RESEARCH ARTICLE OPEN ACCESS

# A Meliorate Routing of Reactive Protocol with Clustering Technique in MANET

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**Abstract**
The field of Mobile Adhoc Network (MANET) has become very popular because of the deep research done in that area in last few years. MANET has advantage of operating without fixed infrastructure and also it can tolerate many changes in the network topology. The MANET uses different routing protocols for End to End Packet delivery. This paper is subjected to the Reactive routing protocols on the basis of identical environment conditions and evaluates their relative performance with respect to the performance metric Packet delivery ratio, overhead & throughput. In this Reactive routing protocols can spectacularly reduce routing overhead because they do not need to search for and maintain the routes on which there is no data traffic. This property is very invoking in the limited resource. Achieve a good efficient network life and reliability need a variation on the notion of multicasting. Geo-casting is useful for sending messages to nodes in a specified geographical region. This region is called the geo-cast region. For geo-casting in mobile ad hoc networks. The proposed protocol combines any casting with local flooding to implement geo-casting. Thus, Protocol requires two phases for geo-casting. First, it performs any casting from a source to any node in the geo-cast region. Also this Protocol works on large MANET, and to achieve high accuracy and optimize output. To perform geo-cast region we use a proposed clustering technique in Large MANET.
**Key Terms:** MANET, TORA, AODV, DSR

## I. Introduction

An Ad hoc Network consists of a set of autonomous mobile nodes that communicates via multi-hop wireless communication in an infrastructure less environment. It is an autonomous system in which mobile nodes connected by wireless links are free to move randomly and often act as routers at the same time. Ad hoc networks have become increasingly relevant in recent years due to their potential applications in military battlefield, emergency disaster relief, vehicular communications etc.

In ad hoc networks, nodes communicate with each other by way of radio signals, which are broadcast in nature. Broadcast is a unique case of multicast, wherein all nodes in the network should get the broadcast message. In ad hoc applications, collaboration and communication among a group of nodes are necessary. Instead of using multiple unicast transmissions, it is advantageous to use multicast in order to save network bandwidth and resources. Multicasting is a communication process in which the transmission of message is initiated by a single user and the message is received by one or more end users of the network. Multicasting in wired and wireless networks has been advantageous and used as a vital technology in many applications such as audio/ video conferencing, corporate communications, collaborative and groupware applications, stock quotes, distribution of software, news etc. Under multicast communications, a single stream of data can be shared with multiple recipients and data is only duplicated when required. Main purpose of multicasting is to provide multiple packets to multiple receivers using bandwidth and energy efficiently.

**Paper Outline:**

The rest of the paper is organized as follows: Section II presents the definition of MANET and TORA protocol. Section III presents the TORA Protocol and clustering technique. Section IV provides challenges and proposed solution. In section V shows simulation of TORA and modified TORA performance metrics. Finally Section VI concludes the paper.

## II. Related Work:

A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure. It is an autonomous system in which mobile hosts connected by wireless links are free to move randomly and often act as routers at the same time. The traffic types in ad hoc networks are quite different from those in an infrastructure wireless network, including:

1) **Peer-to-Peer**. Communication between two nodes which are within one hop. Network traffic (Bps) is usuallyconsistent.

2) **Remote-to-Remote**. Communication between two nodes beyond a single hop but which maintain a stable route between them. This may be the result of several nodes staying within communication range of each other in a single area or possibly moving as a group. The traffic is similar to standard network traffic.
3) **Dynamic Traffic.** This occurs when nodes are dynamic and moving around. Routes must be reconstructed. This results in a poor connectivity and network activity in short bursts. [2]

Mainly TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. A logically separate version of the protocol is run for each destination and the protocol consists of three basic functions: creating routes, maintaining routes, and erasing routes. Creating a route from a source node to a destination node requires establishing a sequence of directed links from source to destination building a directed acyclic graph (DAG) rooted at the destination [7].

## III. TORA Protocol & Clustering Technique

TORA Protocol: *Temporally Ordered Routing Algorithm-(TORA)* [1][4] is a distributed routing protocol for mobile, multihop wireless networks. Its intended use is for the routing of IP datagrams within an autonomous system. The basic, underlying algorithm is neither a distance vector nor a link state; it is one of a family of algorithms referred to as "link-reversal" algorithms. The protocol's reaction is structured as a temporally ordered sequence of diffusing computations, each computation consisting of a sequence of directed link reversals. The protocol is highly adaptive, efficient, and scalable, and is well suited for use in large, dense, mobile networks. In these networks, the protocol's reaction to link failures typically involves only a localized "single pass" of the distributed algorithm. This desirable behavior is achieved through the use of a physical or logical clock to establish the "temporal order" of topological change events. The established temporal ordering is subsequently used to structure (or order) the algorithm's reaction to topological changes. TORA's design is predicated on the notion that a routing algorithm that is well suited for operation in this environment should possess the following properties:

- Executes distributed.
- Provides loop-free routes.
- Provides multiple routes (i.e., to reduce the frequency of reactions to topological changes, and potentially to alleviate congestion).
- Establishes routes quickly (i.e., so they may be used before the topology changes).
- Minimizes communication overhead by localizing algorithmic reaction to topological changes when possible (i.e., to conserve available bandwidth and increase scalability).

Routing optimality (i.e., determination of the shortest path) is of less importance. It is also not necessary (or desirable) to maintain routes between every source destination pair at all times. The overhead expended to establish a route between a given source destination pair will be wasted if the source does not require the route prior to its invalidation due to topological changes.

TORA is designed to minimize reaction to topological changes. A key concept in its design is that it decouples the generation of potentially far-reaching control message propagation from the rate of topological changes. Control messaging is typically localized to a very small set of nodes near the change without having to resort to a dynamic, hierarchical routing solution with its attendant complexity. TORA includes a secondary mechanism, which allows far-reaching control message propagation as a means of infrequent route optimization and soft-state route verification. This propagation occurs periodically at a very low rate and is independent of the network topology dynamics.

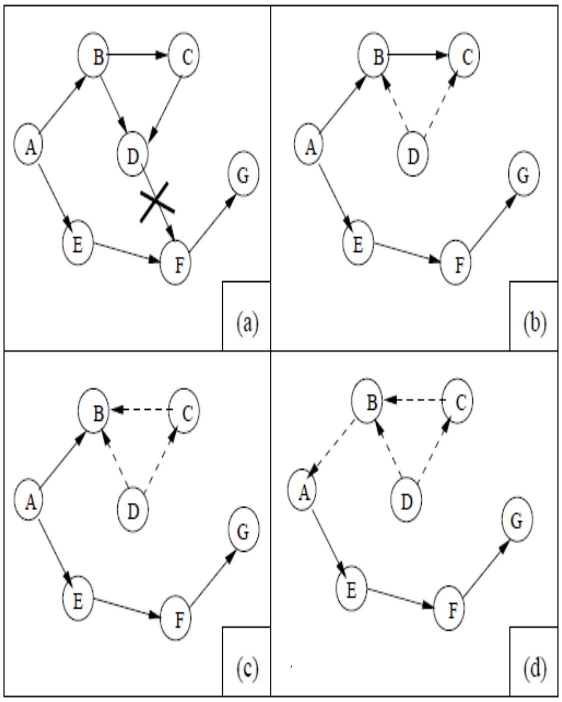
TORA is distributed in that nodes need only to maintain information about adjacent nodes (i.e., one-hop knowledge). It guarantees all routes are loop free, and typically provides multiple routes for any source-destination pair that requires a route. TORA is "source initiated" and quickly creates a set of routes to a given destination only when desired. Because multiple routes are typically established and having a single route is sufficient, many topological changes require no reaction at all. Following topological Changes that do require reaction, the protocol quickly reestablishes valid routes. This ability to initiate and react infrequently serves to minimize communication overhead. Finally, in the event of a network partition, the protocol detects the partition and erases all invalid routes.

A logically separate version of TORA is run for each destination to which routing is required. The following discussion focuses on a single version running for a given destination, j. TORA can be separated into three basic functions: creating routes, maintaining routes, and erasing routes. Creating a route from a given node to the destination requires establishment of a sequence of directed links leading from the node to the destination. This function is only initiated when a node with no directed links requires a route to the destination. Thus, creating routes essentially corresponds to assigning directions to links in an undirected network or portion of the network. The method used to accomplish this is an adaptation of the query-reply process, which builds a Directed Acyclic Graph (DAG) rooted at the destination (i.e., the destination is the only node with no downstream links). Such a DAG will be referred to as a "destination-oriented DAG." "Maintaining route" refers to reacting to topological changes in the network in a manner such that routes to the destination are reestablished within a finite time-meaning that its directed portions return to a destination-oriented DAG within a finite time. However, the Gafni-Bertsekas (GB) algorithms are designed for operation in connected networks.

Due to instability exhibited by these algorithms in portions of the network that become partitioned from the destination, they are deemed unacceptable for the current task. TORA incorporates a new algorithm, in the same general class, that is more efficient in reacting to topological changes and capable of detecting a network partition. This leads to the third function, erasing routes. Upon detection of a network partition, all links (in the portion of the network that has become partitioned from the destination) must be marked as undirected to erase invalid routes.

**Route Mechanism**

TORA accomplishes these three functions through the use of three distinct control packets: query (QRY), update (UPD), and clear (CLR). QRY packets are used for creating routes; UPD packets are used for both creating and maintaining routes, and CLR packets are used for erasing routes.




**Route Maintenance in TORA: Route maintenance is required due to failure of the link between nodes D and F. In the figure, a link that has been reversed since the initial state is shown as a dashed line.**

TORA (Temporally Ordered Routing Algorithm)[4] is one of a family of link reversal algorithms [10] for routing in ad hoc networks. For each possible destination in the ad hoc network, TORA maintains a destination-oriented directed acyclic graph (DAG). Figure illustrates how link reversal is performed in TORA. An arrow connecting a pair of nodes in this figure implies that the two nodes can communicate with each other. That is, the physical link between the two nodes is bidirectional. However, the TORA algorithm imposes a logical direction on the links, as illustrated in Figure (a) this figure shows the destination-oriented DAG with node G being the destination. Observe that, starting from any node in the graph, the destination G can be reached by simply following the directed links. Now assume that the link between nodes D and F breaks (perhaps because node F moves away from node D). Then, in the destination-oriented DAG, node D does not have any outgoing logical link. In response, TORA reverses logical direction of the (D, B) and (D, C) links, as shown in Figure, Now, node C does not have any outgoing logical link. In response, logical direction of link (B, C) is reversed, resulting in the graph in Figure (c). Now since node B does not have any outgoing logical link, the logical direction of link (A, B) is reversed, resulting in the destination-oriented DAG in Figure (d). In this state, each node (other than the destination G) has an outgoing logical link, and is able to reach the destination node G by following the directed links.

Now, node C does not have any outgoing logical link. In response, logical direction of link (B, C) is reversed, resulting in the graph in Figure. Now since node B does not have any outgoing logical link, the logical direction of links (A, B) are reversed, Problem Formulation, need & Significance of proposed research work resulting in the destination-oriented DAG in Figure. In this state, each node (other than the destination G) has an outgoing logical link, and is able to reach the destination node G by following the directed links. The main characteristic of TORA is the centralization of control messages in a very small set of near local nodes in which topological changes have been made. To achieve this property, nodes maintain routing information for the adjacent nodes for some interval. This protocol has three duties: route formation, route renovation and route cleaning. Route formation is performed with QRY and UPD. A route formation algorithm starts by determining a zero set for height of destination node and empty set for height of other nodes.

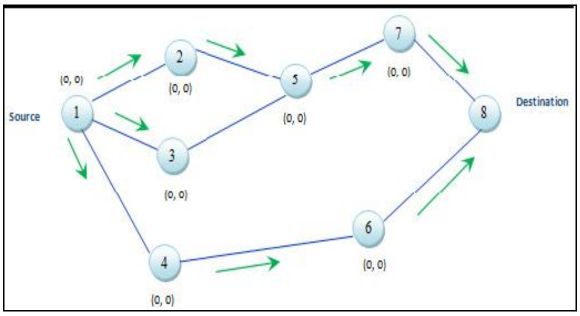
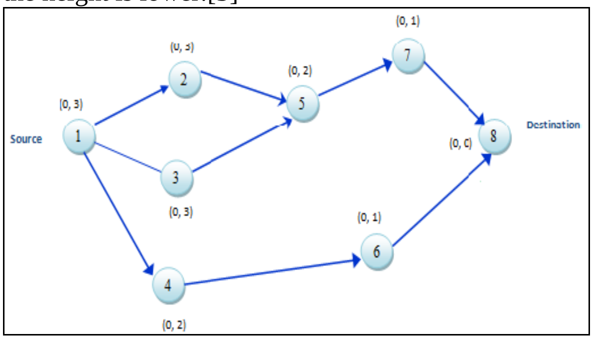



**Fig. Broadcast QRY**

The origin distributes a QRY packet in which destination node identifier is located. In this method, a non-circular graph is created from origin to destination. Figure indicates a process of route formation in TORA. As shown in Figure, node 5 receives the QRY packet from node 3 but it doesn't publish it because this packet has reached this node through node 2 previously. In Figure, the origin, i. e., node 1 can receive the UPD packet from node 2 or node 3 but it doesn't receive it from node 4 of which the height is lower.[3]




**Distribute UPD packet**

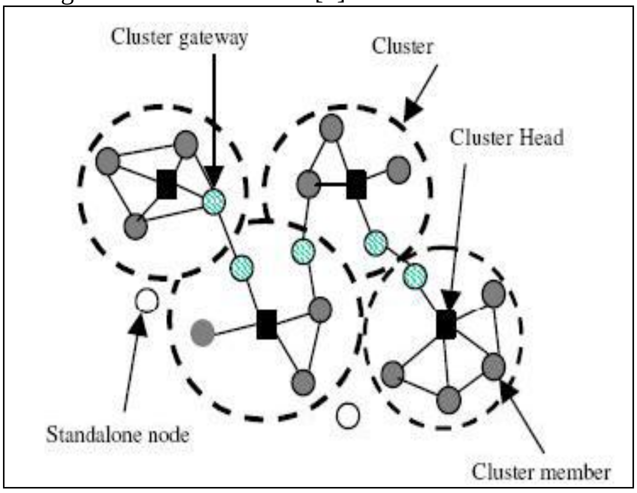
**Clustering in Ad hoc Network**

Clustering [7] is the method which divides the network into separate or overlapping zones. Clustering selects a set of nodes from the whole network such that from these nodes any of the nodes of the network is reachable and it does not require maintaining all the links between all the nodes in the network. The selected subset of the nodes leads to all the other nodes in the network. These leading nodes are called Cluster head. The cluster heads are either directly connected or connected via any other node. These intermediate nodes are called Gateways. Clustering is useful and provides following advantages.

- There is a back bone created considering only special nodes like cluster heads and gateways. So it requires less no of connections to be maintained.
- If cluster based routing is implemented then only cluster heads have to maintain route information.
- Mobility of node affects only when the movement of node is inter cluster.

***Node Role***

There are different node roles assigned to each node while running the clustering algorithm and according to the node role node may contribute in the management of the network. [6]




**Cluster formation and node role**

- **Cluster Head.** They are the nodes selected by different clustering techniques to lead the network to create a back bone. This node serves as the head to the subset of ordinary nodes.
- **Gate Ways.** These are some of the ordinary nodes which are connected to more than one cluster. Thus they connect two clusters and also contribute in creation of the back bone of network.
- **Ordinary node.** The nodes which are connected directly or by k -hop to any of the cluster head in the network are called ordinary nodes.

We have studying following technique for clustering Lowest - ID Technique, Max Degree Heuristic and K – CONID, Max - Min D Hop clustering.[6]

## IV. Challenges & Proposed Solution

### Challenges:

The overhead of TORA consists of data packets as well as control packets (QRY, UPD, and CLR) used to create and maintain routes. Also, few more overhead packets consider when creating a cluster (geo-region) for routing in small area. The overhead increases with increasing node mobility (i.e., decreasing pause time) for all schemes. However, note that the main reason for increasing overhead in GeoTORA is the control packets, not the data packets. With low mobility rate in GeoTORA, routes for forwarding packets are likely to be fixed and, therefore, the number of control packets to maintain the routes is relatively small. As mobility rate goes up, the cost for a route maintenance process, i.e., number of QRY and UPD packets, also becomes higher.

**Proposed Solution:**

We suggest the following approaches to reduce overhead of control packets. Firstly we assume that nodes are stationary node, for that we can modify setdest utility available in network simulator.

Secondly, when the controls packets communicate between source nodes to destination node through intermediate nodes, there is a problem of packets being dropped due to collisions since packets are routed on same channel at same time. This can be solved by adding timer functionality, where in these packets are timely broadcast.

To further reduce the overhead of control packets, small regions of topology and clustering scheme is employed within these small regions. The intra-region control packets overhead is further reduced by employing routing between cluster head to cluster head of different regions.

## V. Simulation and Results

For the purpose of simulation for traditional & proposed TORA Protocol improved accuracy in performance, we have used Network Simulator 2 (NS2) [12]. The traffic is generated with CBR sources and Node random motion is disabled. The source-destination pairs are spread randomly over the network.

We have created the rectangular field of 500x500m with 50 and 100 nodes are spreaded randomly in the field. The simulation is done for 100 sec.

The Simulation parameters are shown in the table.

**Table: Simulation Parameter**

| Parameter | value |
|---|---|
| Simulator | NS-2 |
| Protocols used | TORA, Modified TORA |
| Simulation time | 100 sec |
| Simulation area | 250X250, 5000X5000 |
| Node movement | Random way point |
| Bandwidth | 2Mbit |
| Traffic type | CBR |
| Data payload | Bytes/packet |
| Nodes | 20, 50, 70, 90 |
| Time | 0, 10, 20, 50 |

The Simulation is done to evaluate the performance index *Packet Delivery Ratio.* It is mathematically calculated by the given formula:

$$P = \frac{1}{c}\sum_{f=1}^{e}\frac{R_f}{N_f}$$

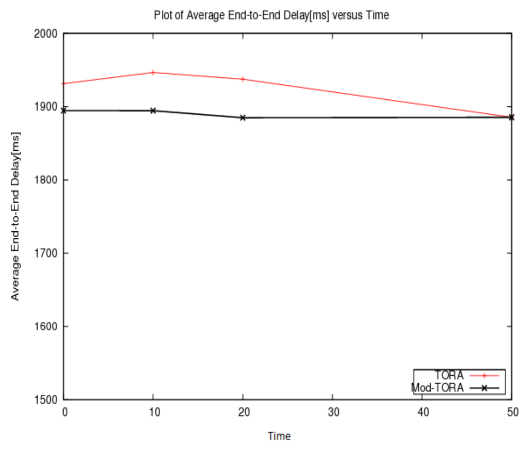
Where P is the fraction of successfully delivered packets, C is the total number of flow or connections, f is the unique flow id serving as index, $R_f$ is the count of packets received from flow f and $N_f$ is the count of packets transmitted to f.

The results of the simulation shows in figure that as we increase the number of nodes and time the end to end delay for protocols increases. But the effect of increasing the number of nodes can be seen in TORA the most. Figure shows the graphs of the End to end Delay with variable parameter time 0, 10, 20, 50 with number of nodes 20 and 50 respectively for area of 250X250 meters.

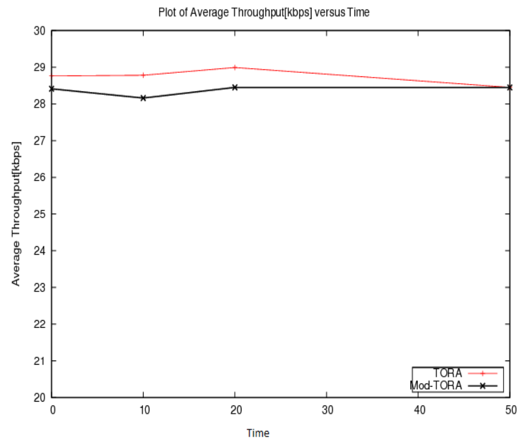
When mobility increase it will decrease throughput and same situation occurs when we are using different number of nodes increase like 50, 70 and 90 respectively. Shown in figure.

When we have increase quantity of nodes then control packets are increase and due to that delay is too much higher than previous. Solution of this situation is to send packet timely, so using this we have reduced few of overhead of control packets and in resultant we got improved throughput than previous throughput which is shown in figure in modified TORA Protocol.

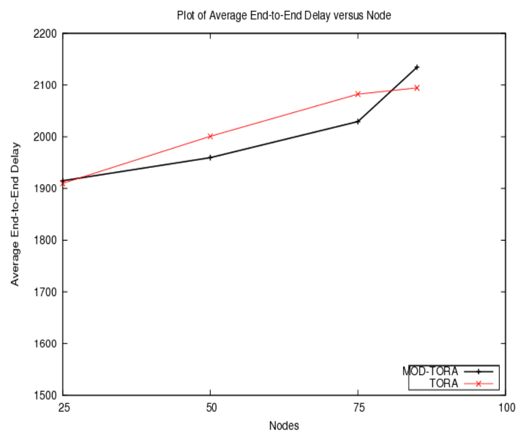
Problem arises when we are increasing nodes then end to end delay increases and throughput decreases. In figure shows that when we are increasing number of nodes at that situation control packets are generates too much high and due to this phenomenon delay increases drastically and throughput decreases drastically. To solve this we proposed another approach which is clustering technique with TORA Protocol routing shows figure.



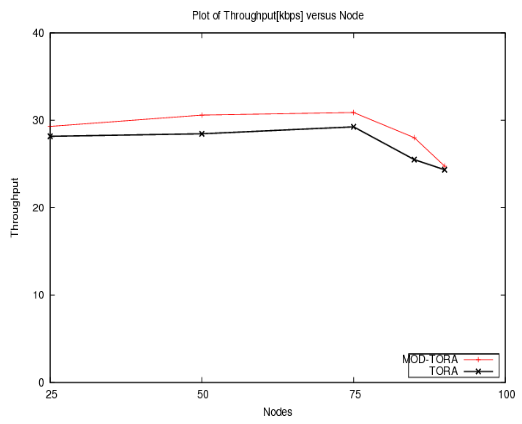

**End to End Delay Vs Time**



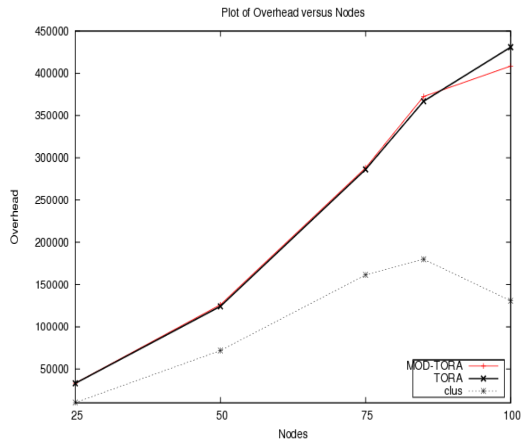

**Throughput Vs Time**




**End to End Delay Vs Nodes**




**Overhead Vs Nodes**




**Overhead Vs Nodes**

Figure: Simulation and results

So, figure shows that when we used modified TORA protocol which is modified by geocasting and clustering scheme. We have implemented optimize result of overhead in terms of control packets which is helpful to reduce delay, increase throughput and makes network more scalable.

## VI. Conclusion

The thesis includes, overview of wireless network and problems of resource constrains like overhead, limited available bandwidth etc. The work mainly concentrates on simulation of existing TORA protocol along with Geocasting and Clustering technique. The performance of TORA Protocol is compared with modified TORA Routing protocol. The modified TORA routing protocol is improved in terms of throughput, overhead and scalability of network.

We have implemented routing protocol simulation with different topologies. We have simulated the same with large area and dense networks. Also Geocasting technique has been implemented. The cluster is created wherein a node of the cluster is selected as a cluster head. After this step, the data from the cluster nodes are transferred to cluster head to reduce the number of overhead packets. Finally clustering hierarchy is created to overcome the overhead during routing process for all nodes.

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