



LINK BREAK PREVENTION IN CDA AODV (COSMIC DUST AVOIDANCE – AD- HOC ON- DEMAND DISTANCE VECTOR) ROUTING PROTOCOL

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ABSTRACT

Mobile Ad hoc Network (MANet) is a network form by the use of Mobile Nodes. Movable nodes creates the Cosmic Dust problem. Cosmic Dust Problem is avoided by the use of CDA algorithm which is developed by the author with his previous work. CDA is implemented over AODV routing protocol. Even though Link break will be occur during the communication due to the nodes movement. This paper propose Link Break prevention over the CDA AODV.

Key words: Cosmic Dust, Link Break

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1. INTRODUCTION

MANet is a collection of mobile nodes network. It is one of the anywhere any time network. When the source want to communicate with its destination then only it will establish the connection between source and destination.

Because of its potential to provide time-space continuity, high reliability, wide regional capacity, and high mobility, the integrated satellite, sky, terrestrial, and ocean networks have become a focus of state, military, and aerospace studies. The integrated network, on the other hand, carries a variety of services that are defined by a big amount of time and space, a lengthy time delay, interruption, multi-track, and multi-type. Because of its independence and flexibility, MANET can not only exist as an independent network, but also as an excellent supplement to an integrated network structure.

MANET is a multi-hop temporary autonomous system which has no fixed base station and basic network, and all nodes in the network have the functions of host and router at the same time, and can be moved at will. Therefore, dynamic topology is one of the most remarkable

characteristics of MANET. Due to the rapid topology changes, established routes can be broken frequently, which brings severe challenges to routing design. In order to reduce reroute operations, the most stable path must be chosen.

2. CDA AODV

AODV is a reactive on-demand routing protocol. As a result, AODV does not begin the route discovery process until a network node initiates such a service in order to send data. When a source node (S) wants to send data to a destination node (D) [1], it first looks in its routing database to see if a route to node D already exists. If the path is not accessible, the AODV protocol initiates a route discovery procedure to find a more recent way to the target.

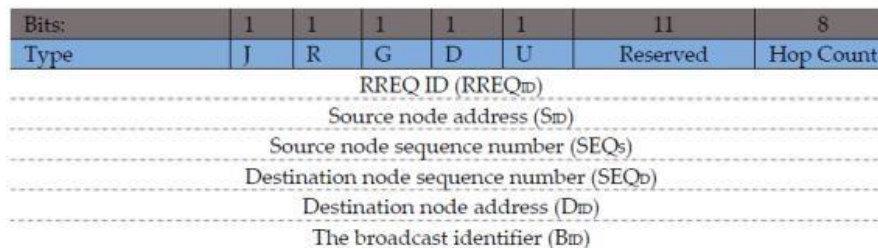


Figure 1. The RREQ packet format used in basic AODV routing protocol

S sends out a route request (RREQ) packet, which is transmitted to all of S's neighbours, who forward it until it reaches its intended destination. The information fields shown in the preceding Figure are contained in the RREQ packet.

The algorithm is implemented using the basic AODV[2] routing protocol, which performs better than traditional AODV. The New Path Find AODV can be tweaked to make better use of the routing data provided by the new neighbours. Every time a node found a new node to neighbour with. The essential information is exchanged between these two nodes. It extracted the destination address, number of hops to that destination, sequence number, and expiration time for each routing table item. To exchange information with the new neighbour node, the extracted entries are formed into a destination table. The destination table is processed as follows: check up the destination address for each entry in the routing table. If the destination end is identified, it signifies that there is a new path through the new intermediate neighbour node in addition to the current path in the routing table. These two initialised pathways' hop counts are then compared. Consider the amount of hops on the old and new paths, which are respectively hop old - HopO and hop new - HobN. If HopO > HobN, the new path will replace the present one if it is superior (fewer hops); otherwise, nothing will change. If the destination end is not discovered in the routing table or neighbour list, a new accumulating path is generated in the routing table for that destination end. The sequence number, number of hops, and expiration time are all obtained from the destination database by the update and accumulated paths. Even if the current path is not broken, source start can now discover and change to a better path with this adjustment. In addition, the collected pathways will lower the number of Route Discovery cycles and the time it takes to find a communication path. As a result, this design increases AODV's performance.

2.1. Mechanism for Choosing a Multipath Route

Mechanism for Choosing a Multipath Route By providing several paths, multipath routing path methods improve network resiliency against unpredictable communication channels. The fundamental purpose of multipath path routing is to locate multiple paths to the destination end and then choose one of them based on specific metrics. As a result, just one principal path is

chosen among various additional options. Increased network longevity, greater load balancing, fault tolerance, and lower packet losses are all advantages of this routing approach. The proposed protocol uses a reserved or unused 11-bit field to add one extra byte to the first four bytes of the RREQ packet to report link quality (LQ). As seen in the following Figure, the LQ field contains information on SNR and RSSI threshold. The remaining fields in RREQ are unaltered, and they are used in the same way as they are in traditional AODV[3]. The RREP packets are sent back in the opposite direction. Unlike AODV, the source considers each RREP in order to discover numerous paths in a single route discovery. The major path is then chosen as the one with the best quality. If the first path fails, the second path is activated, and so on. In multipath path routing, overhead management is a critical issue.



Figure 2 The first 4 bytes of RREQ packet in proposed CDA-AODV protocol containing new Link Quality field

2.2. CDA AODV-Route Maintenance

If any node participating in the route moves after picking the route between the source and destination ends and during data transmission, the node attempting to transfer data will detect a link break. Then it tries to recover the packet by looking for an alternate path to the target in its previously entered cache. If it has, data will be sent over the new path. Otherwise, it sends a "Route Error" packet to the source end node to signal that the link has failed. The intermediate nodes remove the cache entries corresponding to the node that relocated and then forward the packet when forwarding the route error packet (RERR) [4]. The source end node removes the entries pertaining to the node and tries to locate another route to the destination end in its cache after receiving the error packet (RERR).

2.3. CDA AODV-Route Reply

The source end node waits a certain period of time after broadcasting the route request (RREQ) before retransmitting the request. The data packets that will be transferred till then are stored in a temporary buffer. The request is collected by Source until the timer runs out. Then it examines the response (RREP) to see whether there are any repeated following hops. If it is, choose any of the repeated intermediate next hop paths; else, pick a random route from the collected route answers and use it to send the data.

The protocol has been changed as a result of improvements to the mechanisms that cause packet loss. Packet loss can occur in a variety of communication scenarios. One of the cases is link failure, which is caused by network node mobility, which is a prevalent feature of multi-hop, wireless ad hoc networks. Link failure can happen in a variety of ways. Because of the mobility of network nodes and the instability of the infrastructure-less wireless environment, link breakage between neighbouring nodes can occur, potentially rendering the route invalid. Some proposals have been made to make routing protocols more resilient to communication link failures.

2.4. CDA AODV – Operation

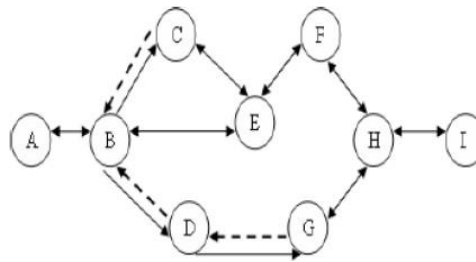


Figure 3 Initial Setup

Step 1: If a source node moves (see Figure Initial Setup and Figure Topology Change), there's a chance the link will fail.

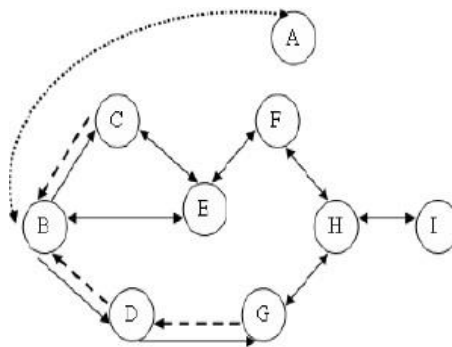


Figure 4 Topology Change

Step 1 Solution: Restart the New Route Discovery Protocol (NRDP) to find a new route to the destination if the node is a source node[5]. AODV is one of the most effective Route Discovery protocols.

Step 2: If an intermediate node moves (Fig Link break owing to source node mobility, Fig Link break in intermediate node), there's a chance the link will break or degrade.

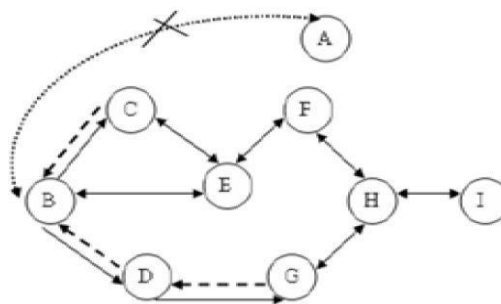


Figure 5. Link break due to source node mobility.

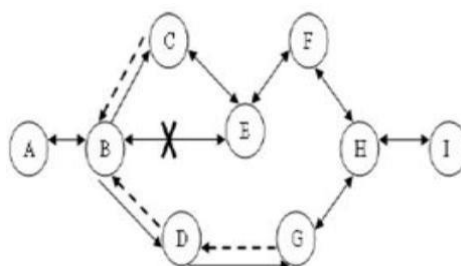


Figure 6. Link break in intermediate node

Step Solution 2: If the node is an intermediate node, try to repair it locally (Local Repair Procedure) by fixing the node itself (RNode). Rnode attempts to rediscover another route if it is not fixed by Rnode.

3. LITERATURE REVIEW

The impact of interference in large wireless networks on system performance is investigated by Haenggi M et al [8].

The influence of co-channel interference on the interruption rate of wireless Ad hoc networks is specified by Ganti R K et al [9].

The link expiration time is predicted by William Su et al [10], assuming that the velocity and direction of the two nodes have not altered since the start.

The present motion information (position, velocity, and direction) of nodes is used by Shah H et al [11] to predict the relative positions of two nodes and whether they are still connected at time t .

The notions of link availability and path availability were proposed by Bruce McDonald A et al [12] and applied to the construction of routing protocols.

Jiang et al. [13] proposed link models for predicting availability, in which the chance that the link would continue for a specific amount of time is anticipated based on possible motion changes.

The transmission reliability is defined to quantify the MANET's transmission performance, the impact of interference is considered, and a genetic algorithm is employed for optimization by Xiang S et al [14].

Rahmani P et al [15] suggested a learning automata-based topology control method as part of a cognitive approach to achieving stack-wide and network-wide performance goals by incorporating cognition into the entire network protocol stack.

Rahmani P et al.[16] devised a Bayesian chase method that predicts node movement parameters by learning the link length from the surroundings.

Artificial neural networks were used by Tùng Tin Nguyn et al [17] to classify the set of cooperative relays under DF-relaying constraints in order to maximise the achievable secrecy rates.

However, the previous literature did not take into account the dynamic changes in network topology produced by mobile nodes, and topologies with more than two hops are not ideal for fast-moving networks. Furthermore, because network topology control necessitates the acquisition of specific network state information, it is inapplicable to mobile Ad Hoc networks lacking a central control infrastructure.

4. MODEL

The modified Random Walk-based Mobility model is used to predict the outcome in this paper. It is difficult to anticipate the future motion state of nodes based on historical data due to the rapid change of topology, limited storage space, and energy of nodes. Link prediction, on the other hand, necessitates that node mobility adhere to a specific habitant rather than being fully random. The topology state of the network can be efficiently anticipated based on the motion habitant of nodes in MANET [18]. Nodes can receive their position through various devices, such as GPS. Assuming that the nodes follow the Poisson distribution and move independently, the linkages will break independently, which is consistent with the real-world situation of transportation and ship navigation.

In this model, the maximum radius of a mobile's radio coverage is considered to be 'ra,' and if a node is within transmission range of another node, the link formed by them is available, and one-way communication is ignored. In wireless communication, signal attenuation happens during the transmission phase.

$$T_p = R_p X D^{-\alpha} \quad (1)$$

Where

$T_p \rightarrow$ Transmitting Power

$R_p \rightarrow$ Receiving Power

$D \rightarrow$ Distance between nodes

$\alpha \rightarrow$ is the path loss index

The epoch lengths are identically, independently distributed with mean $1/\lambda$, the speed and the direction at each epoch change randomly and independently. The speed of nodes at each time interval follows a normal distribution with mean μ and variance σ^2 , the direction of movement at each epoch uniformly distributed over $[0, 2\pi]$, fluctuation range is set to be smaller than $\pi/2$. In the two-dimensional plane, the moving nodes randomly choose the initial place and destination, R^i and $R(t)$ respectively denote the displacement vector of the node in epoch i and the total time t ,

$$\vec{Ri(t)} = \sum_1^{Ne(t)} \vec{Ri^i} \quad (2)$$

Where

$Ne(t) \rightarrow$ Denote the number of the epoch simulated in time t .

According to the random movement model, the magnitude is equal to the distance from $(x(t_0), Y(t_0))$ to $(X(t_0+t), Y(t_0+t))$ which is approximately Rayleigh distribution with parameters of

$$\alpha = \left(\frac{2t}{\lambda}\right) X(\mu^2 + \sigma^2). \quad (3)$$

Therefore, the movement characteristics of node can be described by the parameter $\{\lambda, \mu, \sigma^2\}$. Since $x(t)$ and $y(t)$ are not correlated, the joint probability density of the node is:

$$f_{x,y}(x, y) = \frac{1}{\pi\alpha} \exp\left[-\frac{(x^2 + y^2)}{\alpha}\right] \quad (4)$$

It is assumed that nodes M and N move according to movement parameters $(\lambda_m, \mu_m, \sigma_m^2)$ and $(\lambda_n, \mu_n, \sigma_n^2)$. Since the movements of the two nodes are independent and uniformly, to investigate the joint motion distribution of two nodes, assuming that node N is fixed, where the motion of node N is equivalent to the opposite motion of node M [19] with parameters of In figure 1(a), nodes M and N arrive at positions M' and N' respectively after time t , and the distance between the two nodes is D ; while fig 1(b) is equivalent to figure 1(a), random mobility vector of node M with respect to node N is obtained by fixing N , which is expressed as $R_{M,N}(t)$

$)=R_M(t)-R_N(t)$, and the amplitude is approximately Rayleigh distribution with parameters of $\alpha_{M,N}=\alpha_M+\alpha_N$.

Optimization of capacity to improve the network, link predictive topology control is proposed. Any broken link will cause the path to fail, hence the path's stability is dependent on the stability of all the links in the path. The most stable path during non-breaking time is the one with the most capacity and least interference. One of the main elements impacting outage capacity is transmission method; another major factor affecting network capacity is interference. As a result, link availability and interference must be investigated in order to increase network reliability, and an objective function must be provided to assess topology performance.

5. ANALYSIS OF LINK AVAILABILITY

It is required to examine link availability between nodes in order to predict network topology changes. The likelihood that a link exists at time t_0 and still survives at time $t_0 + t$ is referred to as link availability [20]. To describe the link connectivity of two nodes over time, first analyse the motion distribution of individual nodes, then calculate the connection probability of each node based on the magnitude and direction of one moving node relative to another, which is the influence of motion on link availability [21].

At time t , the distance between two nodes is proportional to the availability of the link. $\vec{D}_{M,N}(t)$ is equal to the product of a random mobility vector $\vec{R}(t)$ and a constant vector $\vec{c}$. Figure 2 depicts the relationships between these factors. The answer is the exact solution to the general issue of determining the sum of a uniformly distributed Raleigh vector and a constant; the full derivation is available in Reference [22]. When you divide $\vec{R}(t)$ into the X and Y components of the normal distribution and add them to the x_c and y_c components of the initial distance, you get the following probability distribution function for the link available time:

$$\begin{aligned} f_{D_{M,N},\theta_D}(d,\theta) &= f_{x,y}(x,y) \begin{pmatrix} \cos \theta & -d \sin \theta \\ \sin \theta & d \cos \theta \end{pmatrix} \\ &= \frac{d}{\pi \alpha_{M,N}} \exp \left[-\frac{(d \cos \theta - x_c)^2 + (d \sin \theta - y_c)^2}{\alpha_{M,N}} \right] \\ &= \frac{d}{\pi \alpha_{M,N}} \exp \left[-\frac{(d^2 + c^2) - 2d(x_c \cos \theta + y_c \sin \theta)}{\alpha_{M,N}} \right] \end{aligned} \quad (5)$$

Where

$$\alpha_{M,N} = \alpha_M + \alpha_N = \left(\frac{2t}{\lambda_M} \right) \times (\mu_M^2 + \sigma_M^2) + \left(\frac{2t}{\lambda_N} \right) \times (\mu_N^2 + \sigma_N^2)$$

According to the law of cosines, when node N travels to the limit of node M's communication range in the triangle, it can figure out the angle between line M' and N' and the X-axis is

$$\theta_D = \theta_z + \theta_{z,D} = \theta_z + \arcsin \left\{ \frac{C}{R} \sin[\theta_z(180^\circ - \theta_z)] \right\} \quad (6)$$

Link Availability $A_{M,N}$ is denoted as the average probability distribution of link connectivity between nodes M and N, which is the probability $P_{M,N}$ that $D_{M,N}(t) \leq R$, thus link availability can be expressed as :

$$\begin{aligned} A_{M,N}(t) &= P_{M,N}[D_{M,N}(t_0 + t) \leq T | D_{M,N}(t_0) \leq R] \\ &= \int_0^R \int_0^{2\pi} f_{D_{M,N}\theta_D}(d, \theta) d\theta dd \\ &= \frac{d}{\pi \alpha_{M,N}} \int_0^R \int_0^{2\pi} \exp \left[-\frac{(d^2 + C^2) + 2d(C \cos \theta_c \cos \theta + C \sin \theta_c \sin \theta)}{\alpha_{M,N}} \right] \end{aligned} \quad (7)$$

Where, the distance $D_{M,N}(t)$ is greater than or equals to 0. When $R \rightarrow \infty$, link availability reaches its maximum value.

6. PROPOSED WORK

The capacity is the goal function while the network is connected. Because the signal is weakened as it travels from one terminal to the next during transmission, each terminal can only connect directly with those who are adjacent to it. If the nodes are far apart, an intermediary terminal is necessary to act as a router, forwarding the information until it reaches its destination. As a result, direct transmission, two-hop transmission, and cooperative transmission modes will be explored [23], and topological features will be examined in three ways in this study.

6.1. Direct Transmission

When the distance between source S and destination D is smaller than the effective communication radius R, the two nodes become neighbouring nodes, according to the initial location. The source S is at the circular's centre, the destination D should be within the source's effective communication range, and typical point-to-point direct transmission can be employed. The received signal's signal-to-noise ratio (SNR) is

$$\gamma_{S,D}(t) = \frac{P_t \times d_{S,D}^{-\alpha}(t)}{N_o} \quad (8)$$

The outage capacity of direct transmission is [17]: it is used to reflect the link rate, which is the link capacity obtained under a modest interrupt link probability.

$$C_{DT}^{\varepsilon}(t) = B \log_2 \left(1 + \frac{1.5\varepsilon \times \gamma_{S,D}(t)}{0.2 - \varepsilon} \right) \quad (9)$$

The interference of the path should be the sum of all participating nodes covered in the transmission to ensure transmission quality. Because direct transmission involves only two nodes, the interfering nodes are those covered by the source and destination:

$$I_{DT} = I(S) \cup I(D) \quad (10)$$

The motion status of nodes will impair link connection and system stability, which will affect network capacity, due to node mobility. The effective value of the vector sum of the random moving velocity vectors VS and -VD is represented as VS, D, which can be written as the relative motion speed between source and terminal. According to the rule of cosines, when

destination D approaches the communication range boundary of source S, according to the law of cosines, relative motion distance between nodes is

$$Z = R \times \frac{\sin[180^\circ - \theta_Z - (180^\circ - \theta_c) - \theta_{Z,D}]}{\sin[\theta_Z + (180^\circ - \theta_c)]} \quad (11)$$

communication time is

$$T_{s,D} = \frac{Z_{s,D}}{|V_{s,D}|} \quad (12)$$

After that, a link's availability can be extended to the path. Because the change in link connection in a MANET is nonlinear, each link is independent of the others. When a route is about to fail, alternate routes should be planned ahead of time based on link availability.

$$T_P = T_{s,D} \times A_{s,D}(t) \quad (13)$$

The three basic factors that define network capacity are link availability, rate, and interference. Network capacity can be improved during communication times by boosting link availability and rate, as well as minimizing interference. Integrating the outage capacity yields the traffic between nodes in communication time; thus, the objective function is:

$$g_{DT}(t) = \int_0^{T_{s,D} \times A_{DT}(t)} \frac{C_{DT}^\varepsilon(t)}{I_{DT}} dt \quad (14)$$

6.2. Two-hop Transmission

Two-hop transmission, which takes two time slots, seeks to improve connection quality by replacing long-distance direct transmission with two-hop transmission. Data is transmitted from the source to the relay in the first slot, and then to the destination in the second slot, as shown in Figure 3. The SNR of the signals received by the relay from the source, as well as the SNR of the signals received by the destination from the relay, are

$$\gamma_{S,R}(t) = \frac{P_t \times d_{S,R}^{-\alpha}(t)}{N_o} \text{ and } \gamma_{R,D}(t) = \frac{P_t \times d_{R,D}^{-\alpha}(t)}{N_o} \quad (15)$$

respectively. The maximum instantaneous mutual information of the two-hop transmission link is:

$$C_{MT}^\varepsilon(t) = \frac{1}{2} \min\{C_{S,R}, C_{R,D}\} = \frac{1}{2} \min\left\{B \log_2 \left(1 + \frac{1.5\varepsilon \times \gamma_{S,R}(t)}{0.2 - \varepsilon}\right), B \log_2 \left(1 + \frac{1.5\varepsilon \times \gamma_{R,D}(t)}{0.2 - \varepsilon}\right)\right\} \quad (16)$$

According to the interference model, all covered nodes must remain silent while the node transmits data, hence the interference of a connection can be defined as the total number of nodes covered during the link transmission. Each hop in a two-hop transmission has its own interference, but it happens at different times and at varied levels of intensity. $I_{S,R} = I(s) \cup I(R)$ and $I_{R,D} = I(R) \cup I(D)$ respectively. Because these two hops cannot be transmitted at the same time, the interference of a two-hop link is determined by the greater of the two:

$$I_{MT} = \max (I_{S,R}, I_{R,D}) \quad (17)$$

The relative motion velocity between source and relay is denoted as $V_{S,R}$, The relative velocity between relay and terminal is $V_{R,D}$, the link communication time are

$$T_{S,R} = \frac{Z_{S,R}}{|V_{S,R}|} \text{ and } T_{R,D} = \frac{Z_{R,D}}{|V_{R,D}|} \quad (18)$$

respectively. Because path availability is tied to the availability of links from source to relay and relay to destination, the expected path communication time can be extended to the path. $T_p = \min (T_{S,R} \times A_{S,R}(t), T_{R,D} \times A_{R,D}(t))$. Therefore, the objective function is:

$$g_{MT}(t) = \int_0^{T_p} \frac{C_{MT}^\varepsilon(t)}{I_{MT}} dt \quad (19)$$

6.3. Cooperative Transmission

Traditional direct transmission just uses signals from the source to the destination, however cooperative transmission can decode the combined signals from the source and relay received at the destination to improve SNR. For cooperative transmission, the DF system with only one relay is used, in which the relay decodes the received source signals, then recodes and transmits them to the destination. The two signals could be decoded using the maximum ratio combining technique (MRC) [24]. It has the following maximal instantaneous mutual information:

$$\begin{aligned} C_{CT}^\varepsilon(t) &= \frac{1}{2} \min\{C_{S,R}, C_{MRC}\} \\ &= \frac{1}{2} \min\left\{B \log_2 \left(1 + \frac{1.5\varepsilon \times \gamma_{S,R}(t)}{0.2 - \varepsilon}\right), B \log_2 \left(1 + \frac{1.5\varepsilon \times (\gamma_{R,D}(t) + \gamma_{R,D}(t))}{0.2 - \varepsilon}\right)\right\} \end{aligned} \quad (20)$$

Cooperative transmission interference is more complicated than the other two transmission modalities; to ensure transmission success, path interference should equal the sum of coverage of all participating nodes [25]. Not only the neighbours covered by the source, but also the neighbours covered by the relay and destination, must be silent during the broadcast stage. As a result, cooperative transmission interference may become more severe, reducing the number of transmission nodes and capacity. The interference set of cooperative transmission includes the coverage of source, relay, and destination nodes.

$$I_{CT} = I(S) \cup I(R) \cup I(D) \quad (21)$$

Due to the fact that cooperative transmission necessitates continuous contact, the expected communication time is

$$T_p = \min (T_{S,R} \times A_{S,R}(t), T_{R,D} \times A_{R,D}(t), T_{S,D} \times A_{S,D}(t)) \quad (22)$$

Therefore, the proposed function is:

$$g_{CT}(t) = \int_0^{T_P} \frac{C_{CT}^\varepsilon(t)}{I_{CT}} dt \quad (23)$$

To maximise connection capacity, this system selects the right transmission mode and relays with low interference [26]. Because the performance of transmission is also dependent on the relative position of the relay, cooperative transmission does not have a higher rate than direct and two-hop transmission. Direct or two-hop transmission should be employed if there is no relay capable of providing higher interrupt capacity. The path's objective function in MANET is:

$$g(j) = \max(g_{DT}, g_{MT}(j), g_{CT}(j)) \quad (24)$$

Therefore, when the relay set $V_{SD}=\{1,2,\dots,m\}$ exists within the communication range of source and destination, The greatest value of the objective function for each relay can be used to determine the transmission mode and relay that will optimise network capacity. Parallel computing can be utilised to speed up the computation because the objective function is split into numerous independent sub-targets.

$$j = \arg \max_{j \in V_j} g(j) \text{ for all } j \in V_{S,D} \quad (25)$$

7. SIMULATION PARAMETERS

Table 1 Simulation Parameter [7]

Parameter	Value
No. of Nodes	10-50
Protocol	AODV
Algorithms	AODV, CDA-AODV
Communication protocol	TCP, UDP
Pause Time	100 ms
Simulation time	600ms
Simulation area	600m X 600m

8. RESULTS AND DISCUSSION

In this part, OmNetpp is used to simulate the performance of the random topology model's dynamic topology reconstruction. Only the effect of network topology on capacity is considered for wireless channels, which follow the Rayleigh distribution of slow fading. 30 nodes were randomly placed over a 600x600 square metre region in the simulation. The random-walk-based mobility model moves nodes and generates a velocity for their next movement at random. Nodes communicate with their neighbours on a regular basis; the effective transmission region is a circle, and each mobile node's transmission range is R.

The topological performance of the LBP-CDA-AODV with reconstruction mechanism is compared to that of the LBP-CDA-AODV without reconstruction mechanism and direct transmission in. The maximum movement speed is 1m/s, with a path loss index of 3.5. The topology performance of LBP-CDA-AODV is higher than other systems, according to simulation findings, and performance optimization is due to the joint design of the reconstruction mechanism and link prediction in the topology algorithm. When the coverage

radius is less than 100m, simulation findings demonstrate that the wider the coverage radius, the more neighbouring nodes are in the simulated area, and the larger the outage capacity. When the coverage radius exceeds 100 metres, topological qualities worsen. This is because a big coverage radius not only increases capacity, but also increases interference. Direct and two-hop transmission perform better than cooperative methods in this scenario, and they use less energy. When the coverage is 100m, the topological performance of the LBP-CDA-AODV system outperforms that of the direct transmission system by 17%.

The connection availability is less than one due to mobility, therefore there is a discrepancy between the expected and practical curves, as seen in Figure 6. Despite the fact that prediction error is unavoidable, they all follow the same pattern, implying that the prediction model can forecast communication time and capacity. Because node cannot leave the designated space, the faster the speed, the easier it is to break the link in the simulation. Low node activity, on the other hand, can improve link prediction accuracy, and prediction error is smaller when angle of motion is $1/2$ than when it is 2 . In the direction of motion, the larger the motion angle fluctuation is, the closer it is to the random walking movement model, and the relative motion speed of the two nodes is small, the link will remain connected for a long time.

A comparison of the LBP-CDA-AODV system's topological performance and prediction under various path loss indexes. The ideal transmission range of nodes is similarly affected by the loss factor; as loss coefficients grow, the optimal transmission range and prediction error decrease. When the path loss index is 3.5 and the transmission range is 100, increasing the average link length improves communication time and topology effect, as shown in Table 2. Because when multiple relays are available in the system, it tends to choose the relay with a low speed relative to the source and destination, 7 nodes with low relative motion are selected, while only one node with high relative motion is selected, increasing the stability of the link and the accuracy of the prediction.

The topological performance of the system improves as the interrupt probability increases. The ideal transmission range improves from 79m to 113m when the path loss index is 3.5, as shown in Table 3. The bigger the path loss index, the smaller the differential value of optimal transmission range when the interrupt probability is 10^{-4} and 10^{-3} , respectively.

Table 2. Performance versus other mobility models: 300m×300m, $\alpha=3.5$

	R=25	R=50	R=75	R=100
communication time	29.188	46.08	45.11	47.3
$T_p \times L(T_p)$	25.53	46.54	44.83	46.9
High mobility relay	0	0	0.5	6.5
Low mobility relay	0	2	3.5	9
Average path length	0.75	1.1	0.912	0.94

Table 3 Coverage radius from higher topology performance for a given (ϵ, α) pair

	$\alpha=2.5$	$\alpha=3$	$\alpha=3.5$	$\alpha=4$
$\epsilon=10^{-4}$	160m	133m	79m	78m
$\epsilon=10^{-3}$	199m	160m	113m	101m

9. CONCLUSION

Because random movement of nodes causes a dynamic change in network topology in MANETs, this paper proposes a predictive topology control mechanism for capacity optimization in highly dynamic wireless self-organizing networks, and link availability can be

used to determine the connectivity probability of the entire route. Cooperative transmission can theoretically achieve more network capacity than direct transmission; nevertheless, it does not always have a higher rate than direct and two-hop transmission since cooperative transmission performance is also dependent on the relay's relative location. Direct transmission should be utilised if there is no relay that can reach the greater interrupt capacity. Cooperative transmission interference is becoming increasingly problematic, reducing the number of nodes transmitting simultaneously in the network. As a result, the performance improvement in this algorithm is derived from the joint design of maintaining optimal transmission mode, more reliable and stable relay nodes, and a minimum interference path in topology control. This algorithm significantly reduces data storage capacity by obtaining node location information within a specified time interval, reduces computational time and complexity by abandoning the multi-hop mode and iterative algorithm to adapt to rapidly changing network structure, improves network capacity by optimising topology for mobile AD hoc networks without central fixed infrastructure, and eliminates unnecessary overhead of frequent information exchange. The theory suggested in this research can be utilised as a useful complement to the integrated satellite, sky, terrestrial, and ocean network structure, as well as a reference for MANET.

Because the error of this prediction model is influenced by mobility and wireless communication settings, no ideal prediction technique with 100% accuracy exists. Despite the unavoidable prediction inaccuracy, this system can properly anticipate the link's existence time and capacity, construct a dependable and stable network topology, and achieve higher network capacity than a fixed topology configuration. However, because to a lack of global information, this article relies on interference of the starting path, and future research can apply a learning algorithm to estimate the degree of interference. Obstacles in the wireless transmission line will impair communication quality and network coverage, hence a multi-hop topology can be used to improve network connectivity. The power of nodes can be depleted during message exchange, hence a more energy-efficient topology model should be considered in the future.

REFERENCES

- [1] S.Gayathri Devi and Dr.A.Marimuthu, "Forwarding Node Reduction with Link Break Time Prediction", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24,2017, pp. 14441-14446.
- [2] Amanpreet Singh, Bhupinder Kaur, "To Propose a Novel Technique for Link Recovery in MANET", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 5 Issue 2, February 2016.
- [3] B.Karthikeyan and Dr.S.Hari Ganesh, "Analysis of Reactive AODV Routing Protocol for MANET", IEEE Xplore, Digital Library,ISBN:978-1-4799-2876-7, Oct 2014, pp. 264-267, Scopus Index, Impact Factor :5.629.
- [4] B.Karthikeyan and Dr.S.Hari Ganesh, "Security and Time Complexity in AODV Routing Protocol", International Journal of Applied Engineering Research (ISSN:0973-4562), Vol. 10, No.20,June 2015, pp.15542- 15546.
- [5] B. Karthikeyan and Dr.S.Hari Ganesh, "Encrypt - Security Improved Ad Hoc On Demand Distance Vector Routing Protocol (En-SIm AODV)", ARPJN Journal of Engineering and Applied Sciences (ISSN: 1819-6608), Vol. 11, No. 2, January 2016,pp.1092-1096.
- [6] B. Karthikeyan, Dr.S.Hari Ganesh and Dr. JG.R. Sathiaselvan, " Optimal Time Bound Ad-Hoc On-demand Distance Vector Routing Protocol (OpTiB-AODV)", International Journal of Computer Applications (ISSN:0975 – 8887), Vol. 140, No.6, April 2016,pp 7-11.
- [7] B. Karthikeyan, Dr.S.Hari Ganesh and Dr. JG.R. Sathiaselvan , "High Level Security with Optimal Time Bound Ad-Hoc On- demand Distance Vector Routing Protocol (HiLeSec-OpTiB AODV)",International Journal of Computer Science Engineering(E-ISSN: 2347-2693),Vol. 4, No. 4, April 2016, pp.156-164.

- [8] Haenggi M, Ganti R K. Interference in large wireless networks. *Foundations and Trends in Networking*, 3(2), 127-248 (2008).
- [9] Ganti R K, Haenggi M. Interference and outage in clustered wireless ad hoc networks. *IEEE Transactions on Information Theory*, 55(9), 4067-4086 (2009).
- [10] William Su, SungJu Lee, Mario Gerla. Mobility prediction and routing in Ad hoc wireless networks. *International Journal of Network Management*, 11, 3-30 (2001).
- [11] Shah H, Nahrstedt K. Predictive location-based QoS routing in mobile Ad hoc Networks. In *Proceedings of IEEE International Conference on Communications (ICC 2002)*. (New York, NY, 2000-04).
- [12] Bruce McDonald A, Taieb Znati. A path availability model for wireless Ad hoc networks. In *Proceedings of IEEE Wireless Communications and Networking Conference 1999 (WCNC'99)*. (New Orleans, LA, 1999-09).
- [13] Jiang, Shengming, N. D. He, and N. J. Rao. "A prediction-based link availability estimation for mobile ad hoc networks." *Infocom Twentieth Joint Conference of the IEEE Computer & Communications Societies IEEE* IEEE Computer Society, 2002.
- [14] Xiang S, Yang J. Performance reliability evaluation for mobile ad hoc networks. *Reliability Engineering & System Safety*, 169(jan.), 32-39 (2018).
- [15] Xiang S, Yang J. Performance reliability evaluation for mobile ad hoc networks. *Reliability Engineering & System Safety*, 169(jan.), 32-39, (2018).
- [16] Rahmani P, Javadi H H S, Bakhshi H, et al. TCLAB: A New Topology Control Protocol in Cognitive MANETs Based on Learning Automata. *Journal of network and systems management*, 26(2), 426-462 (2018).
- [17] Rahmani P, Hamid H S J. Topology Control in MANETs Using the Bayesian Pursuit Algorithm. *Wireless Personal Communications*, (2019).
- [18] Tùng Tin Nguyn, Lee J H, Nguyen M T, et al. Machine Learning-Based Relay Selection for Secure Transmission in Multi-Hop DF Relay Networks. *Electronics*, (2019).
- [19] Zhang H, Zhang H, Liu H, et al. Distributed Motion State Estimation of Mobile Target with Switching Topologies. *Circuits, Systems and Signal Processing*, 39(5), 2648-2672, (2020).
- [20] Hong J, Zhang D. TARCS: A Topology Change Aware-Based Routing Protocol Choosing Scheme of FANETs. *Electronics*, 8(3), (2019).
- [21] Fidan E, Kucur O. Performance of cooperative full-duplex AF relay networks with generalised relay selection. *IET Communications*, 14(5), 800-810, (2020).
- [22] Wang H. Role of Link expiration time to make reliable link between the nodes in MANETs: A Review. *International journal of computational intelligence research*, 14(5), 385-396, (2018).
- [23] Li, Cheng, et al. "Study on the k-Connectivity of Ultraviolet Communication Network under Uniform Distribution of Nodes in a Circular Region." *2019 IEEE 5th International Conference on Computer and Communications (ICCC)* IEEE, 2020. Beckmann P. *Probability in Communication Engineering*. (Harcourt, Brace & World, Inc.: New York, 1967).
- [24] Beckmann P. *Probability in Communication Engineering*. Harcourt, Brace & World, Inc. (New York, 1967).
- [25] Song S H, Almutairi A F, Letaief K B. Outage-Capacity Based Adaptive Relaying in LTE-Advanced Networks. *IEEE Transactions on Wireless Communications*, 12(9), 4778-4787, (2013).
- [26] Ao X, Yu R F, Jiang S, et al. Cooperation-Aware Topology Control for Wireless Ad Hoc Networks with Opportunistic Interference Cancellation. *Ice Trans Commun*, 95-B (9), 3047-3051, (2012).
- [27] Nallusamy C, Sabari A. Particle Swarm Based Resource Optimized Geographic Routing for Improved Network Lifetime in MANET. *Mobile networks & applications*, 24(2), 375-385, (2019).