

# A Survey on Network Coding In MANET

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**Abstract :** MANET is self-configuring, infrastructure-less network. Routing in MANETs is challenging task because of its underlying characteristics. Out of many approaches of MANET routing cluster based routing has significant potential towards providing efficient and power saving method of data forwarding. Simultaneously the network coding method of data forwarding in computer network possess a characteristic of high throughput and low bandwidth consumption. Throughput and delay is major challenges of clustered MANET Network Coding is seen as new promising technique to enhance Network Throughput., reduce Delay, and construct more robust network. In Network coding new forwarding paradigm where Intermediate node perform store, coded and forward operation perform in incoming packets. In traditional routing only store and forward operation is performed on incoming packets. By using Network Coding in clustered MANET the Network throughput Increase. In this paper, basic clustering definition, challenges and issues, various existing routing protocols, detailed analysis of Research paper which is useful to understand Network Coding in MANET. With this survey, researcher can have a more thorough and detailed understanding of ad hoc Network Coding In clustered MANET and the research trends in this area.

**IndexTerms -** MANET, Network Coding, Clustering, Broad- cast, Routing Protocol, Ex-OR, Throughput, Bandwidth.

## I. INTRODUCTION

The mobile ad-hoc network (MANETs) is a collection of two or more nodes or terminals or device which is connected without any wires. In MANET there is no fixed network so it is called infrastructure-less networks [1]. All terminals or nodes are connected to one others via wireless links. MANETs are drawing Increasing interests for data communication because of its development of wireless and social networking technologies. One of the MANETs fundamental issues is to achieve robust transmission [2]. Another issue is to handle the behaviors of large scale networks especially, the behavior of broadcasting the packets consistently with minimum delay and maximum throughput. Network coding is a networking technique in which transmitted data is encoded at sender side after that encoded data will be broadcast and at receiver side data will be decoded to increase network throughput, reduce delay and make network robust [4]. By using network coding in Clustered MANET, the number of transmission is reduce to send packets compare to traditional routing algorithms. Saved

transmission can be used to send new data, increase the wireless throughput and reduce bandwidth constrained [9].

### A. Routing Protocol in MANET

Routing is fundamental and important component of MANET. It networks to support data communication. To make MANETs practical, efficient and effective, it is being a critical issue by unicast routing protocol [4]. For MANETs there has been development of many different unicast routing protocol. These routings are been classified into two ways: Unicast routing and Multicast Routing. Moreover, Unicast Casting is divided into two types. Proactive and Reactive. A Proactive unicast routing protocol is also known by Table-driven unicast routing protocol. Nodes continuously evaluate routes to all reachable nodes, attempt to maintain consistent and up-to- date routing information is done with the help of proactive unicast routing protocol. Hence, whenever needed the source node can get a routing path immediately. Also, all nodes need to maintain a consistent view of the network topology in the proactive unicast routing protocols [3]. Reactive unicast routing gives a different approach to the proactive unicast routing. These reactive routing protocol is also known as source-initiated on demand unicast routing protocol. Such type of unicast routing happens only when desired by the source node. It initiates a routing discovery process whenever a node requires a routing to a destination within the network [3]. The process by which the network gets divided into interconnected substructures is known as Clustering. This interconnected structure is called clusters. In comparison to the Traditional networks, Clustering in Ad Hoc networks has many benefits. Clustering in Ad Hoc networks saves energy as well as communication bandwidth [4]. Updating of the routing tables after topological changes had occurred, clustering decreases transmission overhead [5].

### B. Clustering Algorithm in MANET

Clustering is the process of dividing network into inter- connected substructure. In Cluster, a node is defined as a Gateway if it is the neighbor of two or more Cluster Head. The cluster head (CH) of each node act as a base-station or coordinator within the substructure. Each CH act as a temporary base station within its cluster. A CH selected based on a combination of matrices such as identity, degree, mobility, weight, density, etc. therefore cluster is made of CH, gateway node and member node which is shown in below clustered network topology. In this paper Jon Crowcroft et al. [7] design new technique for robust coding which is call loop coding. This coding technique improve network throughput and TCP throughput. In this each node to know about and coordinate with one hop neighbors. Shuhui Yang et al. [7]. used the directional antennas to network coding-based for forwarding

nodes selected locally only need to transmit broadcast message in specific sectors. So number of transmission will be reduce by using directional antennas. In this paper they also design two approaches for single source/single message issues in the network broadcasting application.

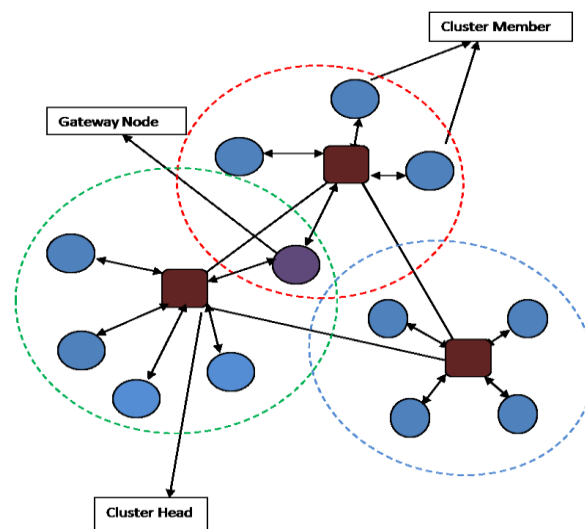


Fig. 1. Clustered Network Example

In Literature of MANET research there are many Clustering algorithms. Many of such algorithms related to our proposal are described in this section. Identifier-Based clustering: A unique ID is assigned to each node in Identifier-Based clustering. Every node knows the ID assigned to its neighbor. And CH is chosen by the following algorithms .Lowest ID [8] and Highest Degree [6]. An efficient protocol proposed by Baker et al. [8]. Link cluster algorithm is another name of Lowest ID. Where each and every node has a unique ID. At Fixed time of interval every nodes broadcast their ID to their 1-hop neighbors. After that comparison of received ID and nodes own ID is occurs. If node has a lowest id than received ID than it declares itself as a CH. thus disadvantage of lowest ID algorithm is that certain nodes are prone to battery drainage due to serving as cluster head for longer time period and because of high mobility of nodes, cluster heads has to be frequently updated. Highest Degree algorithm was proposed by Gerla et al. [6].it is also known as connectivity-based clustering method because it operates based on the value of node degree of particular node. In this algorithm every node broadcast their ID in their domain. Each node calculates its node degree value based on number of received IDs. The node is selected as a cluster head which have maximum degree. In this methodology, the quantity of bunch heads is generally low in examination with most minimal ID approach. Likewise, it additionally diminishes estimation of parcel conveyance delay. However, the number of re-affiliations of CHs increases when the topology changes. This system has a low rate of cluster head change but the throughput is comparatively low. Regularly, every cluster is allotted a few resource which is shared among the part hubs of that group. Significant mistakes of the protocol add the circumstances in which the level of the node alterations quite often, and thus the CHs are certainly not more likely to engage in their function while cluster-heads pertaining to lengthy. Also, as the amounts of regular nodes are greater in the bunch, the throughput drops as well as method performance degrades. Most of these mistakes occur simply because these specific schemes don't even have almost any restriction on the second restriction of the quantity of nodes in the bunch. Cluster based routing protocol:-Cluster Based Routing Protocol is proposed in [18]. In this method, each cluster observes the following rules for changing cluster head i) A member of a cluster never challenges to cluster head for being head ii) If two cluster heads come in same radio range over an extended period of time then only one of them will act as cluster head second will lose its role as a cluster head. When CH listens to a HELLO message from another CH, having bidirectional link, it sets timer to a pre-defined value CONTENTION-PERIOD given in second. When the timer expires, it checks if two CHs are still in the same radio range, then it compare its own ID with other CHs ID the cluster head with smaller ID will continue to act as cluster head and other will force to act as cluster member. These rules provide some short of stable clustering by delaying the CH change for certain time specified by the timer. Weight Based clustering Algorithm: In [19]. R. Pandi Selvam and V. Palanisamy presented a flexible weight based clustering algorithm in mobile ad hoc networks. The proposed algorithm is a 2-hop clustering algorithm. The performance of the algorithm showed that it outperformed the existing LID, HD and WCA to make the number of clusters. It also increases the number of nodes, transmission range and maximum displacement. The weight of each node is calculated by the weight function  $w(p)$ . The cluster head election is done by comparing the weight of each node with its neighbors in the two hop range. The node with highest weight declares itself as the cluster head.

### C. Overview of Network Coding .

Work on Network Coding started with the pioneering paper by Ahlswede et al. [10]. Network coding is a technique for increasing throughput of wireless networks [21]. Network coding performs algebraic operation at intermediate node. Intermediate node packets are mixing and broadcasting in networks. This way, network coding reduces the number of packet transmission. Network coding-based broadcasting aims on decreasing the number of transmissions. Each forwarding node combines some of the received messages for transmission which performs in the multiple sources /multiple messages broadcast applications [22]. The total number of transmissions can be decreased in comparison to broadcasting without coding the same forwarding nodes by the help of network coding [7]. Using network coding lifetime of network will be increased. Now consider scenario where Node

Alice and node Bob wants to exchange Packets to each other via Relay. In traditional approach it will take 4 nos. of transmissions which are first from node Alice to Relay, second from Relay to node Bob, third from node Bob to Relay and the last from Relay to node Alice. Now by using network coding the number of transmission is 3. Node Alice and Bob send packets to Relay. Relay mixing arrived packets from node Alice and Bob. New XORed packet broadcast in network.



Fig. 2. Traditional Routing Approach [9].



Fig. 3 Using Network Coding Routing Approach [9].

This way number of transmission is reduced and time also saved which will be used to transmit new data [9]. Advantages of network coding is save bandwidth, reduce number of transmission, increase throughput [11]. The main drawback of network coding is loss of one packet could affect many other packets and give some information unless at the receiver. The classifications of network coding are local network coding and global network coding [20]. In local network coding relay node send the coded packets to next hop node such that next hop able to decode and code those packets. After receiving coded packet next hop node will decode that packets and use same policy to code that packets. Hop-by-hop coding and decoding is performed in multi-hop transmission. In contrast in global network coding, intermediate node do not perform decoding. It just codes the coded packets again. At last when destination node will receive sufficient packets, they will be decoding them [22]. XOR or binary coding used in local network coding, when Random linear coding is used in global network coding. COPE protocol implements network coding concept to reduce the number of transmission by mixing the packets at intermediate node. It inserts network coding between the IP and MAC layer, which detects coding opportunities and exploits them to forward multiple packets in a single transmission. COPE incorporate three main techniques [9]. Opportunistic Listening:- Wireless is a broadcast medium and it does create many opportunities for nodes to overhear packets when they are connected with omni-directional antennas. In this every node broadcast reception report to tell its neighbor which packets it has stored[9]. Opportunistic Coding:- For coding more than two packets in a single packet, than key question is that which packets are coded together for maximize throughput. The node have many option, but it should be aim to Maximize the number of native packets deliver in a single transmission, while ensuring that each intended next hop has enough information to decode its native packets. Same length packets are coded together to reduce bandwidth consumption[9]. Learning Neighbor state:- Hoe does a node know what packets its neighbor has? For that each node announces reception report to its neighbor. In reception reports the packets information is given. COPE protocol increase Coding Gain, which is the ratio of number of transmission required by the current non- coding approach to the number of transmission used by COPE to deliver same set of packets[9].

#### D. Challenges and Issues in MANET

Due to the fundamental characteristic such as wire- less medium, dynamic topology, infrastructure less network, MANET has so many challenges and issues which are given below.

*Autonomous:-* In MANET there is no centralized administration entity is available to manage operation of different mobile nodes.

*Routing:-* The topology of the network is continuously changing, the issue of routing packets between any pair of nodes it will be challenging task. Routes between nodes include multi hops, which is more complex, compare to one hop communication.

**Bandwidth Optimization:-** Wireless links have significantly lower capacity than infrastructure network. In realized throughput of wireless communication after accounting for the effect of multiple access, fading, noise, and interference condition etc. is often much less than a radio's maximum transmission rate.

**Dynamic Topology:-** Nodes are mobile and free to move in an arbitrary manner; so network topology which is multi-hop, may change rapidly at unpredictable time, and it may consist of both bidirectional and unidirectional.

**Quality of Service:-** In a constantly changing environment, providing QoS will be a challenge.

**Topology Maintenance:-** Updating information of dynamic links among nodes in MANET is a major challenge.

**Routing Overhead:-** Nodes are adjustments in their particular area within the network within an instant network, therefore many stale routes are earned in direction-finding stand which leads to needless direction-finding cost.

**Hidden terminal problem:-** hidden terminal issues identify the crash associated with packets in a receiving node as a result of the simultaneous indication of these nodes which have been not really in the strong signal range of the sender, yet are generally in the indication array of device.

## II. PARAMETER FOR IMPLEMENTATION NETWORK CODING IN MANET

Network throughput and packet delay are the two most important parameters to evaluate the performance of wireless ad hoc networks. Generally it is difficult to achieve both high throughput and low packet delay. Throughput is the number of packets/bytes received by source per unit time. It is an important metric for analyzing network protocols.

**Packet Delivery Ratio (PDR):-** It is the ratio of actual packets delivered to the destination to the total packets sent by source node [24].

**end-to-end delay:-** The average time it takes a data packet to reach the destination. This includes all possible delay caused by buffering during route discovery latency, queuing delay [23]. End-to-end delay metric can be calculated by subtracting time at which first data packets were transmitted by source from which first data packets arrived to the destination [24].

## III. EXISTING ROUTING PROTOCOL IN MANET

Disseminating information through a network requires a path from a source to the desired destination. This path is created by intermediate nodes via a routing protocol. Various routing protocols might possibly create unique paths from the network, every single route having its individual unique performance and QoS characteristics such as throughput, delay and reliability. A primary list of routing practices has been extracted from the actual large literature about routing within MANETs. In contrast to the actual preset facilities, actual qualities connected with MANETs, for example mobility, call for a lot more dynamic route variety algorithms and therefore utilize their own unique routing practices. This provides the description of the random routing practices below study.

### A. Ad hoc On-Demand Distance Vector (AODV):

AODV [12][13] is a completely reactive routing protocol. AODV is an On-demand routing protocol which is a combination of DSDV and DSR. In AODV route information is calculated on demand. Therefore every terminal does not need to keep view of the whole network or route to every node. When mobile terminal has packets to send to a destination at that time mobile terminal needs to discover and maintain route to the destination node. While repairing link breakages then AODV provides loop free routes.

### B. Dynamic Source Routing (DSR):

Dynamic Source Routing is an on demand source routing [12][13]. DSR is designed for use in multi hop ad hoc networks of mobile nodes. In DSR route is calculated when it is necessary. DSR protocol is composed by two On-demand mechanisms, which is requested only when two nodes want to communicate with each other. DSR allows multiple routes to any destination therefore it can lead easily load balancing or increase robustness. In DSR whole route carried with message as an overhead. Without any central administration and network setup. It needs efforts from the MAC layer to identify link failures uses source routing. It allows network to be self-configured and self-organized.

### C. Optimized Link-State Routing (OLSR):

Every single node employing OLSR [15] selects any subset involving nearby nodes to become multipoint pass on (MPRs) and only MPRs have the effect of analyzing management site visitors over the system. It's the result involving limiting the expense involving broadcasting management site visitors over the system. Many nodes inside the system will certainly periodically send HELLO THERE messages to their immediate neighborhood friends regarding website link realizing. Active back links are going to be slipped into an area website link arranged. Using the part topology information (which should be updated periodically), nodes may figure out the shortest path to most obtainable locations.

### D. Partial Dominant Pruning (PDP):

PDP [16] can be a send out project of which engages the Dominant Pruning (DP) algorithm to cut back the quantity of send out mail messages coding the community. Contrary to the original shades surging, where nodes merely rebroadcast all obtained data, DP recognizes a minimum number of 1-hop neighbor to realize all to date unreached 2-hop neighborhood friends. PDP can be even more marketing involving DP of which makes use of a lot fewer forwarding nodes in order to disseminate the details



throughout the community. PDP tends to make selections for each data packet being submitted, according to the latest understanding of a nearby topology, which include which 2-hop neighborhood friends by now obtained the results packet.

#### E. Zone Based Routing Protocol (ZRP):

ZRP [14] is a hybrid routing protocol that divides the whole network into zones. ZRP provides a hierarchical architecture where each node has to maintain additional topological information which requires extra memory. ZRP can be categorized as a hybrid or reactive/proactive routing protocol. It proactively maintains the routing table information of nodes inside the local zone, which reduces the time in route search operation if the destination is inside the zone. However, for the nodes outside the local zone, it reactively searches the route on the basis of route discovery procedure. A routing zone or radius is the distance in number of hops from the node under consideration. Routing zone is divided into two parts: peripheral nodes and interior nodes. Peripheral nodes are nodes whose minimum distance to the central node is exactly equal to the zone radius and whose minimum distance is less than is interior node. ZRP refers to the locally proactive routing component.

## IV. SURVEY OF SOME EXISTING PAPER OF NETWORK CODING IN MANET.

Apart from Routing algorithms, Clustering and some basic knowledge of Network Coding in MANET are describe in previous section, some further Network Coding In MANET related research paper survey is given below. In This Paper Sachin Katti et al. [16] applied network coding to unicast in wireless mesh network to improve network throughput and reducing the bandwidth and power requirement. To reduce the number of transmission, opportunistic coding protocol is used. This protocol aims to balance the tradeoff between reliable and efficient packets delivery. In practical network coding several issues arise like Reliable and efficient broadcast, Maximizing coding gain and power consideration. The physical layer network coding was further investigated by Sachin Katti et al. in [9]. In this network coding applied to unicast wireless mesh network to improve network throughput and for reducing bandwidth consumption and power requirement by using COPE protocol. This paper aims to bridge theory with practice. The advantage of COPE protocol is that it reduce the number of transmission, save bandwidth and increase network throughput. Limitation is that it require Omni directional antennas to exploits the wireless broadcast property and it require more memory to store recently heard packets for future decoding. In this paper Jon Crowcroft et al. [17] presented that, by using loop coding increases TCP throughput and Network Throughput because of in localized network coding, where each node only need to know about and coordinate with only one hop neighbor. Two important problems in localized network coding in wireless network which are applicability and reliability studied. Shuhui Yang et al. [7] used the directional antennas to network coding-based for forwarding nodes selected locally only need to transmit broadcast message in specific sectors. So number of transmission will be reduce by using directional antennas. In this paper they also design two approaches for single source/single message issues in the network broadcasting application. K.Srinivas et al. [25] is proposed 2 Hop Neighbor based protocol to solved broadcast storm problem. In this protocol 2-hop neighbor based protocol like PDP, TDP, Dp to reduce broadcast storm problem in MANET. By selecting the minimum number of 1 Hop node is used to cover all 2-Hop nodes. in this paper network coding is applied on TDP protocol.

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