1	Strong
2	Strong
3	Weak
4	Medium
5	Medium
6	Strong

Table 1 anticipates the route prediction based on the position of the nodes. Before a hub communicates the information to the following hub, it checks the situation with that hub. On the off chance that the status is medium or solid, it will send the parcel to the following hub. On the off chance that the situation with the replacement hub is feeble, it will send a course recuperation cautioning message to every adjoining hub. After accepting the course recuperation cautioning bundle, the adjoining hubs glance around to discover solid hubs. On the off chance that it finds solid hubs, they will start the neighborhood course recuperation measure by changing the course to the solid hubs. If they can't locate any solid hubs, they will start the course recuperation measure through medium hubs.

Phase 2: Appending swarm intelligence

When a data packet is to be forwarded, and it cannot be to the next-hop because no forwarding route for the IP destination address exists; Route REPLY (RREP) is issued. Based on this condition, an unreachable destination message must not be generated unless this router is responsible for the IP destination address and that the IP destination address is known to be unreachable. Moreover, a RERR should be issued after detecting a broken link of a forwarding route and quickly notify PSO routers that a link break occurred and that specific routes are no longer available. If the route with the broken link has not been used recently, the RERR should do the following steps.

Level-1 operation

1. Based on the priority assigned top three attributes are selected for every region.
2. The top three priority nodes are selected.
3. Select the nodes which are nearing the optimal value (relaxation of ± 2). Selection is made for the nodes which would satisfy the relaxation range from 0 to 2.
4. Build a graph to ensure connectivity exists between regions and apply a second-level grade to find the optimal path.

Algorithm: Fuzzified PSO for fitness calculation and packet forwarding

```

Start each particle i in S do
for every dimension d in D do
// Initialise all particles position (X) and velocity(V)
Xi,d = Random (X min, X max )
Vi,d = Random (-V max/3, V max/3)
end for
Initialise all particles best position
pbi = xi
for i=0;
{
i < total no of nodes(N)
for j=0;
{
j < total nodes(N)
//Distance Calculation(Dc)
set k = 0
j < total nodes(N)
Dc  $\sqrt{(x_j-x_i)^2 + (y_j-y_i)^2}$ 
If {
$ g N $i $j
}
}
}
Puts "Distance from node $g = ($i) to ($j)
update all particles global best position (g) using distance Calculation and Position
representation (equation 4.1 and 4.2 and position 4.3 and 4.4)
If f (pbi) < f (gbi) then
gb = pbi
enf if

```

end for

The local best (Lbp) and global best (Gbp) value of fitness and position of each particle as in Figure 4 is estimated using the following equation,

$$F_i = (\psi_1 * L_{tm}) + (\psi_2 * L_{tn}) + (\psi_3 * \beta_i) \quad \text{-----}(1)$$

Update the position of Lbp and Gbp according to the following condition.

i. If $F_i > F_i$ (Lbpi) Then

Update the position of Lbp with the fitness value F_i

End if

ii. If $F_i > F_i$ (Gbpi) Then

Update the position of Gbp with fitness value F_i

The process of next route prediction with a chain of a hop is anticipated by,

$$F_{iPSOR} = \sum_{rule\ set}^z * \beta Z \quad \text{-----}(2)$$

The main components of the proposed improvised protocol (PSOR): Basically, PSOR is a routing protocol that aims at replacing the preset variables of the network parameter (total number of nodes) through a new connectivity metric. Also, it reduces the routing overhead by dropping the extra RREQ packets using a novel dynamic connectivity factor. The proposed improvised protocol PSOR is developed to work under the three main stages of route discovery, route reply, and route maintenance.

To illustrate, any node that has data to be sent to any node in the network must check its routing table for such a destination. If the destination is found, the source node starts to send the data it has; otherwise, it initiates RREQ to find a route to the sink node. Commonly, the only way to find the nodes that have a path to the destination node is the flooding mechanism, in which each node receiving the RREQ for the first time rebroadcasts the RREQ. Then, the sink node or any node that has a route to the destination node replies with a Route REPLY message (RREP). However, due to the frequent movement of nodes, link breakage may occur, and the node that discovers such an event issues Route ERRor message (RERR) to its neighbours to report this breakage. The PSOR addresses the flooding issue at the first stage (route discovery) by reducing the redundant RREQ packets. By reducing these packets and replacing the preset variables, the system performance improves. Coverage Redundancy Time Ratio can be computed as,

$$\sqrt{Q^2 + P^2} dx = \frac{x}{2} \sqrt{Q^2 + P^2} + \frac{Q^2}{2} \sin^{-1} \frac{x}{Q} + c \quad \text{-----}(3)$$

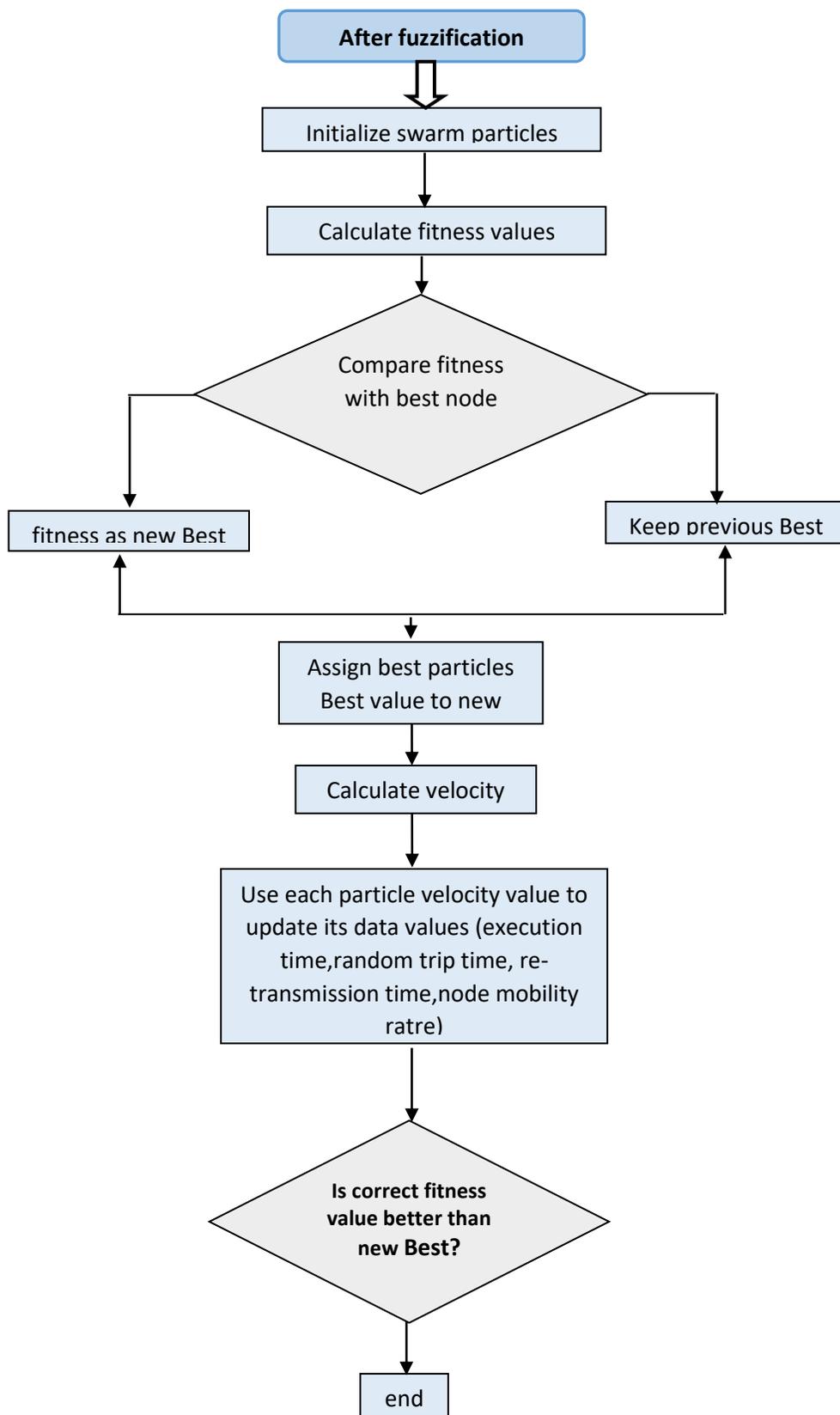


Fig. 4: Fuzzified PSOR flow diagram

Phase 3: Optimal route deciding

Distance Calculation:

This research focuses on parameter selection and aims to generate a different strategy and attempts to reduce the iteration count. To make use of the knowledge of neighbour coverage in an efficient manner a rebroadcast is required to determine the rebroadcast order and then attain a more accurate additional coverage ratio. Connectivity Rate, Coverage Ratio, Neighbour covered Ratio, Coverage Redundancy Time Ratio metrics are considered as a parameter to choose the number of neighbours should obtain RREQ packet to avoid the trouble of unnecessary retransmissions. Figure 5 is representing the broadcasting with optimal route selection process.

A node that has several familiar neighbours with the previous node has a lower interruption. If this node rebroadcasts a packet, some neighbours will know this detail. So, the primary purpose of the rebroadcast delay is nodes that have transmitted the packet spread to more neighbours. After that the determination of rebroadcast probability takes place. In the rebroadcast probability, there are four metrics:

- ConnectivityRate
- Coverage Ratio
- Neighbour coveredRatio
- Coverage Redundancy TimeRatio

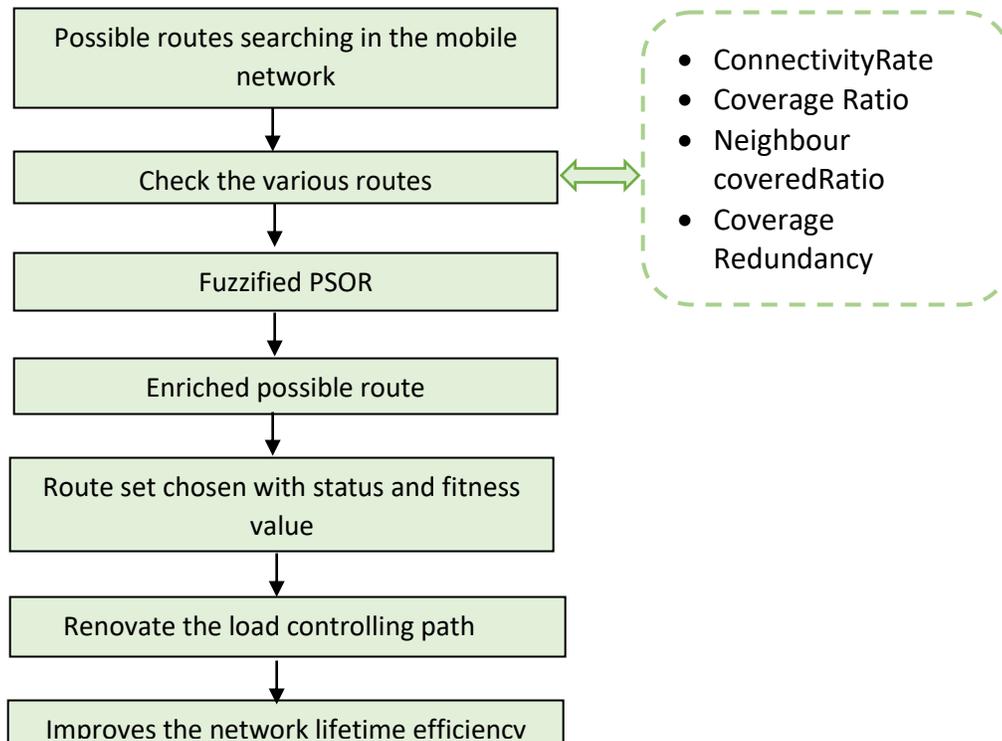


Fig. 5: Optimal route selection process using various parameters

Parameters Setting:

- The first metric is called the connectivity factor is defined as an association of network connectivity and the number of neighbours of a given node.
- The second metric is called the new coverage ratio is defined as the ratio of the number of nodes that should be additionally covered.
- The third metric is called Neighbour covered Ratio is defined as the ratio of the number of nodes that should be covered and the total number of neighbours.
- The fourth metric is called Coverage Redundancy Time Ratio is defined as the ratio of an association of network redundancy time of a given node.

Connectivity Rate is defined in Equation4,

$$cf (n_i) = \frac{c(N_c)}{|N(n_i)|} \text{ -----(4)}$$

The coverage ratio (cr)of the node is defined in Equation5,

$$cr(n_i) = \frac{|U(n_i)|}{|N(n_i)|} \text{ -----(5)}$$

Where Ni-node of i

Nc-Node connectivity $N_c = 5.1774 \log n$

Cf–Connectivity factor

Results and discussions

Now, the proposed improvised algorithm is examined through its implementation in the NS-2 environment. Table 2shows NS-2.34 simulation parameters.

Table 2: Simulation Parameters for fuzzified PSOR

Parameter	Specification
Simulation tools used	NS2 Network Simulator NS 2.34
Network space	1000m * 1000m
Simulation time:	500 second
Traffic model:	CBR
Number of nodes	10,20,40,60,100
Transmission Range	250m
Mobility model:	random walk point
Medium access protocol:	IEEE 802.11
Speed of mobile nodes: 0-20 m/s	0-20 m/s

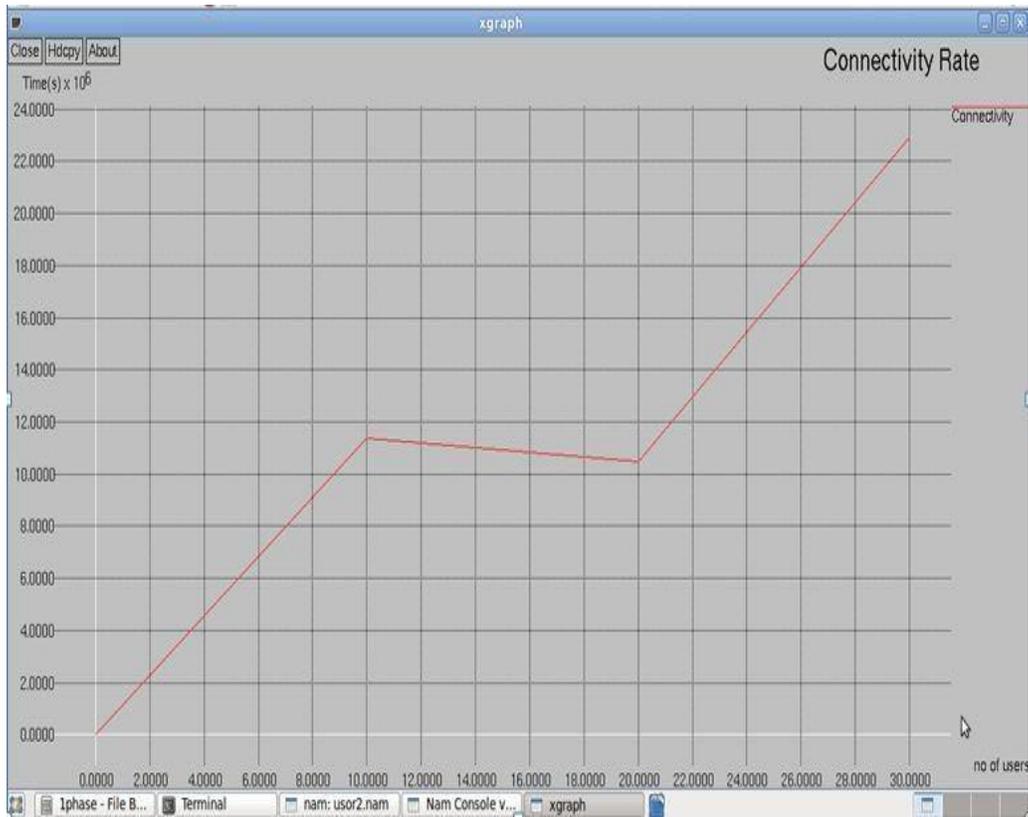


Fig 6: Simulation of connectivity rate with transmission parameters

Table 3: Connectivity Rate of Transmission Parameters

No. of Nodes	Connectivity Rate
50	70
100	110
250	170
300	240

The connectivity factor is defined as an association between network connectivity and the number of neighbours of a given node. From Table 3, when the users (nodes) increase, the connectivity rate ($\text{Times} \times 10^6$) shows an increase. In conclusion, this Connectivity Rate parameter, which is considered in this study, influences the performance of the proposed improvised FPSOR algorithm. Figure 6 shows simulation results of connectivity rate with transmission parameter.

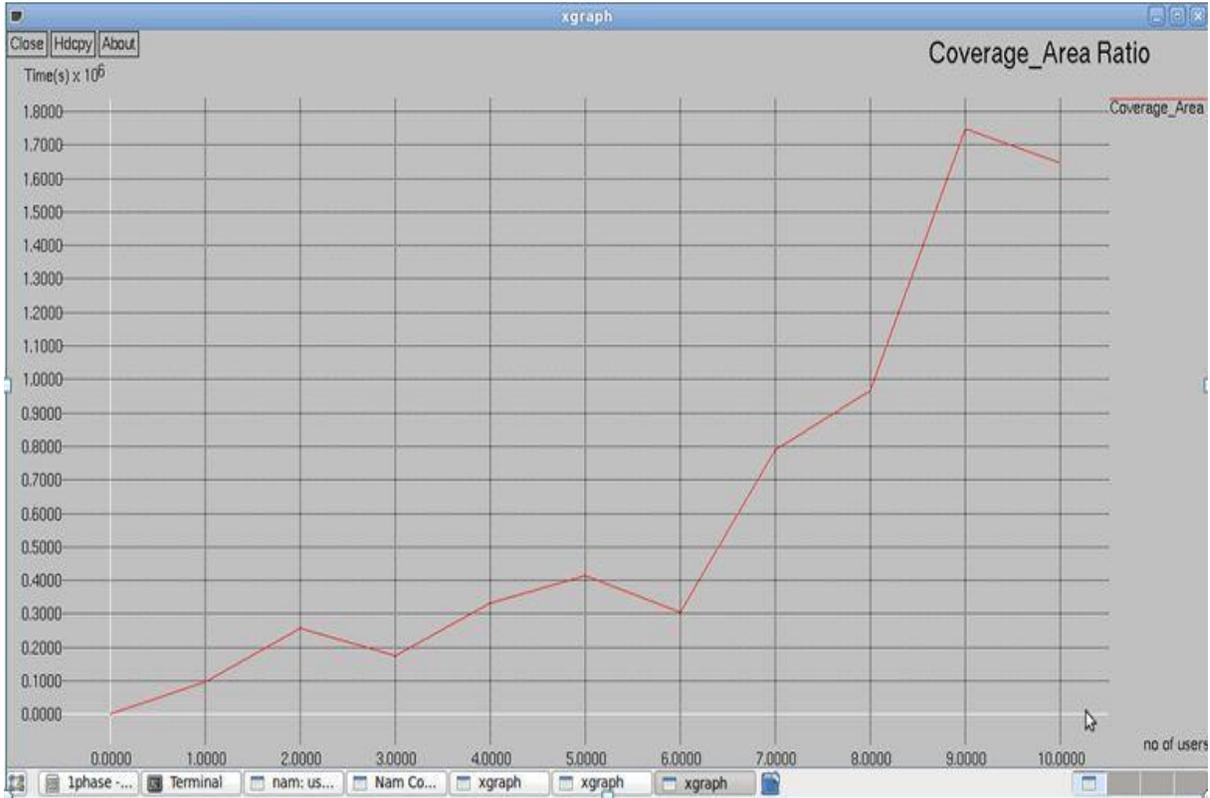


Fig. 7: Simulation of Coverage Ratio with Transmission Parameters

Table 4: Coverage Ratio of Transmission Parameters

No. of Nodes	Coverage area ratio
10	100
20	250

50	422
70	800

Table 4 presents the results of the Coverage Ratio in the proposed FPSOR framework. Figure 7 is the simulation result shows when the users increase, the Coverage Area Ratio (Times*10⁶) shows an increase. In conclusion, this Coverage area Ratio parameter, which is considered in this research work, influences the performance of the proposed FPSOR algorithm.

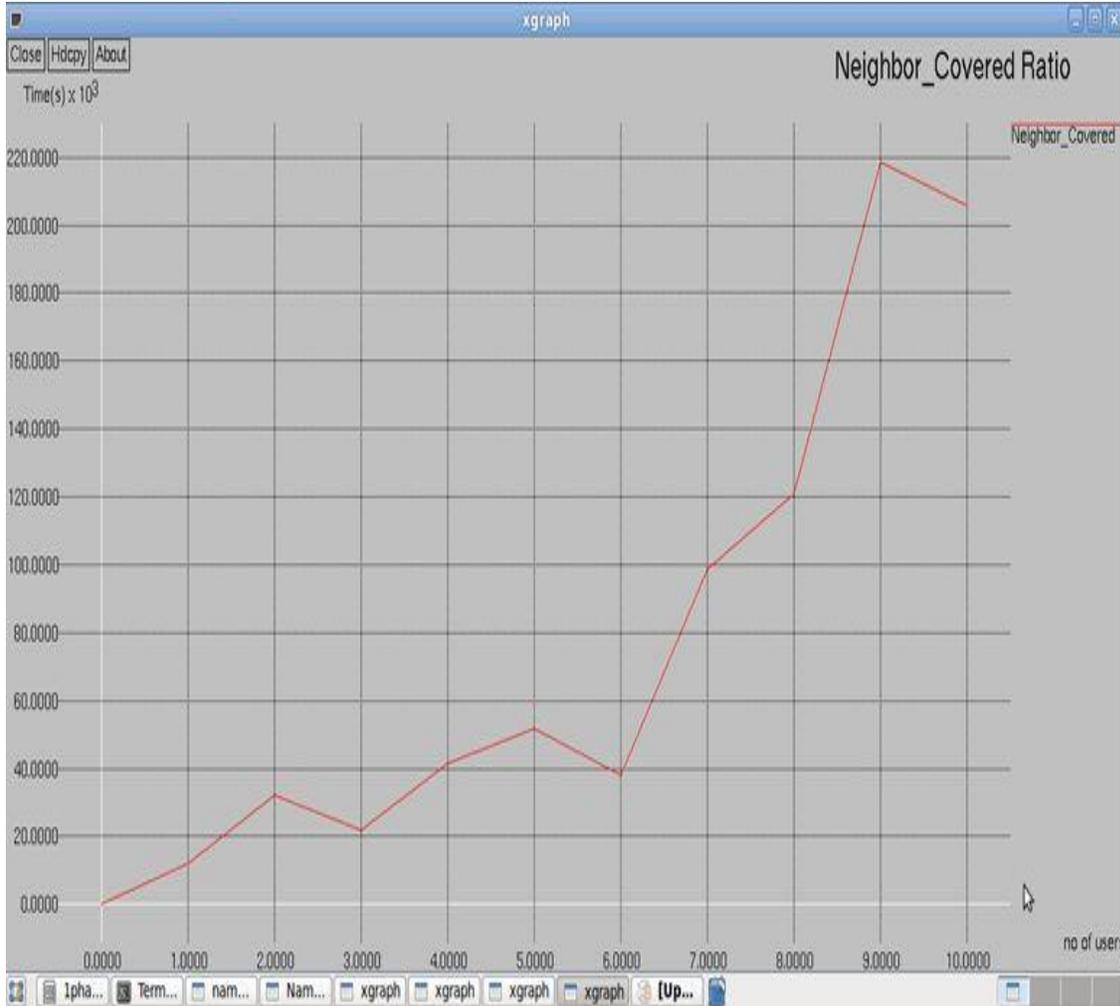


Fig. 8: Simulation of Neighbour Coverage Ratio with Transmission Parameters

Table 5: Neighbour Coverage Ratio of Transmission Parameters

No. of Nodes	Neighbour Coverage Ratio
10	150
20	300

40	420
70	1000
90	2200

Table 5 presents Neighbour Coverage Ratio in the proposed FPSOR framework, Figure: 8 Simulation Results shows when the users increase, the Neighbour Coverage Ratio (Times*10⁶) shows an increase. In conclusion, this Neighbour Coverage Ratio parameter, which is considered in this work, influences the performance of the proposed FPSOR algorithm.

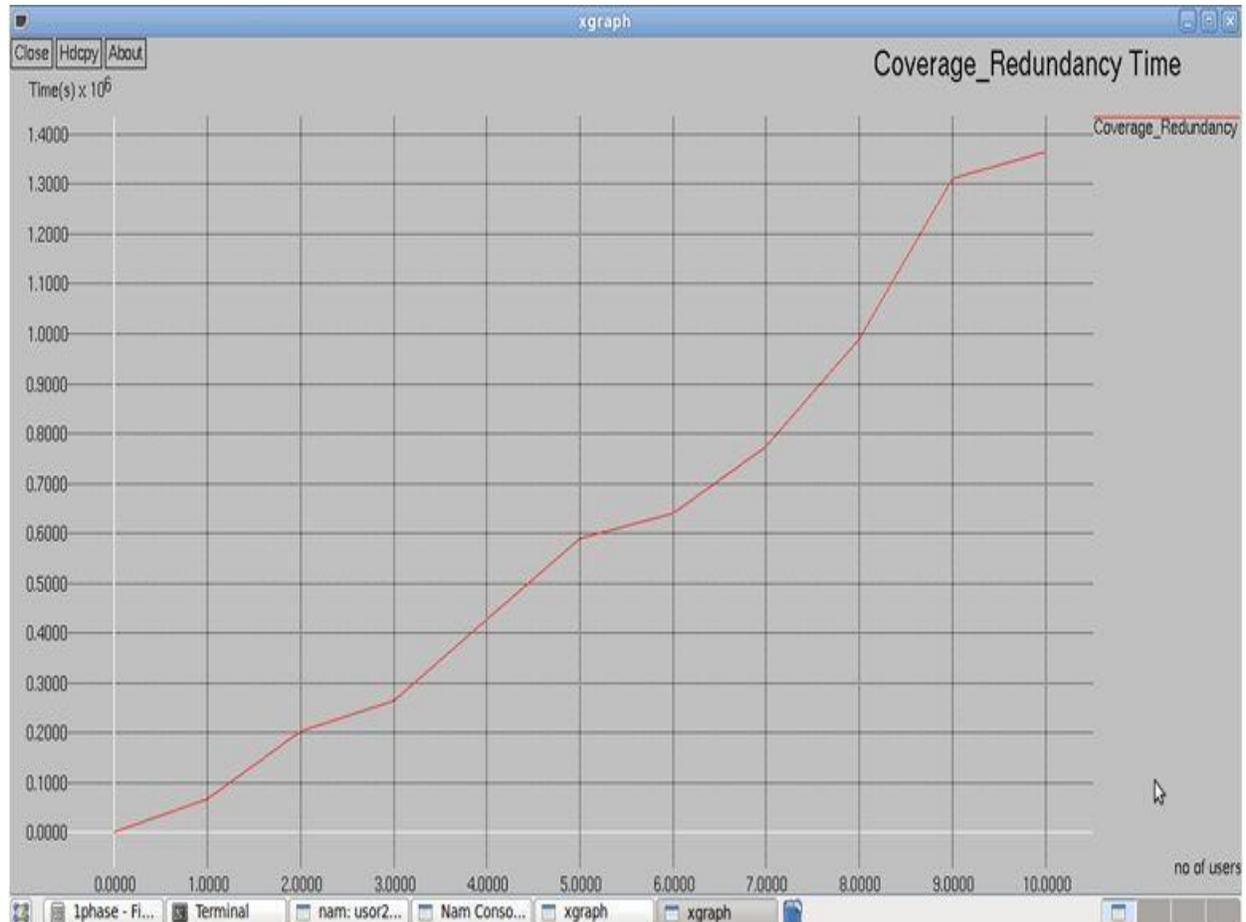


Fig. 9: Simulation of Coverage Redundancy Time Ratio with Transmission Parameter

Table 9: Provides Coverage Redundancy Time of Transmission Parameters

No. of Nodes	Coverage redundancy time
1	0.075
2	0.200
3	0.270
5	0.590
7	0.770
9	1.303

Table 9 presents the Coverage Redundancy Time Ratio in the proposed FPSOR framework. Figure: 9 Simulation shows when the number of users increases, the Coverage Redundancy Time Ratio (Times*10⁶) shows an increase. In conclusion, this Coverage Redundancy Time parameter, which is considered in this work, influences the performance of the proposed FPSOR algorithm.

Conclusion

The fuzzified PSOR framework selects an optimal route to strengthen the network lifetime is the core ideation of this research work. FPSOR has tested the transmission parameters namely Connectivity, Coverage, Neighbour covered, and Coverage Redundancy Time Ratios by reducing the redundant RREQ packets by using NS2.34 simulators. The results of a simulation that is based on the algorithm (FPSOR) developed for this work provide an improvement in the flooding issue in route discovery and route maintenance. The output of FPSOR must also eliminate the non-production nodes in the route selection. By reducing these packets and replacing the preset variables, the system performance improves in areas such as implementing routing discovery, avoiding unnecessary information transfer. Thereby, the efficiency of the MANET platform can be attained.

References

1. Tahboush, M., & Agoyi, M. (2021). A Hybrid Wormhole Attack Detection in Mobile Ad-Hoc Network (MANET). *IEEE Access*, 9, 11872-11883.
2. Gromova, E. V., Kireev, S., Lazareva, A., Kirpichnikova, A., & Gromov, D. (2021). MANET performance optimization using network-based criteria and unmanned aerial vehicles. *Journal of Sensor and Actuator Networks*, 10(1), 8.

4. Sankayya, M., kumar Sakthivel, R., Gayathri, N., & Al-Turjman, F. (2021). Wireless sensor network–based delay minimization framework for IoT applications. *Personal and Ubiquitous Computing*, 1-9.
5. Chung, K. L., Yan, X., Cui, A., & Li, Y. (2021). Circularly-polarized linear antenna array of non-identical radiating patch elements for WiFi/WLAN applications. *AEU-International Journal of Electronics and Communications*, 129, 153526.
6. Abed, A. T., Singh, M. S. J., Thiruchelvam, V., Duraikannan, S., Tawfeeq, O. A., Tawfeeq, B. A., & Islam, M. T. (2021). Challenges and limits of fractal and slot antennas for WLAN, LTE, ISM, and 5G communication: a review paper. *Annals of Telecommunications*, 1-11.
7. Alam, T. (2020). Middleware implementation in MANET of Android Devices. *Tanweer Alam.* "Middleware implementation in MANET of Android Devices.", *International Journal of Electronics and Information Engineering*, 12(2).
8. Ambika, B. J., & Banga, M. K. (2021). A novel energy efficient routing algorithm for MPLS-MANET using fuzzy logic controller. *International Journal of Information and Computer Security*, 14(1), 20-39.
9. Chander, D., & Kumar, R. (2018). QoS enabled cross-layer multicast routing over mobile ad hoc networks. *Procedia Computer Science*, 125, 215-227.
10. Majeed, J. H., Habeeb, N. A., & Al-Azzawi, W. K. (2021). Performance investigations of internet protocol versions for mobile Ad-hoc network based on qualnet simulator. *Indonesian Journal of Electrical Engineering and Computer Science*, 21(1), 497-504.
11. V. Alappatt and P. M. Joe Prathap, "A Hybrid Approach Using Ant Colony Optimization and Binary Particle Swarm Optimization (ACO: BPSO) for Energy Efficient Multi-path Routing in MANET," 2020 *Advanced Computing and Communication Technologies for High Performance Applications (ACCTHPA)*, Cochin, India, 2020, pp. 175-178, doi: 10.1109/ACCTHPA49271.2020.9213196.
12. K. M. Omran, "The Routing Control in Mobile Ad hoc Network Using Intelligent Optimization Algorithms," 2020 *International Conference on Electrical, Communication, and Computer Engineering (ICECCE)*, Istanbul, Turkey, 2020, pp. 1-6, doi: 10.1109/ICECCE49384.2020.9179296.

13. S. Sindhuja and R. Vadivel, "Extensible Particle Swarm Optimization Technique Using Route Set Choosing Algorithm in MANET," 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), Vellore, India, 2020, pp. 1-8, doi: 10.1109/ic-ETITE47903.2020.385.
14. Asokan, R., & Preethi, P. (2021). Deep Learning With Conceptual View in Meta Data for Content Categorization. In Deep Learning Applications and Intelligent Decision Making in Engineering (pp. 176-191). IGI Global.
15. Sherubha, P., Mohanasundaram, N., Rekha, S. S., & Porkodi, V. (2020, September). Task-Driven Approach for Deadline Based Scheduling Across Sensor Networks. In 2020 International Conference on Computing and Information Technology (ICCI-1441) (pp. 1-5). IEEE.
16. Gurung, S., & Chauhan, S. (2020). A survey of black-hole attack mitigation techniques in MANET: merits, drawbacks, and suitability. *Wireless Networks*, 26(3), 1981-2011.
17. Yang, H. (2020). A Study on Improving Secure Routing Performance Using Trust Model in MANET. *Mobile Information Systems*, 2020.
18. Wadhvani, G. K., Khatri, S. K., & Mutto, S. K. (2020). Trust framework for attack resilience in MANET using AODV. *Journal of Discrete Mathematical Sciences and Cryptography*, 23(1), 209-220.
19. Ran, C., Zhang, S., & Huai, S. (2021). Link availability Prediction based on capacity optimization in MANET.
20. Subramanian, V., Durairaj, R. B., Mageshwaran, G., Prakash, S., Deeraj, B., & Dheeban, S. (2020, December). Experimental investigation on mechanical erosion and permeation behavior of plasma nitriding over manet steel. In AIP Conference Proceedings (Vol. 2311, No. 1, p. 070004). AIP Publishing LLC.

Figures

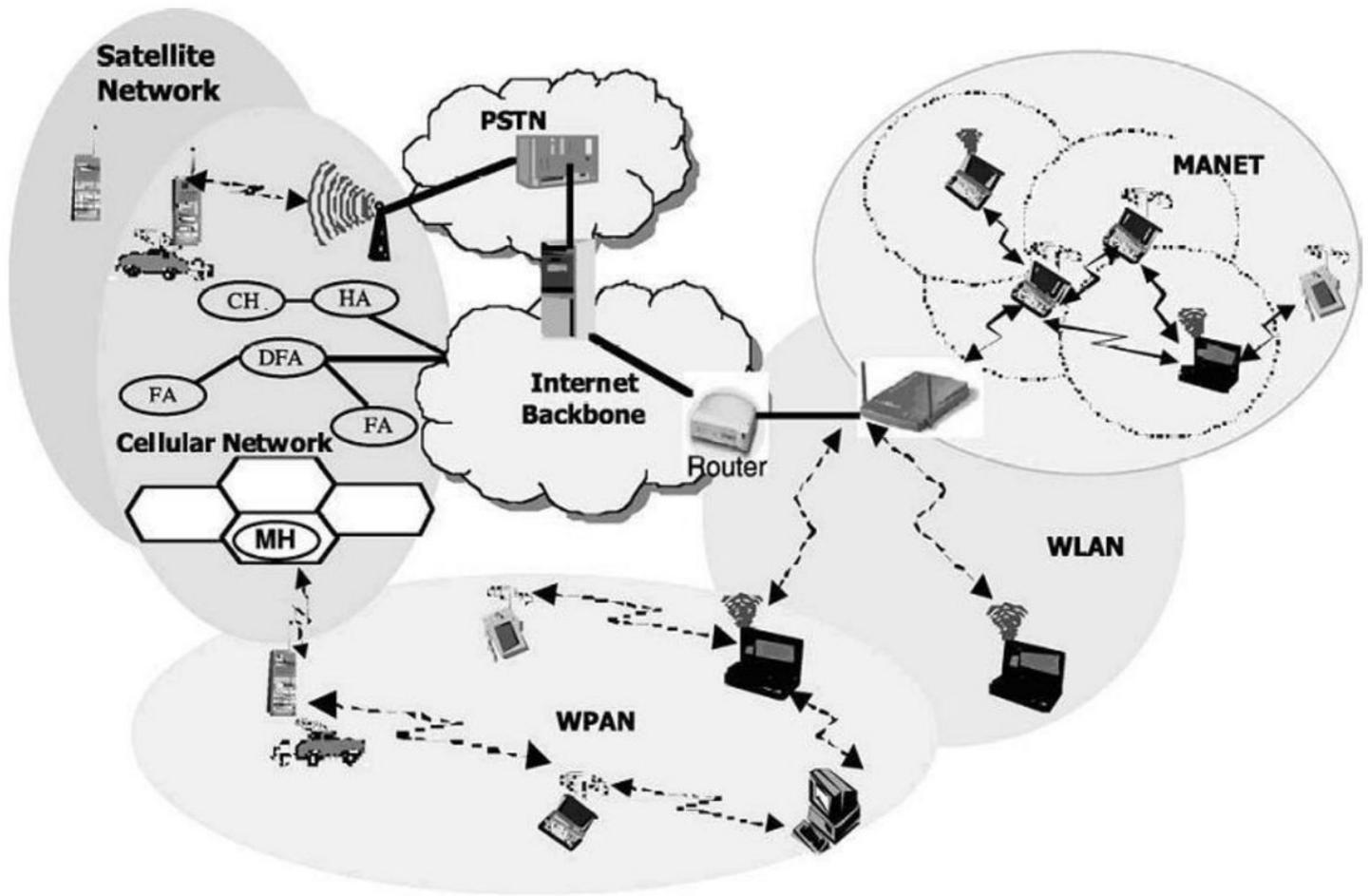


Figure 1

Basic interlink between MANET and WLAN

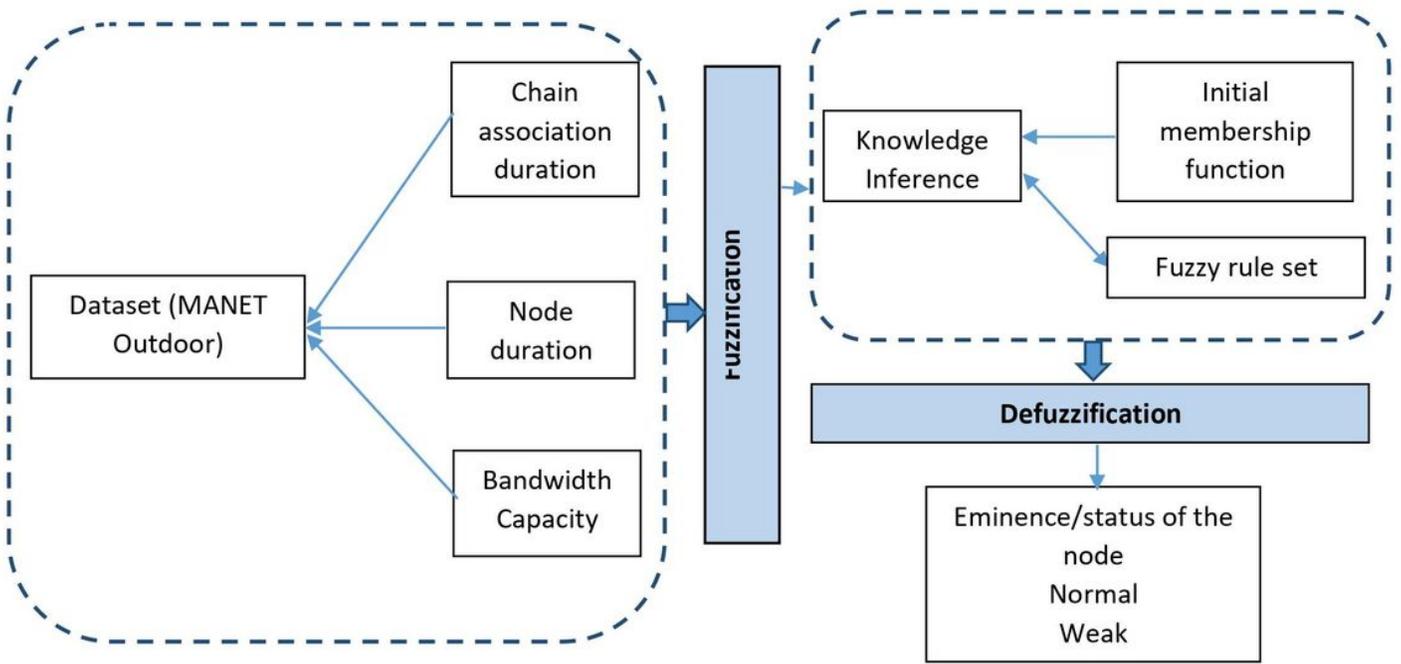


Figure 2

Fuzzified node predictor framework

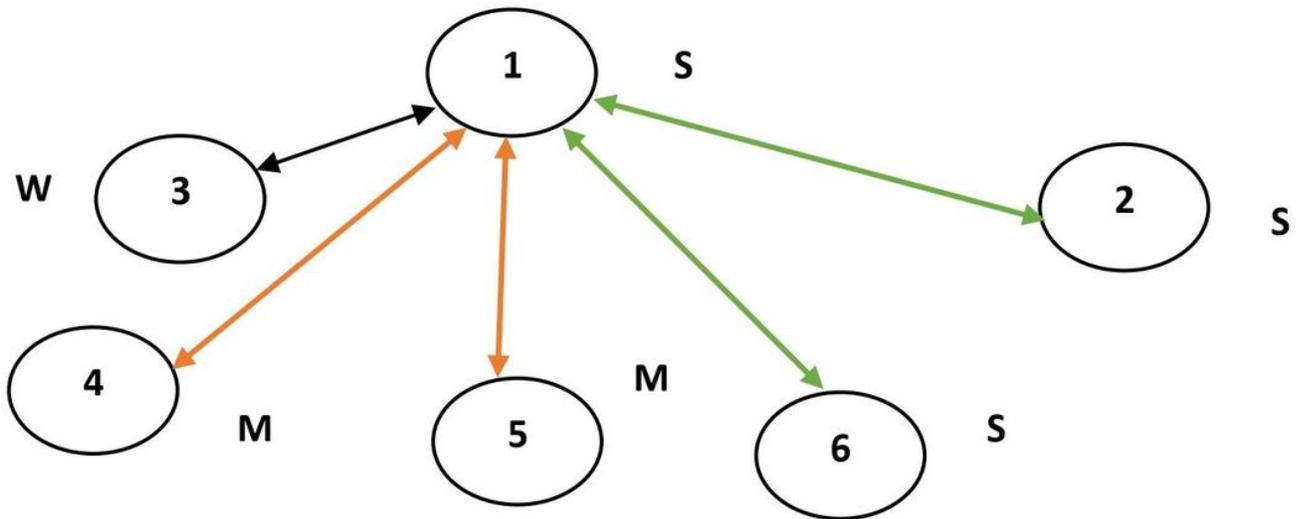


Figure 3

Node priority based on a fuzzified rule

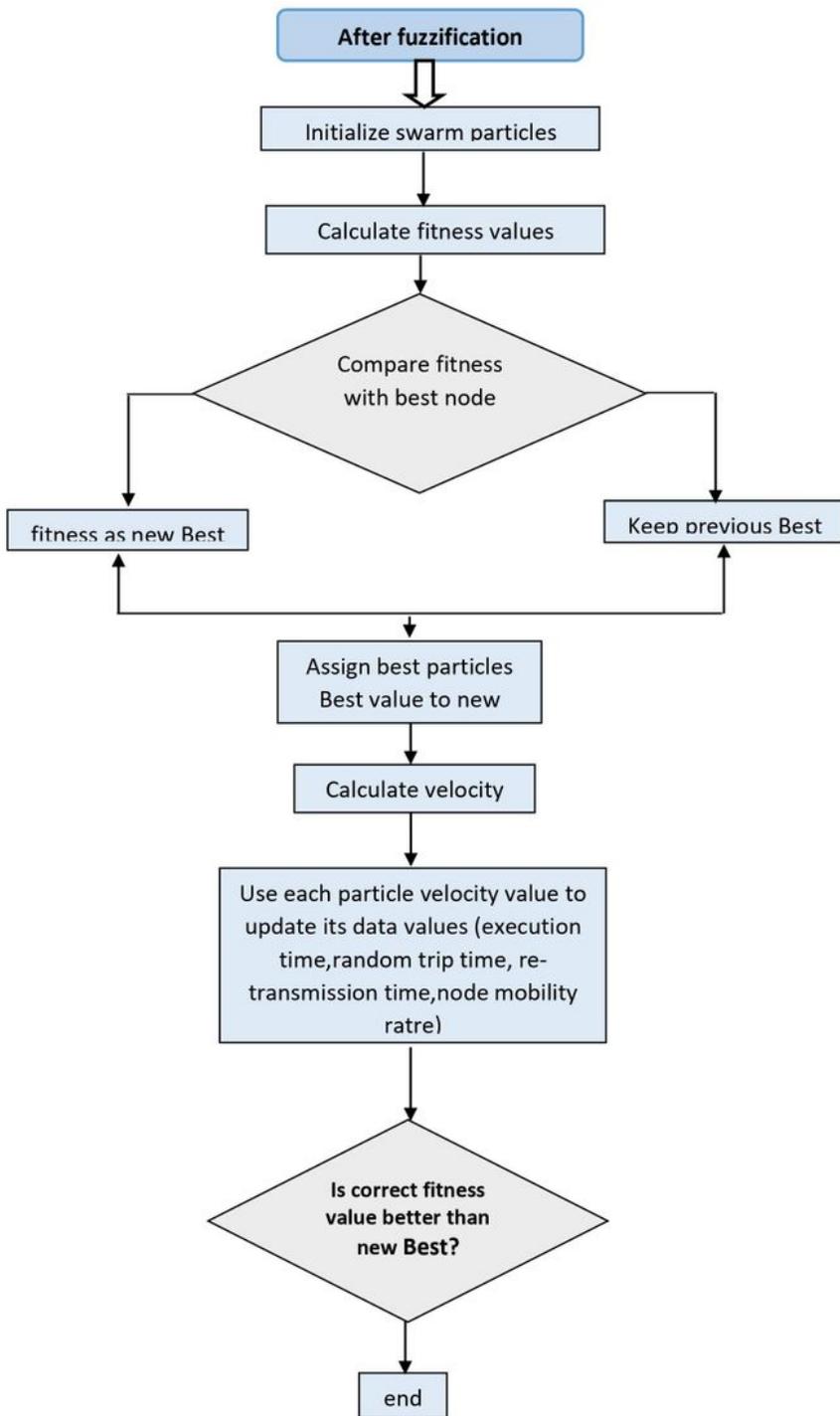


Figure 4

Fuzzified PSOR flow diagram

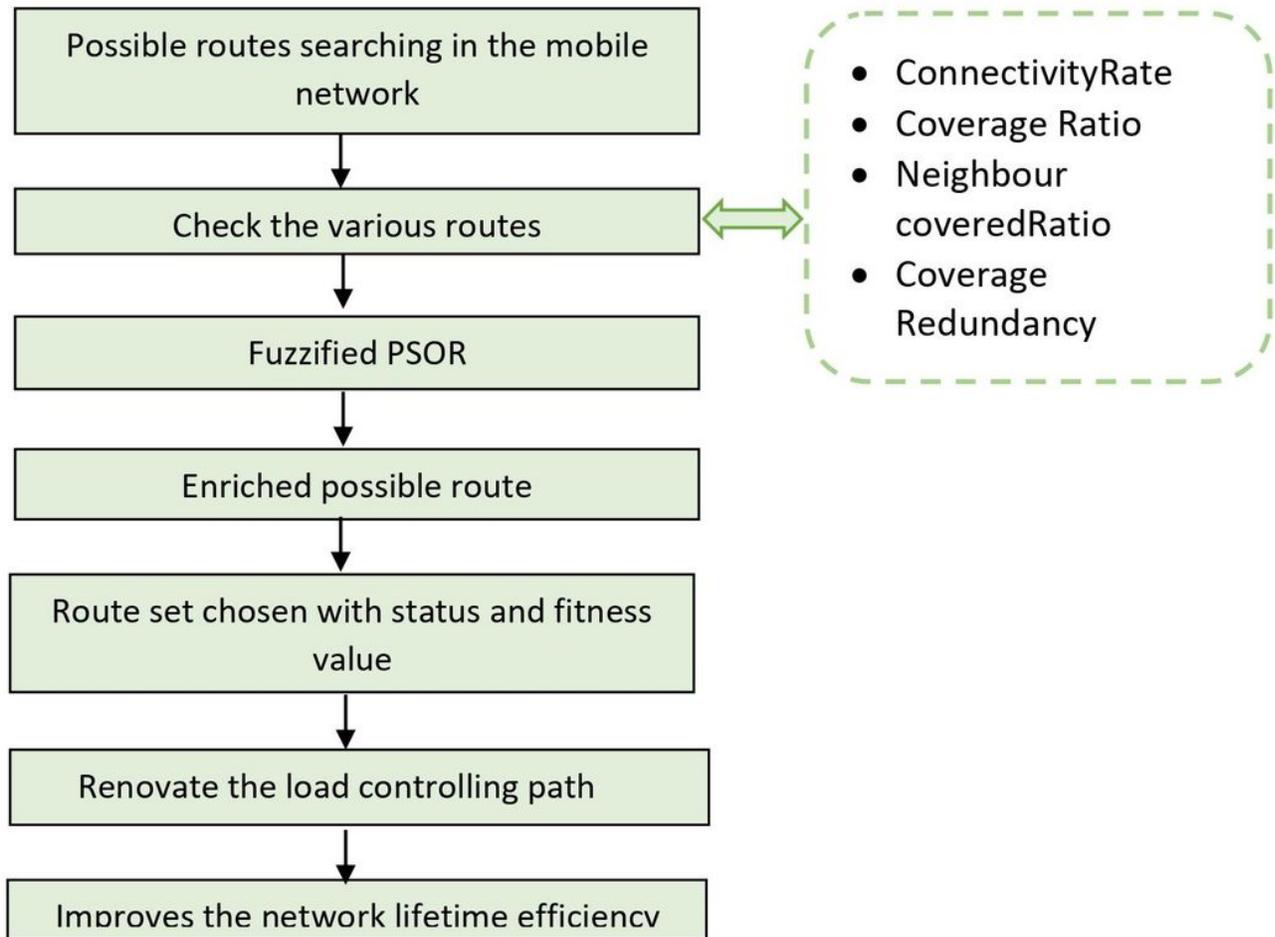


Figure 5

Optimal route selection process using various parameters

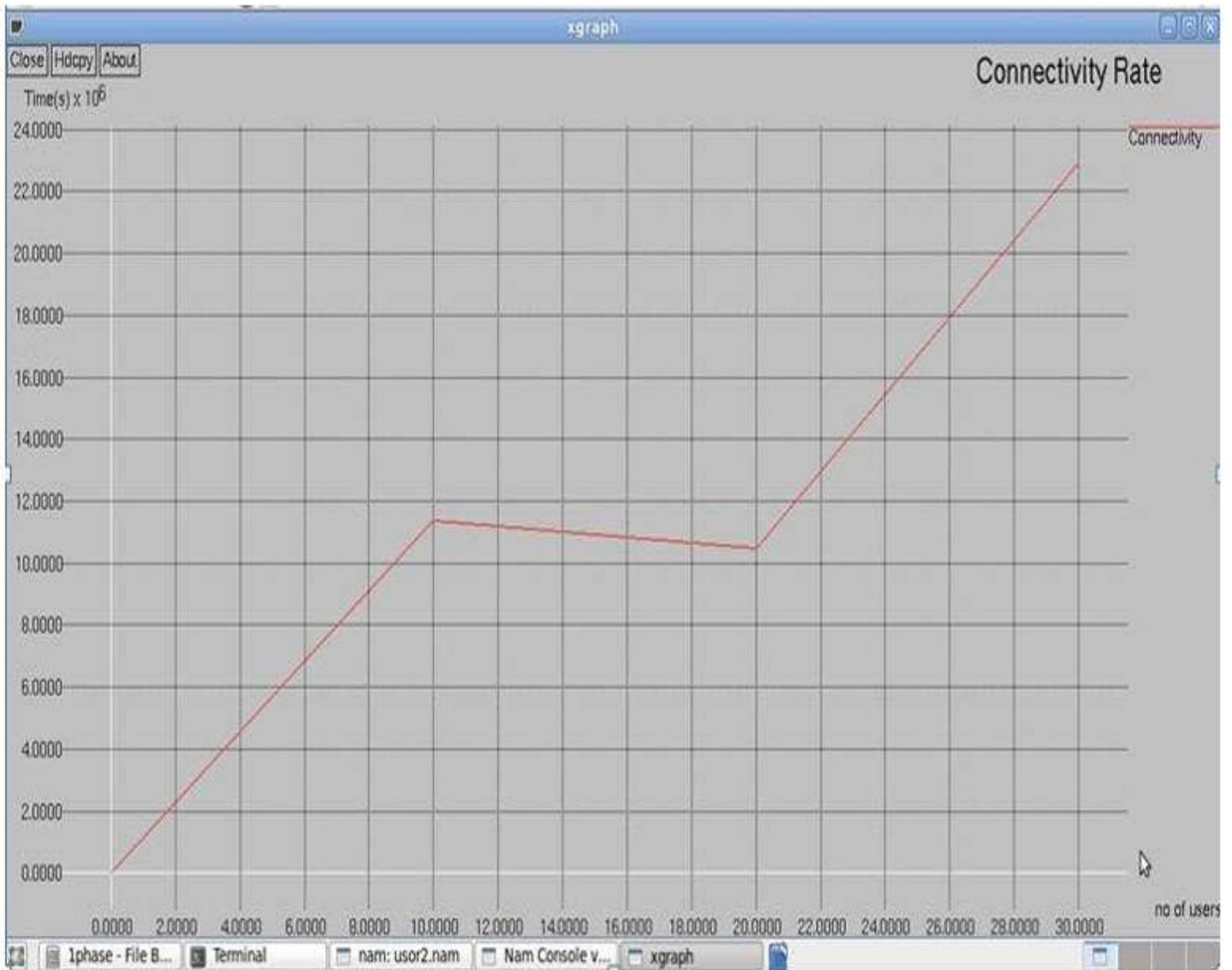


Figure 6

Simulation of connectivity rate with transmission parameters



Figure 7

Simulation of Coverage Ratio with Transmission Parameters

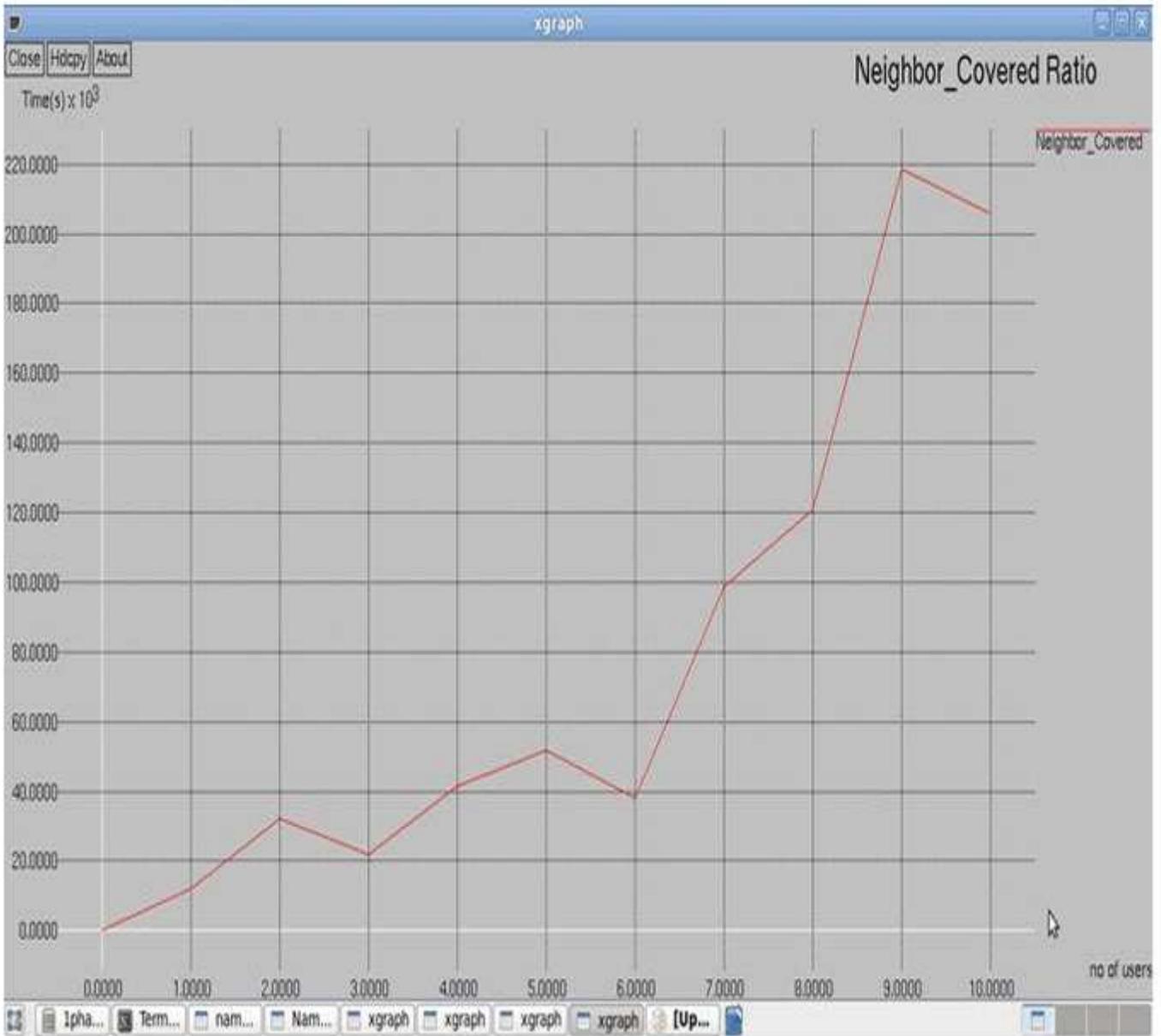


Figure 8

Simulation of Neighbour Coverage Ratio with Transmission Parameters



Figure 9

Simulation of Coverage Redundancy Time Ratio with Transmission Parameter