TEST Engineering & Management

January – February 2020
ISSN: 0193-4120 Page No. 13899 – 13907

Novel Multi Search Optimization Procedure to Handle Multi-Constrained Routing in Ad hoc Networks

J Suman Kumar Kaudinya[1], Dr. P. Sanyasi Naidu [2]

[1]Research Scholar, Dept. of CSE, GITAM University, Visakhapatnam,AP,India

[2]Associate Professor, Dept. Of CSE, GITAM University, Visakhapatnam, AP,India

[1] sumankaundinya@gmail.com,[2] snpasala@gitam.edu

Article Info
Volume 82
Page Number: 13899 – 13907
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 24 February 2020*

Abstract

Mobile ad hoc network (MANET) is one of the ad hoc natures in network structure that can change the locations of node and describe the ability to configure self on their positions. Because of wireless connections between mobile nodes, there may be a complexity in routing because of connection breakage, congestion appear in between nodes. To control congestion and establish new connection between nodes without data loss, conventionally Advanced and Distributed Relative Segment and Opportunistic Routing (ADRSOR) is discussed. In this analyze traffic data using routing relates to opportunistic scenario, but it is only concentrate on routing to control congestion, therefore there is a great need a trusty based optimized multi cast technique is required to transfer data between nodes without loss of data and enable heuristic related meta and multi search objective routing (MMOR). So that in this paper proposes and introduces a Novel Multi Search Multi Objective Framework (NMSMOF) which consists routing relates opportunistic scenario with Pareto optimization model. This approach is used in better understanding of nodes in network and also describes the performance when multiple routes are relevant. Our proposed approach captures the network cross interactions between nodes applied at various interfaces of opportunistic protocol. Performance results of this approach in wireless ad hoc related network giving better and efficient with respect to delay, delivery ratio and energies/power consumptions etc.

Keywords: *Wireless ad hoc networks, multi-objective model, opportunistic routing, Pareto optimization, multicast routing.*

I. INTRODUCTION

(MANET) Mobile ad hoc network is the combination of different mobile nodes in wireless networks which can allow users and devices communicate with each other without any support of network infrastructure. MANET is a self assisted network to form random topology, each node present in MANET act as router or host move about the random topology. Topology of the MANET changes as nodes are in mobility, then routing plays main role in assign routes for transmission of data between nodes via intermediate nodes communication. Continuous changes in topology of network, limited resources can change propagation radio communication with different conditions. To control congestion and establish new connection between nodes without data loss, conventionally Advanced and Distributed Relative Segment and Opportunistic Routing (ADRSOR) is introduced in wireless networks. MANET are good representation to form topology in outside network environment but it has different drawbacks in multi cast routing while passive related data flow appear between multiple nodes in wireless networks. So that recent studies have been focused on implementing different protocols, approaches to improve data management, data transmission, routing and provisioning in quality of service in wireless networks. General representation of quality of service provisioning in wireless networks described in figure 1.

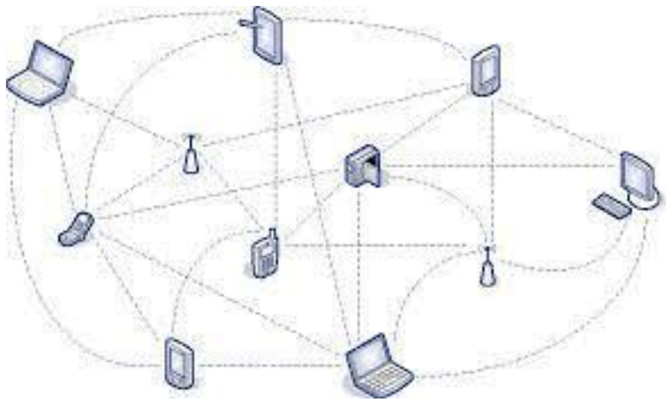

Figure 1 Wireless ad hoc network communications with quality of service

Further implementation of design of these types of networks makes different challenges to equal optimize for all the desirable nodes at different locations in wireless networks. Implementing the trade-off values with respect to different performance metrics will allow not only for selection of possible routes and also for better network architecture with increasing the performance of wireless networks at possible channel allocations. All the procedures directly support routing with respect to practical implementation in present wireless ad hoc networks. For implementing multi cast networks in complex environments, cross-layer interactions between multiple mobile nodes are classified in interference mitigation at all the layers in protocol implementation of networks. So that there is a great need a trusty based optimized multi cast technique is required to transfer data between nodes without loss of data and enable heuristic related to meta and multi search objective routing. So that in this paper proposes and introduces a Novel Multi Search Multi Objective Framework (NMSMOF) which consists opportunistic routing scenario with Pareto optimization model. This approach is used in better understanding of nodes in network and also describes the performance when multiple routes are relevant. Proposed approach descriptions as follows:

a) Propose a multi objective framework with opportunistic routing to capture resource management for route establishment between multiple nodes in wireless network communication.

b) Describe and formulate Pareto optimization in robustness of data transmission, delay in end-to-end communication and energy

c) Efficient experimental evaluation with respect to different network parameters compared with existing approaches used for multi cast routing in wireless network communication.

II. DESCRIPTION OF MMOR IN AD HOC NETWORKS

This section describes multicast optimization routing approach in between multiple nodes, based on some performance metrics in wireless networks such as delay, delivery ratio, energy consumption and throughput and reliability in data transmission. Basic representation of multicast objective procedure discussed in this paper is determined patterns in communication, and also define the basic differences between network parameters varying with opportunistic routing [1] applied on multicast based on probabilities of mobile nodes in ad hoc networks.

2.1 Basic Preliminaries Used in MMOR

Variables of multicast optimization are the routing strategies used in implementation, variable description defined as follows:

Def 1: Variable solution for MMOR is defined as transmission rates i.e. $\gamma_i(p) \in [0,1]$ used for each node i on resource p :

$$VS = \{\gamma_i(p)\}_{[i=1,2,...,M],\, p\in[1,....,R]}$$

Probabilities of forwarding nodes i.e. , it represents routing scenario in network, variable $\{\gamma_i(p)\}$ explore this values from size of the network node I i.e. $T=|I|$, consequence, search space solution is

$$|S|=\sum_{n=0}^{M-2}\binom{M-2}{n}T_{R.m}$$

This equation reduces the size of search space in node selection in opportunistic routing within in time slot at each frame in data transmission; this variable solution is applicable to reflect opportunistic routing in between multicast, multi-hop deterministic or random.

2.2 Pareto Optimal Opportunistic Model

Pareto optimality is the effective concept and applied on different real time computer science related applications, here basic representation Pareto optimality applied on multi node multicast routing. Let us consider S be the available connections at different resources P i.e. $i_1, i_2, ..., i_T : S \rightarrow P$ for identification of presented locations. Select possible connections for particular nodes based on bandwidth of each node i. we define robustness in selection of optimal path between multiple nodes in wireless network communication. $x \in S$ be the Pareto optimal solution for optimal multi path selection from different sources.

Present Pareto optimal selection for multiple path selection for data transmission, let us consider $\chi_M = \{\chi_1, ..., \chi_M\}$ be the nodes in network, let us consider o be the optimal path selected from associated paths available in network, check the intermediate node communication in between source and destination with respect to shortest path which includes optimal bandwidth values in total node set in wireless ad hoc networks. If P be the different paths then Pareto optimality is described as follows:

$$P_j = [d_1(j), d_2(j), ...d_T(j)] \in R_+^T, j \in \{1, 2, ..., N\}$$

For each optimal data path p_i corresponding to the sample collection of nodes χ_i from presented χ_n (d be the dissimilarity in optimal path selection). Pareto point Pi effectively dominates another point Pj, if $d_l(i) \le d_l(j)$ for all $l \in \{1, ..., T\}$ and $d_l(i) \prec d_l(j)$ for some nodes i. Main description of this optimal solution is described which optimal path is better from multiple paths.

III. NOVEL MULTI SEARCH MULTI OBJECTIVE FRAMEWORK (NMSMOF)

This section describes implementation procedure of novel multi objective framework, our proposed framework consists probabilistic representation of network, probabilities in routes (links), transmission rate based on link probabilities.

3.1 Probabilistic Representation of Network

Based on two probabilistic measures i.e. link probability, probability of node, proposed approach constructs random network structure, these two measures are classify the network infrastructure and describe the cross interactions between different nodes

Probability of node (χ_i) identifies the possible node i for routing scenario, i.e. each node i probability re-broadcasts received packets, mainly probability of node i consists two components $(\chi_i = \xi_i . x_i)$, one component is determined protocol implementation at different layers ξ_i (control of congestion, failures in nodes, variations in energy and risks in privacy) and the other component x_i describes the routing relates to optimize in multi objective implementation framework.

Probability of link (p_{ij}) identifies availability of links, random selection of transmission over each path (i,j). Classification of probability in link enhances at various layers present in protocol which described in medium access control. Basic

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representation of link and node probabilities described in figure 2.

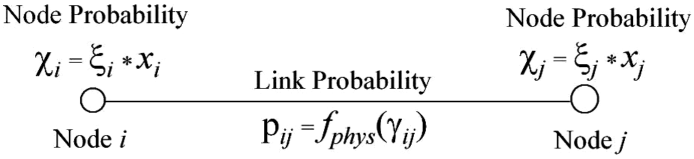

Figure 2 Representation of node and link probabilities on path (i,j)

Link and node probabilities mainly dependents on wireless channel nature, once probability of node (χ_i) is set then interference distribution and activity of each node in network is determined and fixed on wireless channel with activity of node i. Probabilities of link evaluates signal to noise ration, once these probabilities are available in network, calculate various metrics for transmission schemes i.e. multicast, broadcast etc. In following, using Pareto optimal solutions identifies the optimal path when more number of paths is available, also reduces set of probabilities of node that optimize one particular path in network with in multi cast objective infrastructure and optimize the performance metrics of network also. Basic representations of proposed implementation consider all the independent and probably transmitted nodes based on their bandwidth values in wireless ad hoc networks. Based on half-duplex transmission mode communicate any of two nodes performed to multi-hop connections, channel allocation of different nodes in routing divided into different resources P.

If transmit packet is received at destination i then

Generate $\chi_{random} \in [0,1]$ for each node i

$\chi_{random} \le \chi_i \;\&\, (node\_count(pkt) < H_m)$ then

Store pkt into registered buffer & generates probability_value $p_i \in [0,1]$ $for(k=1; k \le R; k^{++})$ then

$if\left(p_i \le \frac{\tau_i(k)}{\sum_{k=1}^{R}\tau_i(k)}\right)$ then

Sent pkt using k resource;

Else

Sent pkt using resource r

End all loops till drop packets if they are not satisfy loop conditions

Algorithm 1 Relay data transmission based on availability of resources

Multi hop data transmission, source node i transmits continuous traffic on one node at R time slots, relay configuration of node doesn't keep track on packets transmission and consequently same packets transmitted in several times. Nodes relay the packets whether they are received in any of available resources (using the procedure described in algorithm 1), if several packets transmitted in same time frame, it can be transmitted proportion of global probability in transmission x_i. Maximum numbers of hops are fixed in network of packets transmitted.

3.2 Probabilities of link

Realistic link (i,j) in time slot r is classified based on its probability of transmission $t_{ij}(r)$, it is the static distribution function of signal to noise ratio (SINR) at location of each receiver node j, this evaluation identifies inter connection between different nodes in routing since activity of all the nodes in network are countered as statistical in network infrastructure. Some of the preliminary functions are defined link probability:

Node Interference, which appear transmission occurs between different nodes using same time slot at same channel, then interference power $I_{ij}(r)$ on link (I,j) based on evaluated node values are described as:

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$$I_{ij}(r)=\sum_{k=1}P_k a_{kj}\ for(i\neq k)$$

K be the interference signals in r resources.

Signal to noise ratio, SINR between different nodes i and j at resource r is described as

$$\overline{\gamma_{ij}}(r)=\frac{P_{ij}}{N_0+I_{ij}(r)}$$

P_{ij} be the received power in j, $I_{ij}(r)$ be the inference power on link and N_0 be the density of power, $P_{ij}=P_i a_{ij}$ for fixed power of transmitted and path loss factor a_{ij}.

Data transmission error rate, for specific SINR , packet error rate PER is calculated as

$$PER(\gamma)=1-[1-BER(\gamma)]^{N_b}$$

$N_b$be the data packets number of bits and $BER(\gamma)$ be the error rate in terms of bandwidth described for SINR per each bit γ which is directly depends on route layer with respect to statistical analysis of nodes.

Rate of data transmission Main activity of network node in transmitted channel $\tau\in[1,2,...R]$ then transmitted rate $\tau_i(r)\in[0,1]$ in transmitted channel. This rate also described percentage of time node describes node I transmits using the resource r.

Based on above notation link probability can be calculated as

$$p_{ij}(r)=\sum_{l=1}^{L}[1-PER_l(r)],P_l(r)$$

l be the one of the interesting set, consequently, $\gamma l(\tau)$ be the signal to noise ratio on link (i,j)for resource r corresponding with PER.

3.3 Transmission rate based on node probabilities

Main variables of proposed model are probabilities $\chi_i=\xi_i.x_i$ in this each node re-transmit data received from others, we consider that ξ_i equals to 1 to clarify our proposed model, main variable representation of probability in forwarding x_i , there is no notion paths here and sent packets by source to destination may use different paths parallel. For each x_i equals to 1, received packet by node I forwarded, for $x_i<1$ node i drops packet loss with different probabilities $1-x_i$, node related values of $x_i\in]1,R]$ are not allowed which imply node i transmit several copies of same packet information.

Packet transmission rate $\tau_i(r)$ at resource r is the node probability function x_i it also mainly worked on data transmits from ith node which is other nodes i function present in communication of network. This procedure helps important implementation of multi objective optimization cross layer interaction between nodes and determines associated forwarding node probability x_i at routing scenario present in wireless ad hoc networks.

IV. SYSTEM DESIGN AND IMPLEMENTATION

4.1 Simulation Design

This section describe design implementation of NMSMO with infrastructure relates to node communication to explore efficient data transmission between nodes in ad hoc networks. To develop this infrastructure, use Linux platform, Ubuntu operating system and NS3 implementation simulation tool with different network notations. Simulation is implemented in NS3 and for the experimental study, two-way topology with different routing hierarchy is considered. By using predefined protocol headers in NS3, networks with different

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nodes are constructed and then simulate routing among all the nodes for efficient data transmission. Mobility relates to network simulation applied for all the nodes in network. The parameters used for the network simulation are shown in the following Table 1.

Table 1. Different simulation parameters used in implementation

Simulation parameters	Description
Neighbor node distance	256m
Transmission radius	357m
Interface Radius	655m
Size of data segment	2048bytes
Window Width	50-250m
Simulation Time	35-70secs
Number Of Nodes	10,20,30,40,50,60
Number Of Connections	4, 8, 16, 24, ...48
Protocol	AODV, Opportunistic

Based on the simulation parameters are as shown in Table 1, node routing motilities in between node communication over wireless ad hoc networks is as shown in Figure 3.

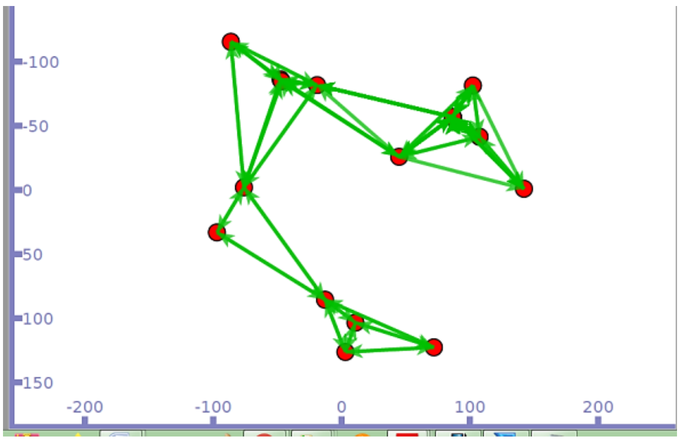

Figure 3 Network topology with selection of optimal path between nodes

As shown in figure 3, it describes different nodes with different bandwidths with optimal selection of paths using the procedure of novel multicast optimization, based on above equations, it identifies optimal path with probabilities of node and links (if some of the nodes not appeared in within range) then select the appropriate neighbor node communication in wireless over networks. Figure 4 describes efficient packet transmission over optimal path selection.

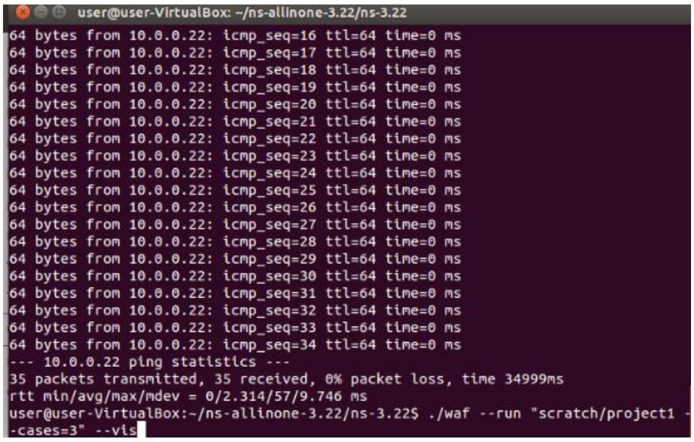

Figure 4 Efficient data transmission with different nodes communication

It represents efficient data transmission whenever optimal route selection from multiple node communication in wireless networks, Pareto opportunistic routing helps to generate optimal sequence number to each node then it directly transmit data via sequence acknowledgement to all the nodes present in network communication.

4.2 Experimental results

Because of self generating nature of nodes presents in wireless network communication, proposed approach gives better performance metrics with comparison to different approaches like Memetic algorithm (MA)[4] and new Cuckoo search algorithm [5]. The number of nodes (10-100) taken and describe the network with different parameters with different approaches. The following results

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describes the performance of proposed approach with comparison of packet delivery ratio, throughput, delay, energy consumption and transmission rate with different bit error rates in between in wireless network communication. Table 2 describes the packet delivery ratios with different node communication in networks.

Nodes	Memetic algorithm (MA) [4]	Cuckoo search algorithm [5] [5]	**NMSMOF**
10	92.4	94	**98**
20	91.25	93.7	**98.6**
30	87.8	89	**99.94**
40	91.56	92	**99.15**
50	89	88	**99.45**
60	88	87	**99.97**

Table 1 Delivery ratio for different node communications

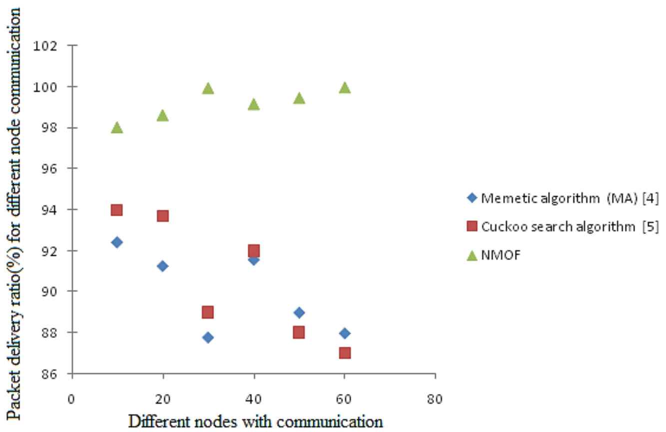

Figure 5 Performance evaluation of delivery ratio with different nodes

As shown in table, taken 10-60 nodes with different communications, if multi cast optimize routing appear between nodes then delivery ratio of proposed approach increased when compare to traditional approaches with different notations. Performance evaluation of proposed approach with delivery ratio with comparison to traditional approaches described in figure 5. Table 3 describes efficient throughput values with different notations between nodes in wireless network communication.

Nodes	Memetic algorithm (MA) [4]	Cuckoo search algorithm [5]	NMSMOF
10	125	152	**178**
20	152	168	**192**
30	178	179	**220**
40	162	186	**198**
50	164	224	**286**
60	185	196	**245**

Table 3 Throughput values with different node communication

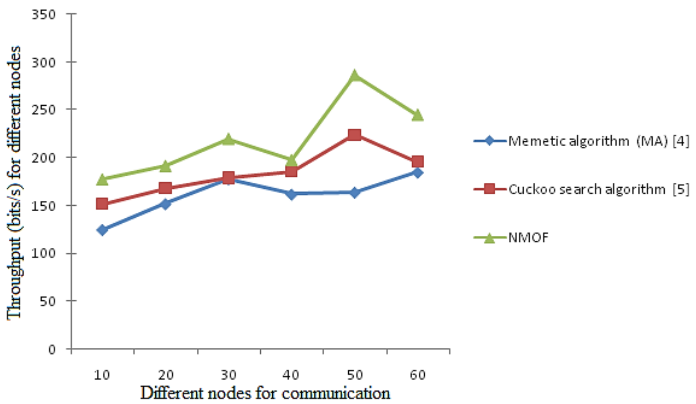

Figure 6 Performance of throughout with different node communication

As described in table 3 and figure 6 explores different nodes from 0-70, which describe the performance of performance of proposed approach with respect to different traditional approaches described in network communication. Table 4 defines power consumption values with different nodes.

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Nodes	Memetic algorithm (MA) [4]	Cuckoo search algorithm [5]	**NMSMOF**
10	224	152	**106**
20	195	168	**193**
30	223	179	**138**
40	226	186	**145**
50	198	224	**124**
60	264	196	**185**

Table 4 Power consumption values with different node communication

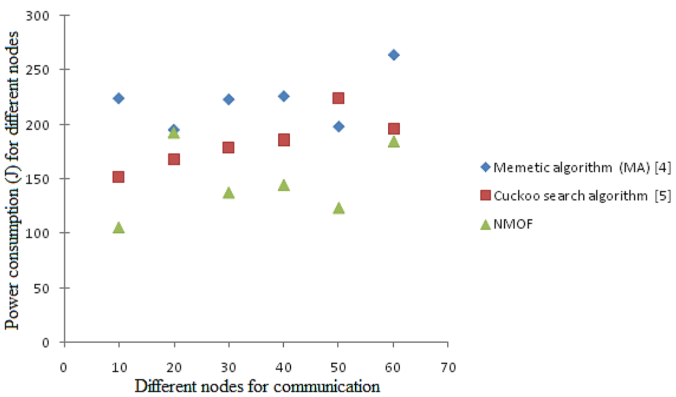

Figure 7 Performance of power consumption values with different node communications

As shown in figure 7, if more number of nodes increased in optimal network communication, existing approaches were used high amount of power to evaluate data transmission for multiple nodes in networks, proposed approach gives better energy optimized results. Table 5 describes the end-to-end values for different nodes in wireless communication.

Nodes	Memetic algorithm (MA) [4]	Cuckoo search algorithm [5] [5]	**NMSMOF**
10	10.00	10.00	**8.89**
20	11.01	10.98	**10.83**
30	10.01	10.95	**9.75**
40	12.02	10.92	**10.82**
50	10.9	10.88	**9.79**
60	16.95	10.87	**10.75**

Table 5 Execution time values for different node communication

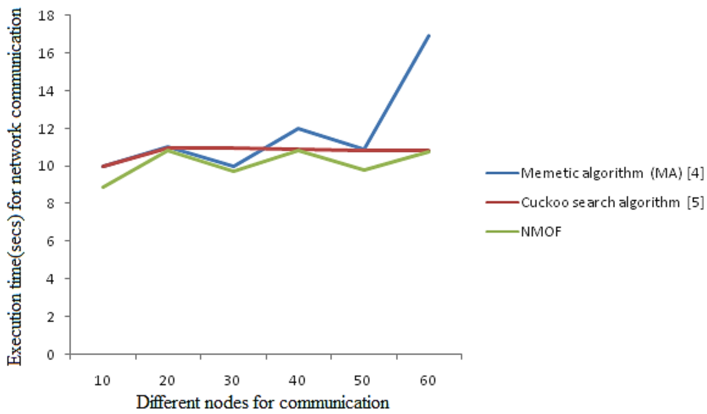

Figure 8 Performance of execution time with different node communication

As shown in figure 8 and table 7, if nodes simulates with optimal communication with each other, maximum all the approaches gives approximately equal range in time for network data transmission between different multiple nodes in wireless networks.

V. CONCLUSION

This paper introduces Novel Multi Objective Framework (NMOF) which consists opportunistic routing scenario with Pareto optimization model, in this framework mainly highlights are optimal routing between multiple nodes while multiple link communications in wireless networks. We also define the Pareto optimization procedure to handle communication between multiple nodes using opportunistic routing scenario applied between nodes in wireless networks. Main contribution of this approach is to handle multi cast optimization with cross layer interaction between multiple nodes.

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Performance evaluation of proposed approach describes efficient metrics compare to traditional multicast approaches. Further improvement of proposed approach is to handle dynamic data transmission with multi hop communication in ad hoc networks.

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