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Improved Cooperative Opportunistic Routing Protocol in MANET Using Channel Reuse Method Based on Ant Colony Optimization Approach

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Abstract

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less ad hoc network of mobile devices connected without wires. Basically, the performance of MANET is depends on use of routing protocols. These protocols are used as per the real time application requirements due to their performance requirements. From the recent survey in MANET, AODV gives better performance in most of the network scenarios. However, AODV is also suffered from limitations like it cannot do opportunistic data transfer in MANET. To solve this problem, protocol called as CORMAN was presented which can do opportunistic data transfer in MANET. But still CORMAN also has limitations, one of them we are considering here is, CORMAN could not do better spatial channel reuse. By extending the CORMAN using efficient channel reuse method based on Ant Colony Optimization (ACO) approach, a new protocol (ICORMAN) shows better performance than CORMAN and AODV routing protocol. ICORMAN is totally the network layer method which can be designed based on the off the shelf wireless networking devices. The algorithm proposed for ACO is presented in this paper. The practical analysis of proposed work is carried out using NS2 in order to claim the efficiency of proposed routing protocol against the existing routing protocol.

Keywords: AODV, CORMAN, Mobile ad hoc network, Routing Protocols, Channel Reuse, Ant Colony Optimization, Delay Jitter, PDR,

Introduction

Mobile Ad hoc Network (MANET) is a type of ad hoc network that can change

locations and configure itself on the fly[1]. MANET does not have any predetermined topology or central control. This is because MANETs can be characterized as having a dynamic, multihop, potentially rapid changing topology. Routing is the process of forwarding packet towards its destination by choosing most efficient path. Path efficiency is depends upon various metrics like, Number of hops, traffic, security, etc. In Ad-hoc network each host node acts as both host as well as specialized router itself[1]. Routing is one of the core problems of networking for delivering data from one node to the other. Thus, the goal of research in wireless networking was to make wireless links as good as wired ones. Unfortunately, this ignores the inherent nature of broadcasting of wireless communication links. For mobile ad hoc networks to truly succeed beyond labs and testbeds, we must tame and utilize its broadcasting nature rather than fighting with it. A new research area namely, Cooperative communication is an effective approach to achieving such a goal.

Research on cooperative communications physical layer community began to attract interest, but more recently its importance and utility also felt on top of the network protocol stack layers. CORMAN is a powerful extension to the pioneering work of ExOR. CORMAN method is used to tackle the problem of opportunistic data transfer[2]. In an average AODV is a good performance driven routing protocol in all kinds of network scenarios. But practically CORMAN shows the good performances as compared to the AODV routing protocol. However, CORMAN also has some limitations so that it further needs to be extended in many ways [2]. The existing CORMAN is having less efficient channel reuse method. In this paper the extended version of CORMAN is introduced called as ICORMAN by using efficient channel reuse method based on Ant Colony Optimization approach.

Proposed Approach Framework and Design

- Problem Definition. We have observed that CORMAN achieved great performance for delay, Jitter, PDR, and throughput as compared to AODV routing protocol[3]. However there are still some points on which we can work over CORMAN protocol further to improve overall network routing performances. One such problem associated with CORMAN routing protocol is better spatial channel reuse.
- Proposed Architecture. To overcome the above stated problems associated with CORMAN, in this paper we are presenting improved CORMAN (ICORMAN). Below figure 1 is showing the proposed system architecture. In this paper we are going to extend CORMAN by using the efficient method for spatial channel reuse with aim of improving the performances.
- Mathematical Formation/Algorithm. The ACO_MH (Ant colony optimization meta-heuristic) is nothing but the group of methods those are inspired by ‘foraging behavior of real ants’[4,5]. The ACO based algorithms are responsible to finding out the optimal path from source mobile node to destination mobile node in MANET [4].

In order to solve the problem of optimization using ACO based channel reuse method, the given problem is represented by using the graph theory. Using the graph, the sequence of nodes and its solution is constructed. In graph, the nodes are representing the problem components and links indicating the communication links between these components.

Following algorithm showing the ACO based channel reuse method which we have added into the CORMAN.

Notations:

- $G'=(V',E')$: Represents the problem
- V' = components of problem
- E'= communication links between components of problem.

ACO Algorithm:

- Step 1: the population of initial ants generated once input communication paths discover.
- Step 2: Optimization problem is build using the graph.
- Step 3: Initial state assigned to every ant and finding out starting node for each ant.
- Step 4: A 'probabilistic transition rule' [14] is used by every ant in order to make a decision to move to the next node. This is based on the heuristic information and pheromone intensity.
- Step5: A Heuristic function, nothing but the 'problem dependent function' [14], for indicating the desirability of selected node.
- Step 6: Pheromone intensity is build for representing the desirability of chosen path. This desirability of every path is discussed from the perspective of other ants.
- Step 7: For pheromone intensity, the updating rule is used to finding the effect of the last deposited pheromones.
- Step 8: The set of possible nodes N_i^k is prepared for avoiding the forming a loop during the path construction. It shows the optimal nodes from the perspective of ant *k* when it is placed on *i-th* node.
- Step 9: Finally the cost function is assigned to every selected path from source and destination node in order to show the optimal path of communication.

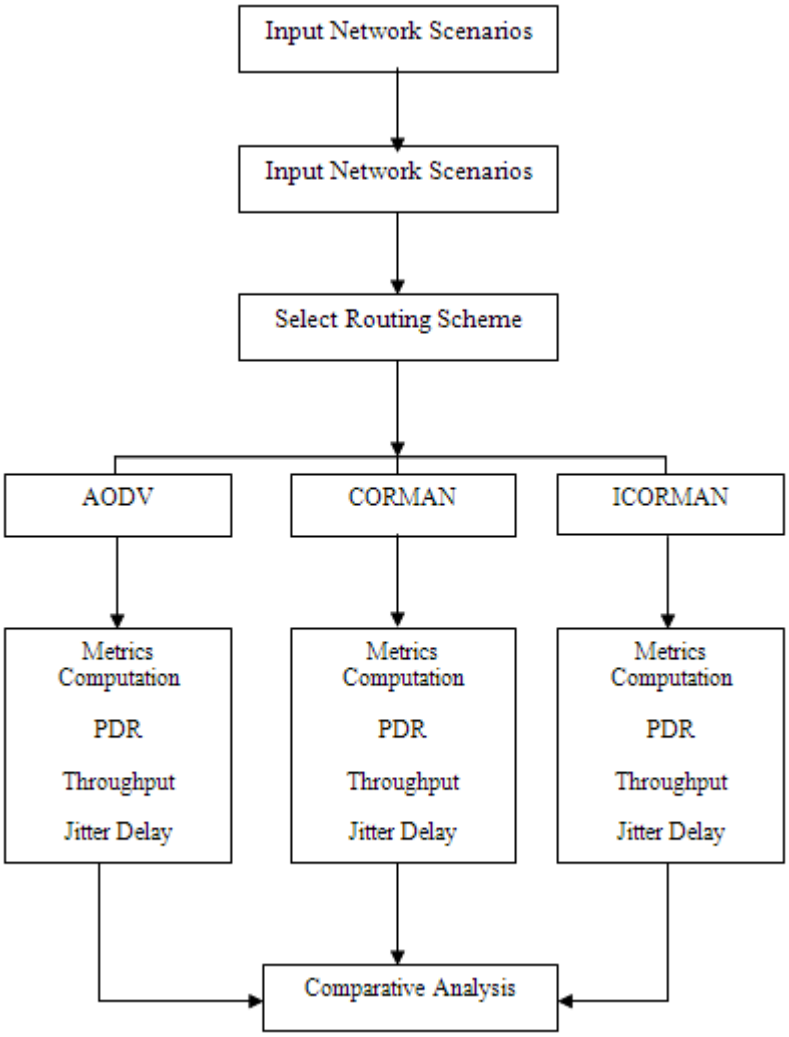


Figure 1: Proposed System Architecture

- Workdone. In this section we are presenting the practical environment, scenarios, performance metrics used etc.
- Simulation Platform. For the simulation of this work we have to need the following setups:

1) Cygwin: for the windows XP
2) Ns-allinone-2.32.

- Network Scenarios. The number of scenarios and traffic files needs to generate in order to evaluate the performance of the routing protocols under the different network conditions.

Table 1: Network Scenario 1

Number of Nodes	50
Traffic Patterns	Constant Bit Rate
Network Size (X x Y)	200x200/300x300…1000x1000
Max Speed	10 (m/s)
Simulation Time	100 (s)
Transmission Packet Rate Time	10 (m/s)
Pause Time	1.0 (s)
Routing Protocol	AODV/CORMAN/ICORMAN
MAC Protocol	802.11

Table 2: Network Scenario 2

Number of Nodes	100
Traffic Patterns	Constant Bit Rate
Network Size (X x Y)	300x300
Max Speed	2/4/6/8/10/12/14/16/18/20 (m/s)
Simulation Time	100 (s)
Transmission Packet Rate Time	10 (m/s)
Pause Time	1.0 (s)
Routing Protocol	AODV/CORMAN/ICORMAN
MAC Protocol	802.11

Results Obtained

Following graphs showing the result obtained for AODV, CORMAN and ICORMAN:

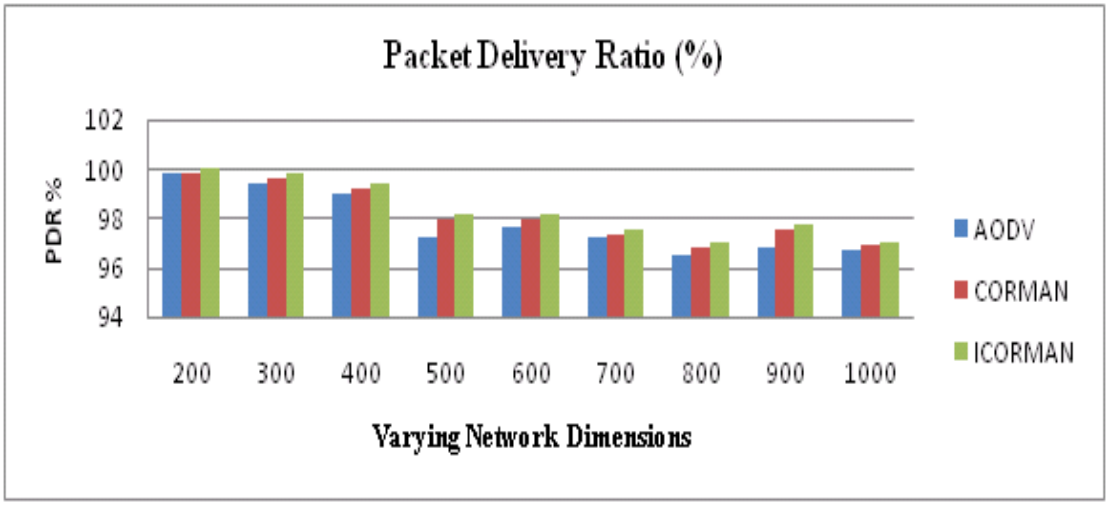
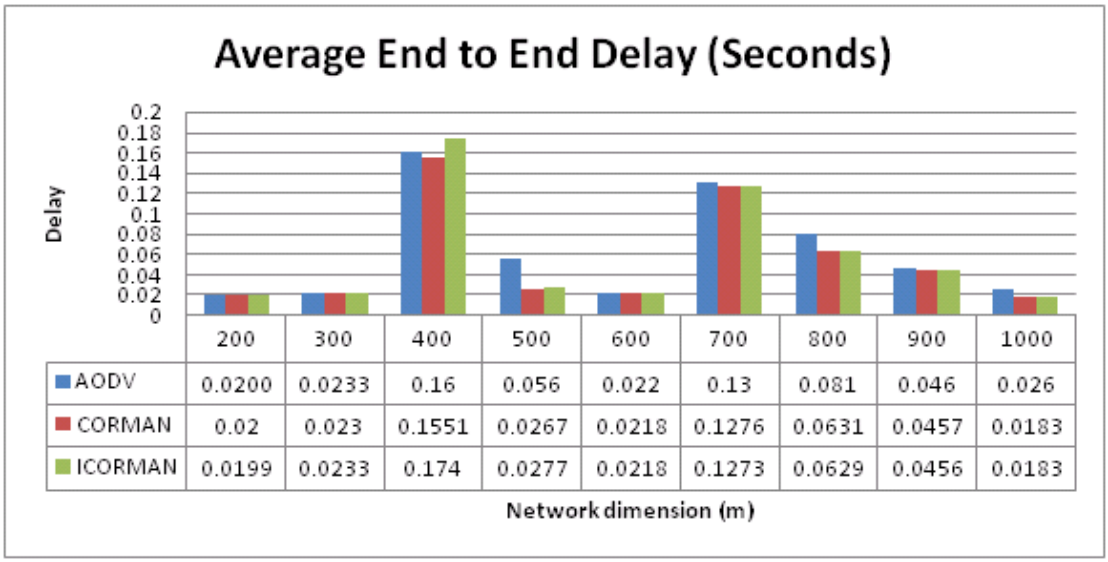
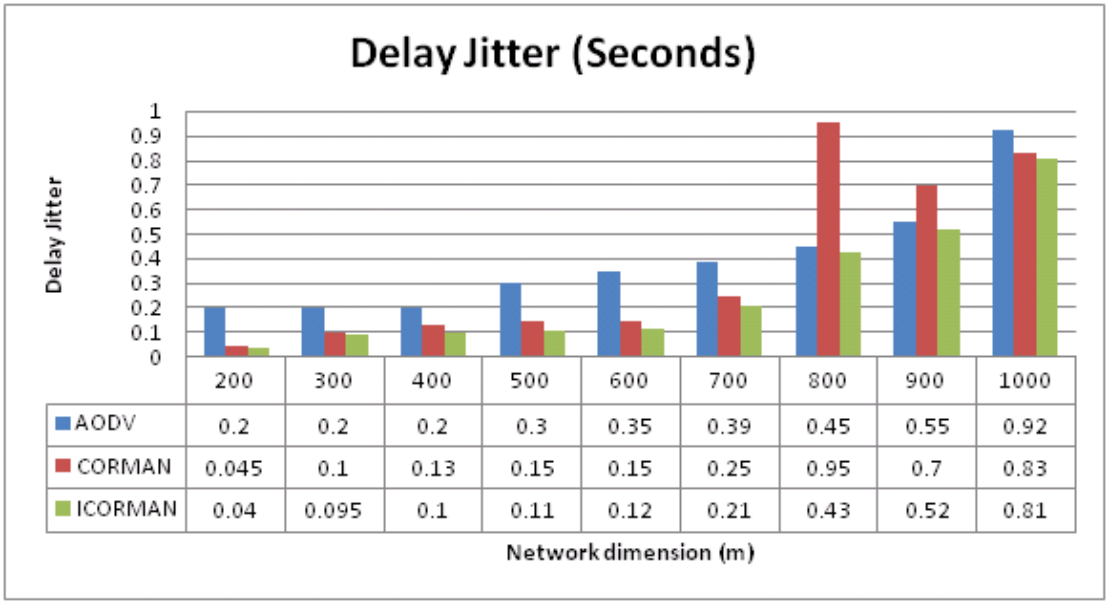


Figure 2: PDR vs. Network Dimensions



	200	300	400	500	600	700	800	900	1000
AODV	0.0200	0.0233	0.16	0.056	0.022	0.13	0.081	0.046	0.026
CORMAN	0.02	0.023	0.1551	0.0267	0.0218	0.1276	0.0631	0.0457	0.0183
ICORMAN	0.0199	0.0233	0.174	0.0277	0.0218	0.1273	0.0629	0.0456	0.0183

Figure 3: Delay vs. Network Dimension



	200	300	400	500	600	700	800	900	1000
AODV	0.2	0.2	0.2	0.3	0.35	0.39	0.45	0.55	0.92
CORMAN	0.045	0.1	0.13	0.15	0.15	0.25	0.95	0.7	0.83
ICORMAN	0.04	0.095	0.1	0.11	0.12	0.21	0.43	0.52	0.81

Figure 4: Delay Jitter vs. Network Dimensions

Conclusion and Future Work

As MANET communications and MANET performance is totally depends upon the use of routing protocols. This paper presented improved method called ICORMAN, to solve the problem of opportunistic data transfer in MANETs. ICORMAN is based on recently presented CORMAN protocol and efficient channel reuse method which is based on ACO approach. The graphs presented in this paper are showing the current

state of results. From these results, ICORMAN outperforming the existing CORMAN as well as AODV routing protocol. For the future work we suggest working on overcoming the existing problems of CORMAN and present the next extended version of the same.

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