Implementation of DSTC and PSO Algorithm Using CLD to Improve the Performance of MANET

Sheetal Bhale, Abhilasha Mishra and Mazher Khan

Abstract Throughput is a valuable parameter for mobile ad hoc network (MANET), it is defined as a number of successfully received packets in a unit interval of time. In wireless communication for the extension of coverage as well as capacity MANET is used. In this paper cross-layer is designed between physical and network layer using received signal strength (RSS) as a cross-layer interaction parameter. The given technique proposes strong route formation in ad hoc on-demand distance vector (AODV) through cross-layer design (CLD), distributed space-time coding (DSTC), and particle swarm optimization (PSO) in MANET. The simulation results show the improvement in performance of MANET.

Keywords Mobile ad hoc network (MANET) · Ad hoc on-demand distance vector (AODV) · Cross layer design (CLD) · Distributed space-time coding (DSTC) · Particle swarm optimization (PSO)

1 Introduction

As wireless LAN has flexible as well as simple architectures, it has been utilized in many applications of wireless networks. However, the technical growth in wireless networks relied on infrastructures like an access point and a router. So, many researchers proposed ad hoc networks with no need of infrastructures and still the research is continued. Ad hoc networks are made up of mobile nodes with router functions as well as wireless media (Figs. 1 and 2).

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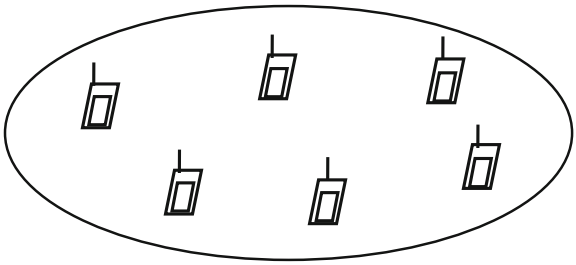

Fig. 1 Ad hoc network [3]

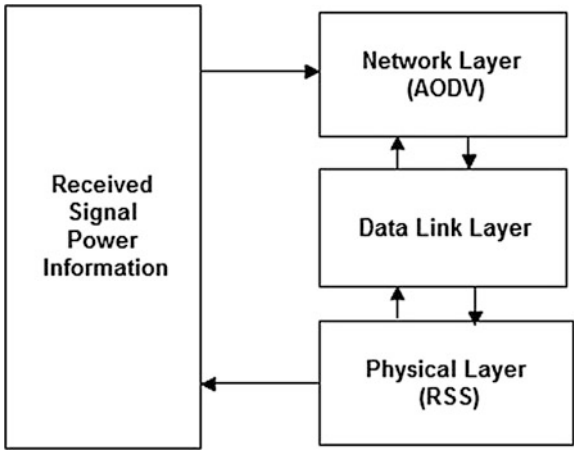

Fig. 2 Cross-layer design for information sharing

2 Theory

2.1 MANET

Wireless mobile ad hoc networks include a collection of mobile nodes which forms a network to communicate with each other without the help from stationary infrastructure like access points. So as to forward packets nodes communicate directly through wireless links when in radio range but nodes which are not in each other's radio range utilize other nodes as intermediate routers via multiple-hop routing. The nodes that communicate directly are said to be neighboring nodes. Furthermore, due to the movement of nodes, the network topology changes rapidly. Therefore, an efficient routing protocol is needed in order to do better communication between the nodes in ad hoc network [1]. Numerous advantages coming out of wireless technology are not the physical setup for data transfer. They are lower installation and maintenance costs [2]. Mobile ad hoc network has many real life applications such as in business meetings, outside the offices, in Bluetooth, Wi-Fi Protocols, etc. [3].

2.2 AODV

This topic tells about AODV, which is the routing protocol of on-demand types under study by MANET. Here, every node consists of the routing table, and the newly produced routes use sequence number with every routing information. At the reception of control packet which occurs in on-demand by each node the routing table updation is done dependent upon the sequence number or the number of hops. Route discovery phase establishes the route while route maintenance phase maintains the route (Figs. 3 and 4).

AODV is based on two steps

1. Route Discovery: It has RREQ (Route Request) and RREP (Route Reply)
2. Route Maintenance: It has RERR (Route Error) and Hello message [4].

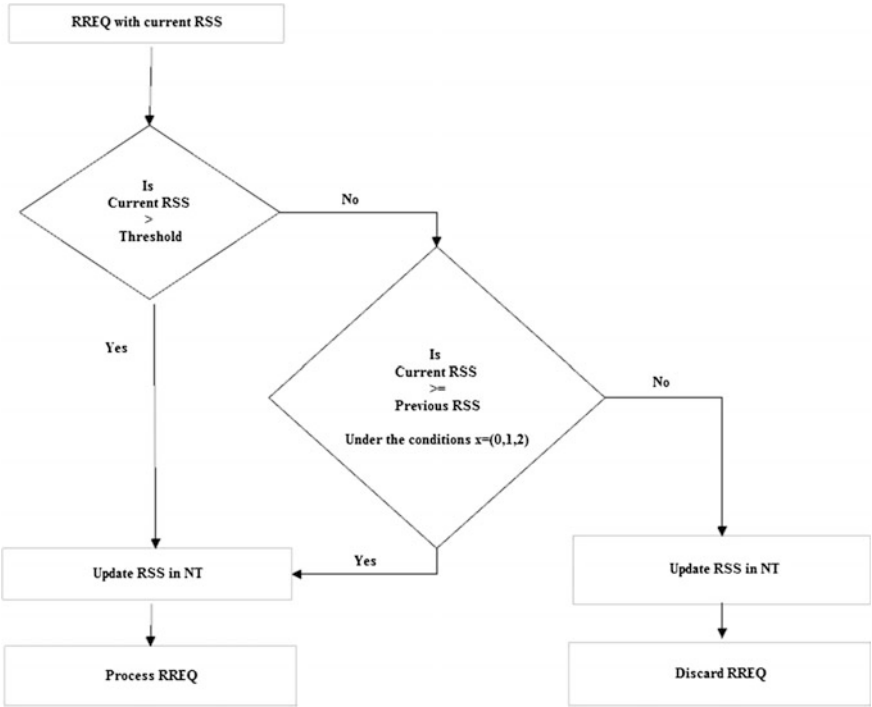

Fig. 3 Flow diagram of the cross-layer protocol with different values of x

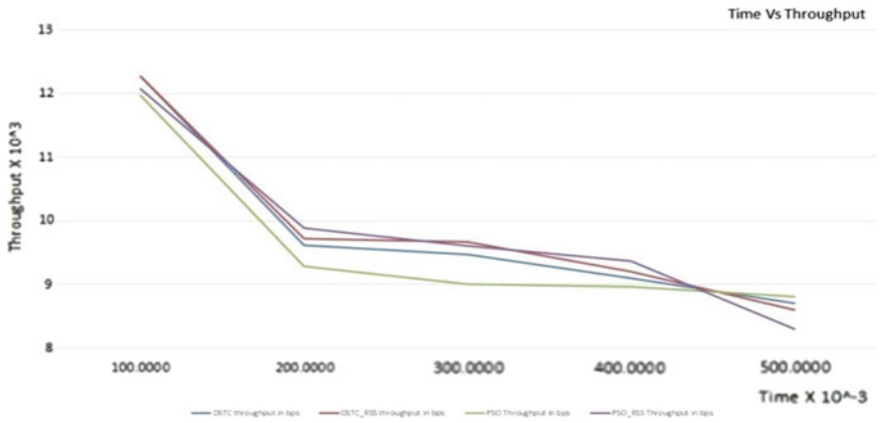

Fig. 4 Time versus throughput

3 System Modeling

3.1 Proposed Cross Layer Design

The advanced technology for ad hoc networks is a cross-layer design. This approach enhances the possibilities to improve the adaptability and performance of MANET. Coincident points like adaptation loop avoidance as well as protocol stack improvement are the concentrating areas of the cross-layer architectures. Along with this advanced architectures for rapid and systematic deployment of current and new Cross Layer optimizations are also necessary [5].

Jing and Hassibi gave the idea of DSTC transmission strategy. It has the concept of simultaneous relaying and is used for mutirelay networks. Where total relays are allowed to send the source signal in the same subchannel simultaneously. Only time slots are needed instead of the quantity of relays considering a single data transmission [6].

Kennedy and Eberhart has given PSO algorithm in IEEE Evocomp, 1995 which is reliant on stochastic techniques, alike evolutionary techniques. The modification of pBest and gBest by the particle swarm optimizer is logically same as that of the crossover procedure used by genetic algorithms. Here, a group of particles as potential results are used to find a better solution at the end [6].

3.2 Proposed System Flow Chart

Proposed system for improving performance of MANET based on AODV protocol by using RSS as an interaction parameter for implementing CLD. Strong route will be selected in AODV as RSS values are being used and updated in NT (Neighbor

Table) [7]. This will result in improving throughput of system. This can be understood by following flow chart under different values of x, as below

1. $x = 0$ (Using only RSS values),
2. $x = 1$ (Using RSS values with DSTC),
3. $x = 2$ (Using RSS values with PSO)

Now to improve route formation in AODV, DSTC and PSO algorithms are implemented.

3.3 Steps of DSTC

1. DSTC technique has two stages which utilizes a concept of listen and transmit protocol.
2. Relays carry the vector of symbols transmitted by the source node, which is the first stage of transmission.
3. Second stage performs multiplication operation of the distributed relays with received vectors with a quite arbitrary matrix. Further transmission of the obtained vectors toward the destination is done.
4. In the received signal of destination, i.e., final stage of DSTC, a linear space–time codeword is generated [6].

3.4 Steps of PSO

1. A group of particles as potential solutions is taken in search space for few iterations. We have to initialize pBest and gBest where pBest represents best location having best fitness value which the particle has individually inspected since the first stage and gBest denotes the location of best fitness experienced.
2. Initialization of random position and velocity of particles is done, i.e., ${x_p}^n(t)$ and ${v_p}^n(t)$ for a particle $p(1 \leq p \leq N_{\text{Particle}})$.
3. For tth iteration $(1 \leq t \leq N_{\text{Iteration}})$ in the nth dimension of search space $(1 \leq n \leq N_{\text{Dimension}})$ the position of particle is modified as

$$ {x_p}^n(t+1) = {x_p}^n(t) + {v_p}^n(t+1) \tag{1} $$

4. As per the upgradation velocity of pth particle is

$$ {v_p}^n(t+1) = \omega . {v_p}^n(t) + c_1 . \text{rand}_{1.} \left({\text{pBest}_p}^n - {x_p}^n(t) \right) + c_2 . \text{rand}_{2.} \left({\text{gBest}_p}^n - {x_p}^n(t) \right) \tag{2} $$

Factor ω is a constant in between the scale 0 and 1 which denotes the velocity rising range towards gBest and pBest. The cognitive and social rates are scaled in respective to acceleration factors, i.e., constants c_1, c_2. Factors rand_1 and rand_2 return uniformly distributed random numerals in the range 0 and 1 [6].

4 Implementation of Proposed System

For formation of strong route in AODV following steps are implemented.

(1) RSS values are used for selecting route.
(2) DSTC algorithm is applied in AODV for selecting route.
(3) DSTC algorithm is applied in AODV for selecting route by using RSS as an interaction parameter in CLD.
(4) Power is allocated to all nodes and PSO algorithm is used to select strong route.
(5) Power is allocated to all nodes and PSO algorithm is used to select strong route by using RSS as an interaction parameter in CLD.

5 Simulation Scenario

Simulation setup can be summarized in following table:

Parameter	Meaning	Value
x * y	Size of the scenario	1000 * 1000 (m)
Nn	Number of nodes	50
Initial energy	Initial energy in Joules	100
Relay	Relay	35
Simulator		ns-2.32
Routing protocol		AODV
Traffic		Constant Bit Ratio (CBR)
Mac layer		IEEE 802.11
Antenna type		Omni antenna
Total energy consumption		25.9315

5.1 Simulation Steps

(i) Creation of wireless network topology for DSTC algorithm only.
(ii) Creation of wireless network topology for DSTC algorithm along with RSS values (CLD).
(iii) Creation of wireless network topology for PSO algorithm only.
(iv) Creation of wireless network topology for PSO algorithm along with RSS values(CLD).

6 Results

6.1 Throughput Graph for RSS, DSTC and PSO

See (Fig. 5).

6.2 Packet Delivery Ratio Calculation for RSS, DSTC, and PSO

Above graph shows the improvement of throughput and PDR for CLD with DSTC and CLD with PSO.

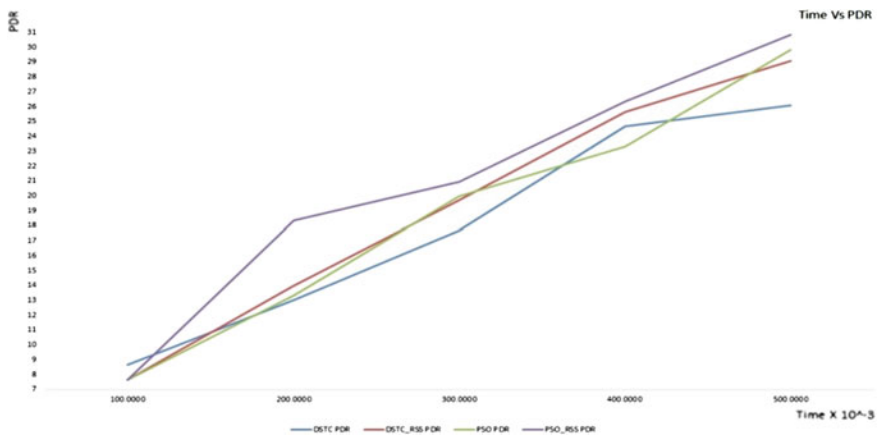

Fig. 5 Time versus packet delivery ratio

7 Conclusion

Mobile ad hoc networks serve as a promising technology to increase coverage area and capacity of wireless networks with no infrastructure. With the use of received signal strength as an interaction parameter for a cross-layer design for AODV-based MANET with the help of DSTC and PSO algorithms performance of the system improves. The proposed system for formation of best route in AODV by using RSS, DSTC, and PSO algorithm shows better results for wireless mobile network. Proposed system will provide reliable network for wireless communication. As future scope, we can implement energy-based sleep scheduling algorithm for AODV protocol and compare its performance with the proposed technique.

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