Trimming Broadcasting Approach in Mobile Ad Hoc Networks

By

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DEDICATION

To my parents

To my lovely family

To my wife and my first son

Because of your love, support,

care, and encouragement,

I am here now…

You are the reason of my success…

Tareq

ACKNOWLEDGMENTS

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First of all, I thank ALLAH, for helping me and giving me the strength and patience to complete this work.I would like to express my deep tanks, gratitude and respect to my supervisor, prof. Ismail Ababneh, for his patience, support and careful review, corrections and comments of my thesis work. In addition, I would like to thanks the committee member.

Special thanks to my lovely and always caring mother and father my brother (Maher), (Moawia), (Ahmad), and sisters especially (Suzan). In addition I would like to dedicate special thanks to my wife (Nour) and my son (Mohammad), who have always encouraged me towards success. Without their encouragement and prayers, this work would never exist.

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LIST OF ABBREVATIONS

MANET	**Mobile Ad hoc Network**
IEEE	**Institute of Electrical and Electronics Engineers**
WPAN	**Wireless Personal Area Network**
AODV	**Ad Hoc On demand Distance vector**
DSR	**Dynamic Source Routing**
TBA	**Trimming Broadcasting Algorithm**
LSRPs	**Link-State Routing Protocols**
OSPF	**Open Shortest Path First**
RIP	**Routing Information Protocol**
DSDV	**Destination-Sequenced Distance–Vector**
Optimized Link State Routing	**OLSR**
RREQ	**Route Request**
RREP	**Route Reply**
RERR	**Route Error**
IP	**Internet Protocol**
ERS	**Expanding Ring Search**
B-ERS	**Blocking Expanding Ring Search**
OSI	**Open Systems Interconnection**
GPS	**Global Position System**
Gbps	**Giga bit per second**
DV	**Distance Vector**

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LAR	**Location Aided Routing**
TORA	**Temporally Ordered Algorithm**
TBRPF	**Topology Dissemination Based on Reverse-Path Forwarding**
SF	**Selective Flooding**
NS-2	**Network Simulator-2**

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ABSTRACT

Trimming Broadcasting Approach in Mobile Ad hoc Networks

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TAREQ M. AL AMOSH

An ad hoc network is a special type of networks that consists of a number of nodes that interact with each other wirelessly without a need for a base station or infrastructure. There are many advantages to using Mobile Ad hoc Networks (MANETs). The special characteristics that distinguish these networks include their dynamic topology, battery energy constrains, and limited transmission range. Many research works were carried out for improving the performance of MANETS. In this thesis, we focus on improving the on-demand routing discovery process that is used in many algorithms such as AODV, DSR and their variants.

In our proposed scheme, the destination node initiates the process of trimming redundant route request packets by broadcasting a special trimming route request packet that has for goal halting the route search process once a route to the destination is found.

The performance evaluation of the scheme is carried out using simulation. The results reveal that the proposed scheme reduces end-to-end packet delays and achieves low routing request overhead.

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Chapter One: Introduction

1.1 Overview

A computer network is a group of independent devices that are connected together to form a network. The communication between these devices is done by wired or wireless links. A node means any cooperating device that participates in the network, such as a computer or mobile phone. Wired networks are useful but not suitable alone for mobile phone environments. The production and popularity of mobile devices increased the interest in wireless networks, and increased the need to adopt changes in communication [1].

1.2 Mobile Ad hoc Networks (MANETs)

With the tremendous development in the networking sector, ad hoc networks appeared recently, where the node plays a role in routing, and in sending and receiving packets. It acts as a host and router. Ad hoc is a Latin word that means to use in a special way at any time. A Mobile Ad hoc Network (MANET) is a concept in computer communication that means nodes can communicate with each other using a temporary network without any form of centralized administration. The IEEE802.11 standard defines two different modes for wireless networks. The first mode is called infrastructured, where there is a control unit called base station and a number of nodes, as in Figure 1.1. The second mode, namely ad hoc operates with the absence of this kind of administration. It is a temporary network that can be created at any time for a specific goal. In addition, the nodes operate on batteries. The topology changes frequently (because of nodes leaving, nodes entering, and movement of nodes

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from one place to another), and the transmission range is limited as illustrated in Figure 1.2.

Figure 1.1: Infrastructure based wireless network

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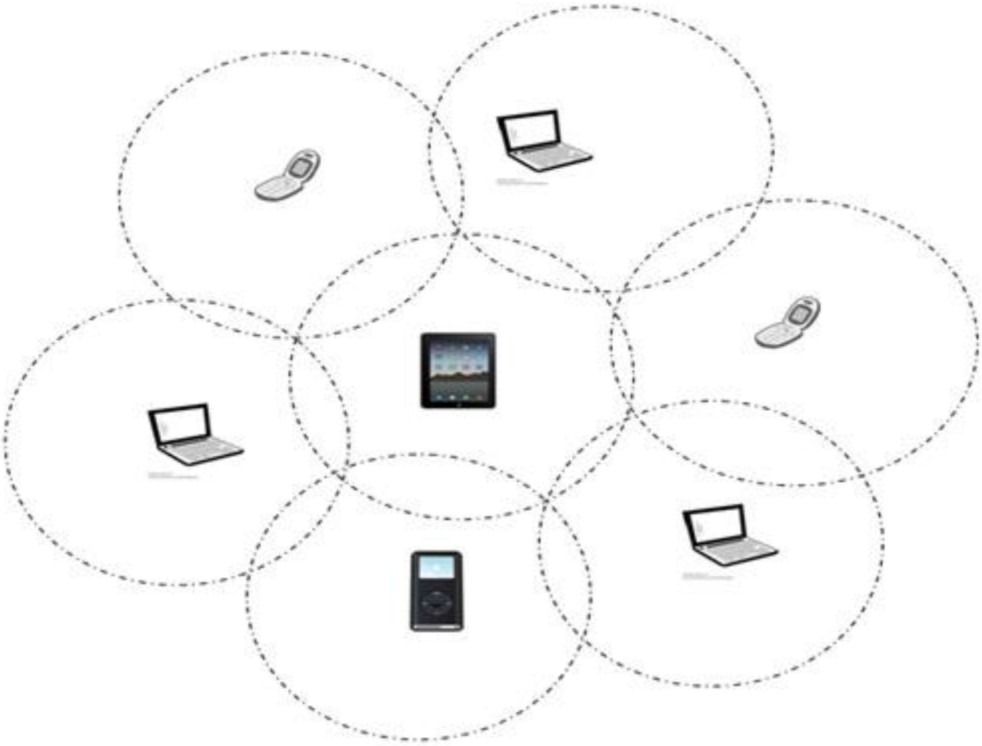

Figure 1.2: A simple ad hoc wireless network

Some advantages of MANETs are the ease and speed of deployment, which reduces cost and improves flexibility. Much research has been carried out for MANETs, mainly in the areas of medium access control, routing protocols, resource management, power control and security [1]. Given the importance of the routing protocol, a huge amount of work has been done to improve routing procedures throughout the past decade [10, 11, 12, 13, 14]. Many challenges have been faced in designing of MANET routing protocols [2, 3, 4, 5, 6], such as the mobility of nodes that causes frequent topology and network partitioning. Another challenge is the frequent packet losses because of unforeseen variables, and the unpredictable capacity of wireless links. Furthermore, there is a hidden and exposed terminal problems. A number of routing protocols have been proposed to overcome these limitations; these protocols are classified as proactive (table-driven), reactive (on-demand), and hybrid protocols [1, 3].

In proactive (table-driven) protocols, each node in the network has complete information about the topology of the network, and maintains up-to-date routing information by sending this information to its one-hop neighbours

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[10, 3]. One drawback of proactive protocols is that they are not suitable for large scale mobile networks as there is a need to update and modify the information shared between nodes when the topology changes. In contrast, reactive (on-demand) protocols appear to overcome such drawbacks. In reactive protocols, the routing paths are determined only when needed using distance-vector to build a path to the target node. Reactive protocols can adapt to a specific network topology and are suitable for deployment in large scale environments [5, 11, 14]. Despite solving problems associated with table-driven protocols, a reactive protocol has drawbacks of its own. Reactive protocols commonly use flooding by sending routing broadcast packets (e.g., route discovery packets) across the network to find and maintain routes. Such as in the Ad hoc On-demand Distance Vector (AODV) protocol. Flooding causes packet transmission redundancy, contention, and collision of packets. Such problems are referred to as the broadcast storm problems [10].

1.3 Characteristics and Challenges of MANETs:

MANETs share many properties of wired networks, but they have some unique characteristics. These characteristics should be taken into consideration as guidelines when improving routing protocols. These characteristics are as follows:

- **Dynamic topology:**

Since mobile nodes move independently, MANET topology changes could occur randomly, rapidly and frequently. When the topology is dynamic, routing protocols that depend on the relative location of nodes are not suitable since each node can move out of the range of another node, and this will cause link breakages.

- **Self-Administrating:**

The node in MANETs is self-organizing without deploying any infrastructure. Because there is no base station to mange transmission and communication of data packets in the network, the nodes involved in

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MANETs should collaborate and each node should act as relay as needed to implement the required routing functions.

- **Energy- constrained:**

The nodes operate using a battery so they have a very limited power source. Therefore, the lifetime of the node depends on the power level of the battery. Many wireless routing protocols adapt to this constraint by using routing that saves the energy level in individual nodes.

- **Limited range:**

Each node has a limited radio transmission range that allows it to communicate directly with those nodes within transmission range. But, when a node needs to communicate with another node out of its range, it uses multi-hop communication.

- **Hidden terminal problem:**
  This problem occurs when two nodes want to send data packets at the same time to a third node without them sensing each other as they are out of each other's range. In other words, it is a collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of each other, but are within the transmission range of the receiver.

1.4 Applications of MANETs

Due to the flexibility of MANETs, they are attractive for several applications and are widely used in military, disaster recovery, group communication and Wireless Personal Area Networks (WPANs).

1.4.1 Military Applications:

MANETs can be very useful in setting up an infrastructure-free network used to make fast and reliable communication between soldiers.

1.4.2 Disaster Recovery:

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Natural disasters occur in any place and at any time. Emergency rescue operations can cover places where communication is impermissible, because of fire, flood, or earthquake and so on. Ad hoc networks are suitable in emergency and rescue operations.

1.4.3 Group Communications:

In many work environments, people need to communicate and collaborate with each other in or outside the work place to exchange information or discuss projects. Examples of such environments exist in education and industry. MANETs are very useful in supporting collaboration between individuals.

1.4.4 Wireless Personal Area Network (WPAN):

WPAN is another and very important application of MANETs. A WPAN is deployed between different mobile nodes that communicate through ad hoc networks. Mobile nodes are personal devices such as a laptop, digital camera and MP3 player with short transmission range devices used for exchanging digital information.

1.5 Problem Statement

Researchers have proposed many schemes for solving the broadcast storm problem encountered during the broadcasting-based route discovery process of on-demand routing protocols. In these protocols, RREQ packets are initiated by a source node when it needs to find a route to a destination. Other nodes that receive the RREQ packet for the first time rebroadcast it. When the RREQ packet reaches the destination, it responds with a Route Reply (RREP) packet destined to the source. Recently, researches have proposed a scheme that uses chase packets broadcast over a special reserved high speed channel for halting the broadcasting of Route Request (RREQ) packets once a route to the destination is found.. In this thesis, we propose a new route discovery algorithm that has the destination node attempt to halt the route search process when it is reached without the need for a special reserved channel. The proposed algorithm's name is the Trimming Broadcasting Algorithm (TBA), where the target node attempts to prevent broadcasting further RREQ packets

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when the destination is found. When found, the destination node broadcasts a packet that tells nodes not to further forward RREQ packets for the request.

The main goals of our work is to optimize on-demand routing protocols, such as AODV, minimize their average end-to-end delays, packet loss and routing overhead.

1.6 Research Objectives

The main objective of the work is to present a new mechanism that restricts the transmission of RREQ packets during the route discovery process. The goal of the new work is to:

1. Design and implement a new algorithm that aims to reduce the cost of route discovery.
2. Give a chance to a destination node to play a significant role in the network by trimming any extra broadcasting messages.
3. Allow transmitted packets to be received in a timely manner, by minimizing end- to-end delays.

1.7 Thesis Structure

This thesis is divided into five chapters. Chapter 1 presents an overview of MANETs along with the problem statement. Chapter 2 discusses the theoretical background and concepts of ad hoc mobile network routing protocols. Chapter 3 presents the proposed scheme. Chapter 4 covers the performance metrics, simulation tools and analysis of the simulation results. Chapter 5 provides the conclusion and future works.

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Chapter Two: Ad Hoc Routing and Management

2.1 Overview

A routing algorithm finds routes between communicating nodes in a network, to enable the transfer of data between source and destination nodes. When a packet, which is the smallest amount of data that is routed through a network, is received by a node it will examine its routing table to get the next hop on the route to destination [1].

There are two types of routing algorithms: static and dynamic. In the first type of routing, routing table information are set and updated by the network administration for each node. The common information in such tables are IP addresses, and next hops. Static routing is used in the network that has a fixed structure. The main drawback of this type appears when the network is heavily congested. The route cannot be changed to move away from the congested portion, which decreases the network performance [10, 11].

The dynamic routing protocols depend on the current state of the network. The routing table is periodically updated to take into account changes that happen in the network topology. Because static routing systems cannot react to network changes, they generally are considered unsuitable for today's large, constantly changing networks. Most of the dominant routing algorithms today are dynamic routing algorithms, which adjust to changing network circumstances by analyzing incoming routing update messages. Notwithstanding, many proposed ad hoc routing protocols have a conventional routing protocol as an underlying protocol. Therefore, it is important to present an overview of the basic operation of conventional protocols, like link state, distance vector and source routing [2].

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2.2 Classical Routing Protocols:

2.2.1 Link-State Routing Protocols (LSRPs):

Also, they are known as shortest path algorithms. Every node in the network stores information about all links in its routing table. When a node wants to find a route to certain destination, it will run the shortest path algorithm to find the best route. That route can be chosen based on some metric like link speed, number of hops, monetary cost or traffic congestion. When the network topology changes, a notification message will be flooded to the whole network, and all nodes will update their link state [13].

Open Shortest Path First (OSPF) is an example of LSRPs. Although, it is adaptable to the high mobility of networks, it consumes network resources and causes contention and collision over network due to the flooding of the notification messages [14].

2.2.2 Source Routing

Source routing is a method in which the source specifies the route that a packet should take through the network. This path is discovered by the source node or device by flooding a query to all nodes in the network looking for a path to a given destination. Flooding means that any node that receives the packet will retransmit it again to all its neighbours except the neighbour node from which the packet was received. Two types of flooring are used: uncontrolled and controlled flooding. In uncontrolled flooding, each node rebroadcasts a packet that it receives, which causes the broadcast storm problem, infinite loops, and high redundancy. This reduces the performance of the network. On the other side, controlled flooding aims to avoid the problem by using Sequence Number Controlled Flooding (SNCF) and Reverse Path Flooding (RPF) algorithms [17].

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In SNCF, packets are uniquely identified by <source address, sequence number filed>, which makes it possible for node to detect and discard duplicate packets. In RPF algorithms, the node will only send the packet forward. If it is received from the next node, it sends it back to the previous node. Flooding decreases the performance of network and consumes its resource, but it can have good delivery ratio [17].

2.2.3 Distance Vector Routing Protocols (DVRPs)

The term distance vector refers to the fact that the protocol processes vectors of distances to other nodes in the network. Each node has updated routing information. When topology changes, that information is propagated to all nodes. Each node maintains a routing table whose dimension is equal to the number of nodes in the network. The information in routing tables includes how far the destination is and the next hop to be used to reach the destination.

The basic operation in each node is to recalculate the distance to all destinations using the Bellman-Ford algorithm [15], when routing information is updated. Since the information is sent periodically, slow convergence of the routing information is the major drawback of DV algorithm. The Routing Information Protocol (RIP) is an example of (DVRPs). Although it is easy to configure, it is not adaptable for a large network since the maximum number of hops allowed for RIP is 15 [16].

2.3 Routing in Mobile Ad Hoc Networks Requirements and Classifications

Routing protocols are required to deal with Ad hoc networks characteristics; in this section we present these characteristics.

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2.3.1 The Qualitative Critical Features of Ad Hoc Routing Protocols

- ***Energy-constrained***: The nodes operate using batteries that have limited power, and nodes act as routers, transmitters and receivers. So, batteries are quickly consumed. Designing a routing protocol should consider reducing energy consumption. One of the proposed mechanisms is using the sleeping mode, where the node sleeps while it is inactive or idle. This will extend the node lifetime and thus network lifetime [2, 3, 4, 5, 6, 7].
- ***Routing loop problem avoidance****:* There is a routing loop when the data packet continually goes around the same routers. One of the mechanisms for avoiding looping uses a maximum hop count that is decremented by one each time the packet reaches a node. The packet is dropped when the count reaches zero [2, 3].
- ***Network security***: mobile nodes interact wirelessly. This makes them vulnerable to numerous attacks, ranging from passive eavesdropping to active interference. Therefore, routing protocols must have schemes for authentication and key management [19].
- ***Minimal traffic load****:* improving and designing any routing protocol must be done with a minimum number of control packets to save the battery power and bandwidth, and decrease congestion in the network [5, 6].
- ***Reliability****:* The hidden terminal problem and mobility cause packet losses. In addition, data transmission errors are more likely in wireless environments. The routing protocol must be aware of the reliability problems of wireless communication between moving nodes [7].

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2.3.2 Classification of MANET Protocols

MANETs are classified in many ways. One of the most popular classifications is based on the way the route information is maintained and stored, as follows:

a) Proactive Routing Protocols (Table–Driven Protocols)

In this type of routing protocols [18, 19], each node maintains a route to all destinations at all times. It stores the most recent information for routes to all nodes in the network. This information is stored in one or more tables and it can be changed if the topology is changed. Keeping a consistent view of the network topology is the main goal of proactive protocols. This consistency is achieved by propagating information throughout the whole network. Two propagation methods were proposed: periodic propagation and event-driven propagation (triggering update). In periodic propagation, each node broadcasts its route table to the network periodically. However, in event-driven propagation, any change in node neighbours must be broadcast to the network.

If any node needs to communicate with any other node, the source already has a route to the destination. Many of proactive routing protocols are based on link-state routing protocols.

The main advantage of this type of protocols is decreasing the latency of route discovery because a route to each node in the network is available when needed. These protocols waste network resources (i.e., bandwidth and battery power) by the excessive control packets that are used to determine and maintain routes, even if they are not to be used at all. In addition, the number of updates is increased in high mobility environments. The most popular proactive routing protocols are Destination-Sequenced Distance–Vector (DSDV) [18], Optimized Link State Routing (OLSR) [19], and Topology Dissemination Based on Reverse-Path Forwarding (TBRPF) [24].

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b) Reactive Routing Protocol:

This category of routing protocols are also called On-Demand Routing Protocols [20, 21]. They establish routes when needed. The routing activity is suspended until routing discovery is needed. When any source node needs to find a route, it initiates a route discovery process looking for a path to the target node by flooding the network with a RREQ packet. When the RREQ reaches the target node a Route Replay (RREP) is sent from the target to inform the source that a route has been found. When any used route in the network is broken, a route maintenance operation is performed to fix the problem.

This type of protocols has many advantages compared with proactive protocols, such as: it reduces overhead by avoiding unnecessary updates of routing information. On the other hand, these protocols increase the latency and end-to-end delay. The most popular proactive routing protocols are: Ad hoc On Demand Distance Vector (AODV) [20], Dynamic Source Routing (DSR) [21] and Temporally Ordered Algorithm (TORA) [22, 23]. In our work, the AODV protocol is considered since it is a well-known reactive protocol that has received the attention of many researchers.

c) Hybrid Routing Protocols:

This type of routing protocols combines the best features of proactive and reactive protocols [24, 25]. In this routing protocol, the network is divided into zones. The proactive routing protocol works to establish and maintain routes to the destinations within the node zone and reactive routing protocol establishes and maintains routes to the destinations outside the zone. Zone-based Routing protocol (ZPR) [24] and Sharp Hybrid Adaptive Routing Protocol (SHARP) [25] are examples of hybrid protocols. Figure 2.1 shows the classification of MANET protocols.

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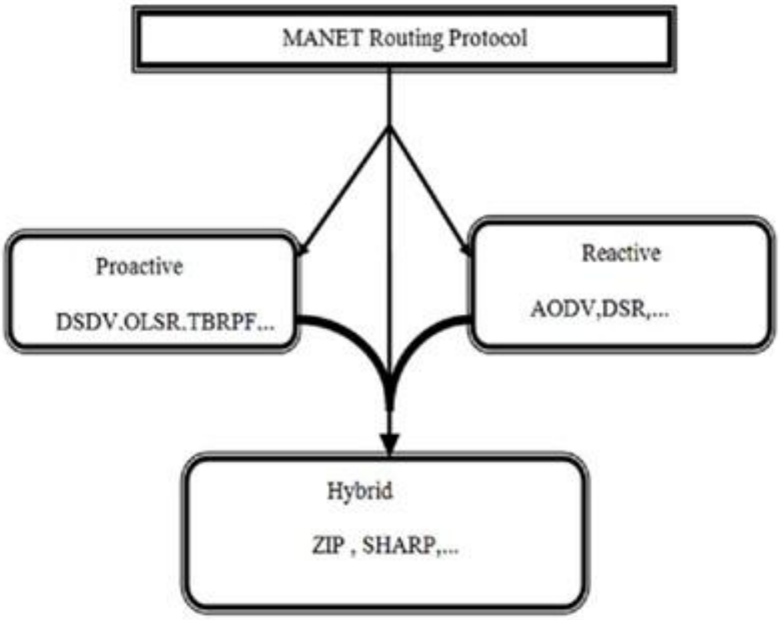

Figure 2.1: Classification of MANET Protocols

2.4 Ad Hoc On-Demand Distance Vector Routing Protocol (AODV)

AODV is a relative of the Bellman-Ford distant vector algorithm [20]. It is a reactive, simple, efficient, and effective routing protocol that is suitable and works in mobile environments to find the shortest path for nodes that do not have a fixed topology [20, 26].

Like other on-demand routing protocols, AODV aims to find a route between the end-points in mobile multi hop ad-hoc dynamic networks. It uses four types of messages: RREQ (route request), RREP (route reply), RERR (route error) and Hello messages. These messages are used to build routes between nodes for data transfer. A main goal of AODV is to achieve improved performance, robustness, and obtain better scalability in mobile environments [17].

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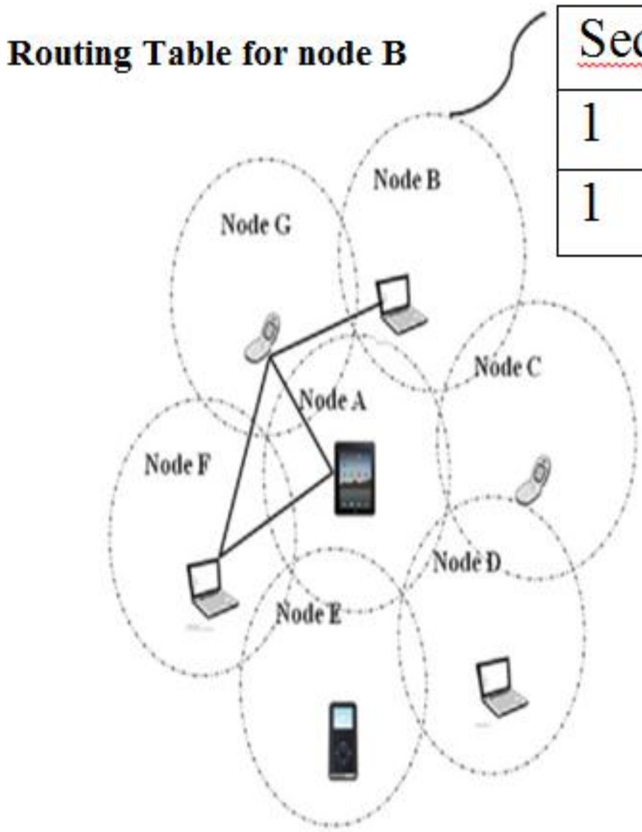
AODV utilizes routing tables. Each routing table entry contains the following information: destination, next hop, number of hops, destination sequence number, and active neighbors for this route and expiration time for this route table entry. Figure 2.2 shows an example of routing table. The main feature of AODV is its use of a destination sequence number to avoid routing loops at all times. The requesting node always selects the node with the greatest sequence number. This protocol works for both wired and wireless networks. In AODV, the intermediate nodes use Hello messages between them so as to indicate connectivity. When a node doesn't hear a Hello message from a neighbor, it will consider it as unreachable. Routing in AODV includes two phases: route discovery and route maintenance [20].



Seq	Des	Next	Hop
1	F	G	2
1	G	G	1

Figure 2.2: An example of routing table

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2.4.1 Route Discovery Phase:

The route discovery phase is used to find an appropriate route to reach the destination. When a source node has data to send to a desired destination and no routing information is available in the source node's routing table, route discovery is initiated by the source. This is done by propagating two types of control packets, namely Route Request (RREQ) and Route Replay (RREP). In addition, there is another control packet, namely the Route Error (RRER) packets. This packet is not used to discover routes. It is a maintenance message used when the route is broken.

The RREQ in AODV can be presented as a vector of the following important fields: <destination-address, destination sequence-number, dest-addr, dest sequence #, broadcast-id, hop cnt> [27]. So there are two counters maintained by a node, namely the broadcast-id and sequence number, where the broadcast-id is incremented whenever the source issues a new RREQ packet for the same destination and the Dest_Seq field represents the last destination sequence number known to the source. A RREP packet contains the same fields except the Originator Sequence Number, which is changed to Life Time that represents the time in milliseconds for which nodes receiving the RREP packet consider the route as valid [27].

In route discovery, when there is data to be sent to a target T, the source node S will follow these steps:

Node S checks its routing table for the existence of any path towards this target T. If one is found, it is used. Otherwise, the route discovery process is initiated and S will broadcast a RREQ packet to its neighbours. When any neighbour receives the RREQ packet, it checks if it has a fresh route to the target with a sequence number that is

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greater than or equal to the one in RREQ or if this packet is a duplicate (received previously). If it is a duplicate packet, it will be dropped. If a fresh route is found, it is sent to the source. Otherwise, the intermediate node rebroadcasts the RREQ packet (to its neighbours) until it reaches the target node. During these operations, each node that receives a RREQ packet records the reverse link back to the source. When a target node T receives a RREQ packet it will send a replay packet back to the source node S.

Every RREP packet consists of < source _add, dest_add, deste _seq#, hop_count, life time> [27]. The hop count is equal to the number of intermediate nodes between the source and the target. A discovered route can be valid for a short period so each route has a life time value. When it expires, the route becomes invalid. Therefore, it will be deleted from the routing table. Finally, when a source node receives a route reply packet, it sets up a forward route to the destination node and starts sending data packets.

2.4.1.1 AODV Route Discovery Example:

<u>Step</u> 1: The source node S wants to communicate with a destination T. As in figure 2.3.

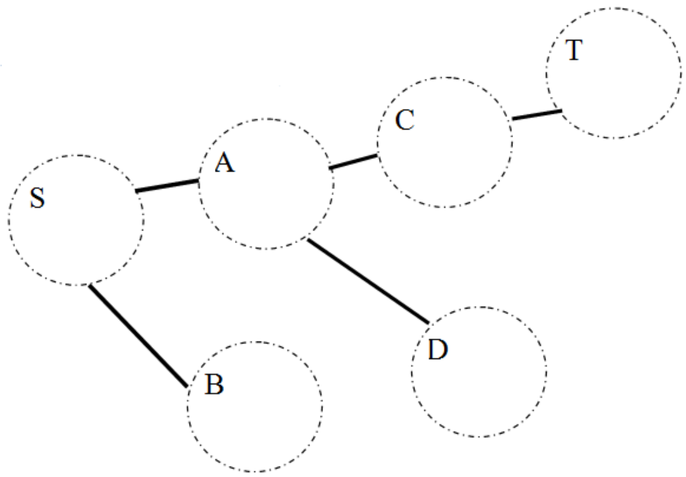

Figure 2.3: The source node (S) wants to communicate with a target node

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Step 2: Node S checks its routing table. In this case node S does not have a route to the target T. So it creates a RREQ packet and enter T's IP (address, destination sequence number, hopcount (=0)).

Step 3: Node S propgate RREQ packet to its nieghber (A, B).

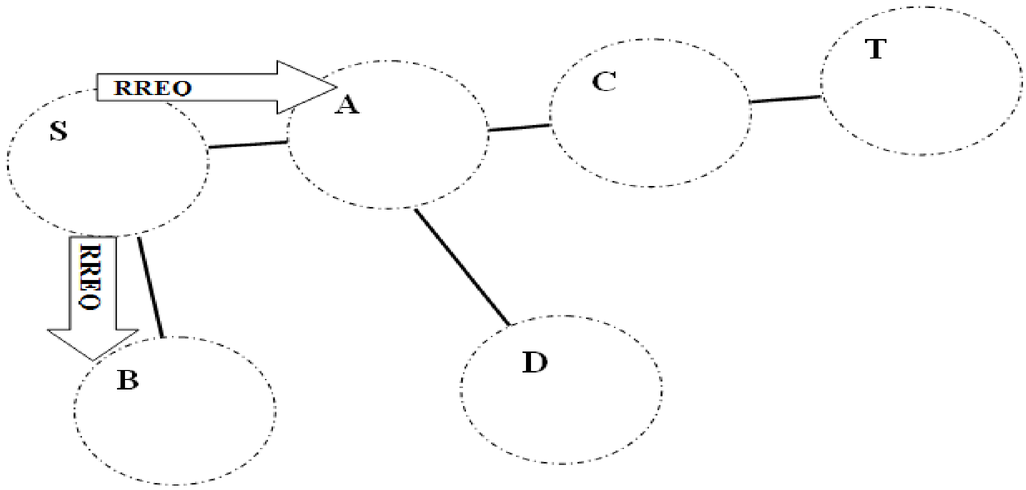

Figure 2.4: The source node propagates RREQ packets

Step 4: Nodes A and B receive the RREQ :

i. They make a reverse route entry for S (dest=S, nexthop=S, hopcount=1).

ii. No route to T, so they reboadcasts RREQ packets .

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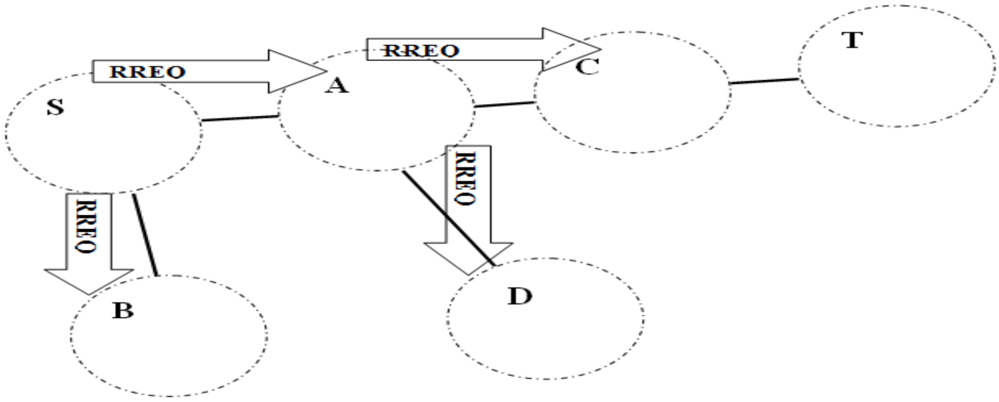

Figure 2.5: Node (A) propagates RREQ packets

Step 5: Node C receive RREQ packet:

i. Makes a reverse route entry for S. dest=S, nexthop=A, hopcount=2

ii. It has a route to target node T, and the sequance number for route T is >=T's sequnace in RREQ packet.

iii. C creates a RREP. It enters T's IP adresses, sequance no, S's IP adresses, hopcount to T(=1).

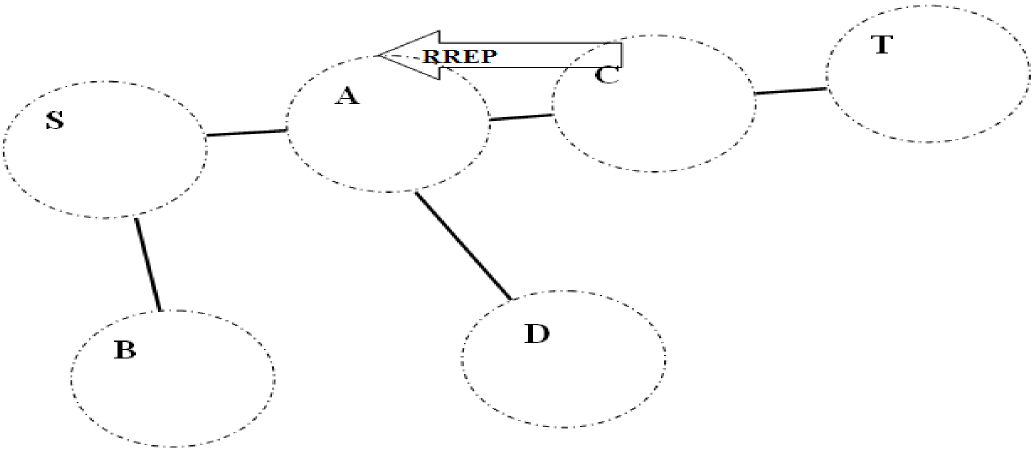

Figure 2.6: Node (C) sent RREP to node (A)

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<u>Step 6</u>: Node A receives the RREP packet:

i. Makes a forward entry route to T (dest=T, nexthop=C, hopcount=2).

ii. Unicasts RREP to S.

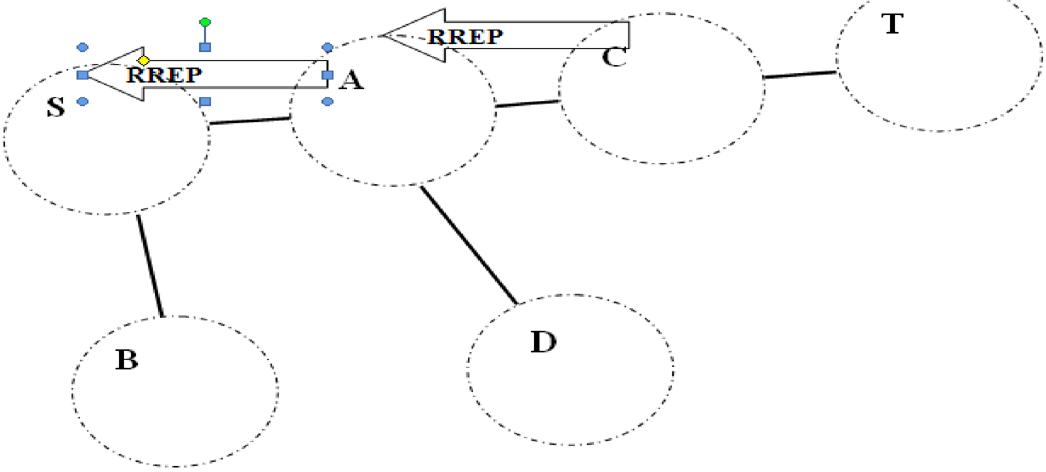

Figure 2.7: Node (A) sent RREP packet to a source node (S)

<u>Step 7</u>: Node S receives the RREP packet and it will record the forward route entry to node T (des =T, nexthop=A, hopcount= 3) and sends data packet on route to node T.

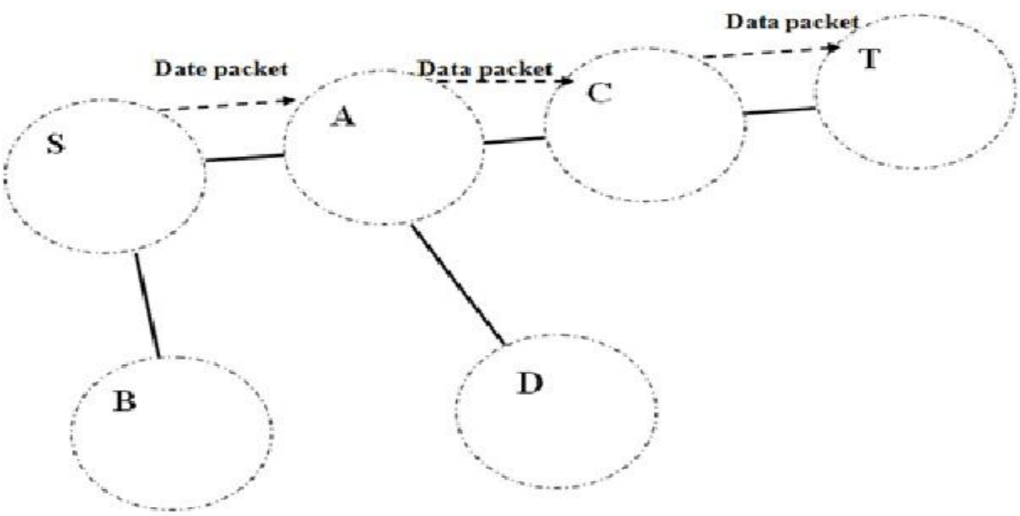

Figure 2.8: Node (S) start to send data packet

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Note that when receiving multiple RREQ packets the node only forwards the first RREQ packet it receives.

i. All other RREQ packets will be discarded.

ii. The RREP contains the <current seq # of destination , hop-cont=0, life-time> if it is sent by the destination. Otherwise, if it is sent by an intermediate node, it will contain its record of the <dest- seq#, hopcont =distance to destination, value of life time>. In addition, it contains <ip address of source and target>**.**

2.4.2 Route Maintenance Phase:

Route maintenance is a mechanism used to repair routes in case of link failure detection. Each node in MANETs uses Hello packets to keep track of all its neighbors [27]. If there is a link failure in an active route, the node that has detected the error will try to correct it locally by running a repair procedure. If it cannot repair it, it creates RERR packet and propagates it to all nodes until it reaches the source node. Once the source node knows of a broken route it tries to overcome the failure by reinitiating route discovery if it still requires the route.

2.4.2.1 Example of Route Maintenance:

Suppose that a link between node C and node T breaks as in the figure:

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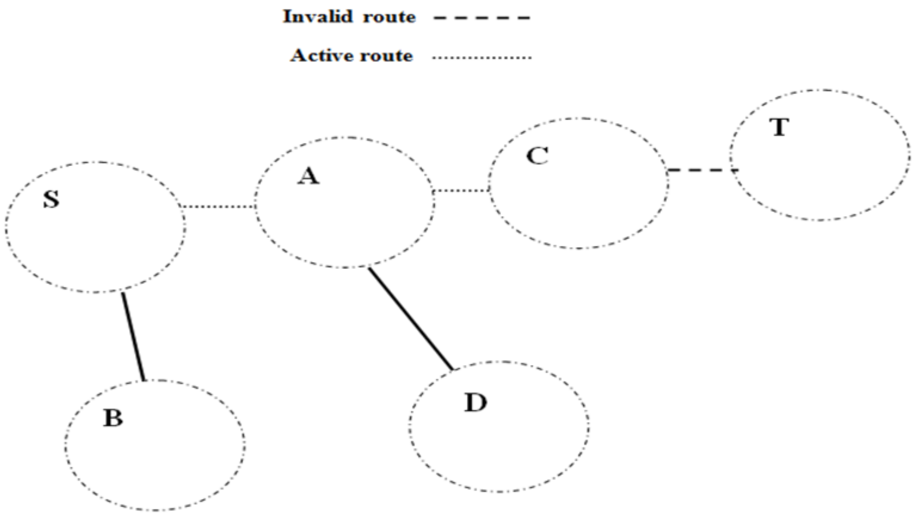

Figure 2.9: A broken linked happen between node (C) and (T)

<u>Step 1</u>: Node C propagates a RERR packet to neighbors upstream and lists all destinations that are now unreachable.

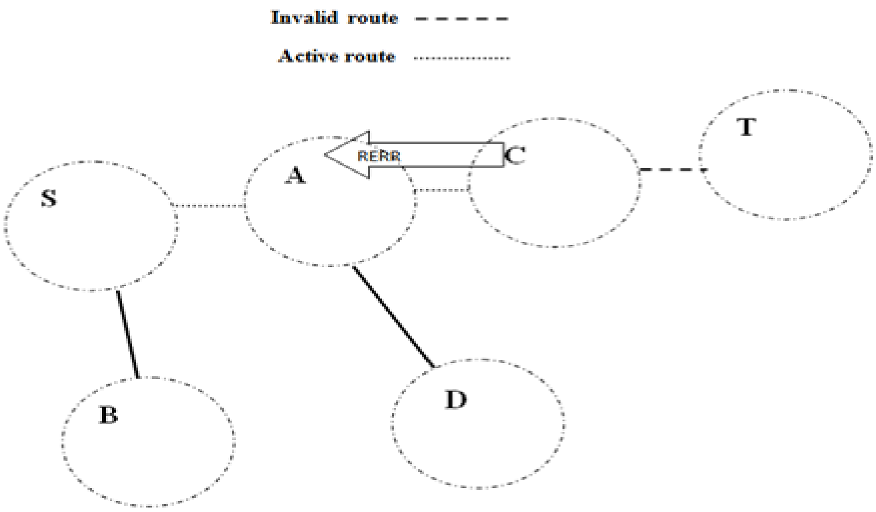

Figure 2.8: Node (C) sent RERR to node (A)

<u>Step 2</u>: Node A receives RERR packet and checks if C is its next hop on a route to T and deletes the current route to T by making the distance to T infinity. Then it forwards RERR packet to node S.

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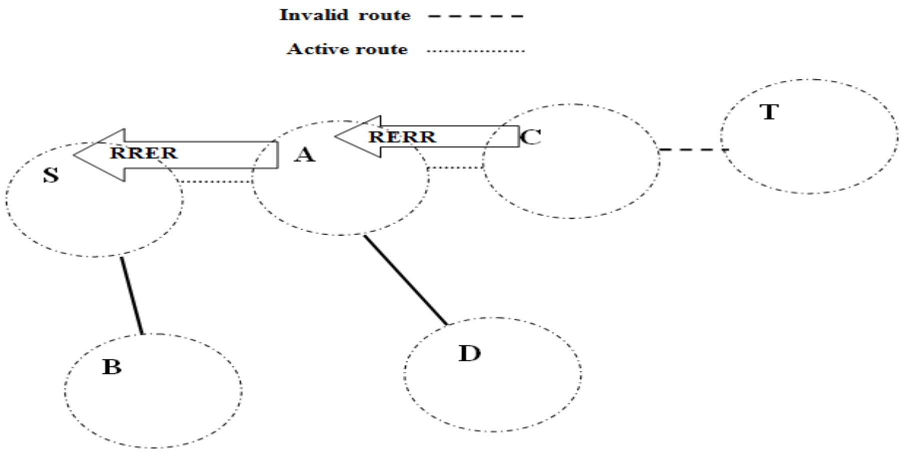

Figure 2.9: Node A sent RERR packet to source node S

Step 3: Node S receives RERR and checks if node A in the next hop on route to node T, then it deletes the current route to node T. if it still needs the route to node T, it reinitiates a route discovery process.

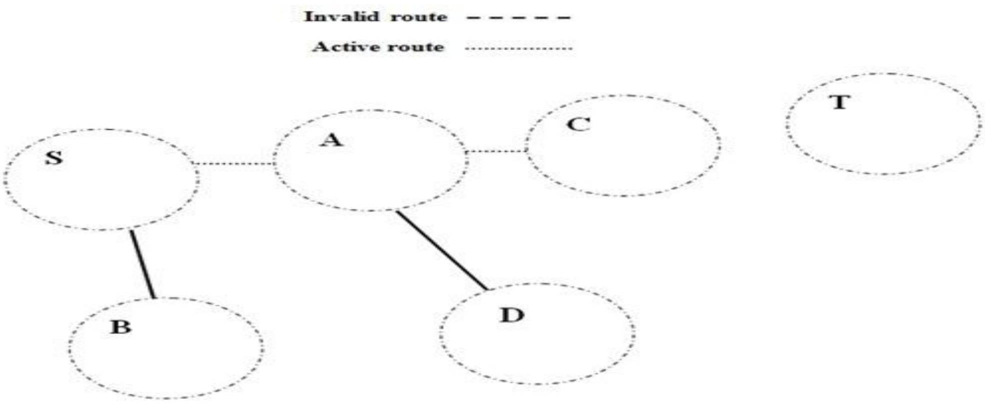

Figure 2.10: Node S deletes the route to node T

2.5 Broadcasting in MANETs

Broadcasting is an important process in MANETs and it is used to send out information messages between nodes. Several proactive protocols use broadcasting to find a particular route to a particular destination, page a particular host, and send an alarm signal [28], like AODV, Dynamic Source Routing (DSR), and

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Location Aided Routing protocols [26]. The transmission by any node in a MANET can reach all nodes that are within the nodes transmission range.

Broadcasting in MANETs has several characteristics. First, broadcasting is spontaneous, because of using the broadcast operation at any time by any node [4]. Second, the broadcast is unreliable; because no feedback information is provided, no acknowledgment mechanism is required [5].

AODV protocols are based on simple flooding. This means that serious problems may happen, like collision, contention, and redundant retransmission (broadcast storm problems [9]). In addition, this operation can be very costly. To alleviate this challenge facing the AODV protocol, we will summarize some related works by researchers in the next section.

2.5.1 Literature Review and Related Works

Using a simple flooding to perform the broadcasting operation will waste network resources [9]. Flooding means that any node that receives a packet will retransmit it again to all its neighbours. Many schemes where suggested to reduce flooding problems in AODV.

In [29], the authors have classified broadcast protocols into simple flooding, probability-based, area-based, and neighborhood-based.

- **Simple flooding scheme:** In this method, a source node sends a message to all its neighbors. Each of these neighbors will check if they have seen this message before. If so then the node will drop the packet. Otherwise, the message is seen for the first time and it will be transmitted to neighbors.
- **Probability-based schemes:** These schemes are divided into probabilistic, counter and hybrid schemes. In probabilistic schemes, nodes only send the packet with a

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predetermined probability. The researchers in [9] have described a probabilistic scheme where they set the probability (P) to some value. When a node receives a broadcast packet, it will rebroadcast it with a predetermined probability that is less than one. If P is equal to one the scheme is equivalent to flooding. This scheme aims to reduce redundant retransmissions. In counter-based schemes when a node receives a packet, it initializes a counter and timer to count the number of times the same broadcast message has been received. If the counter reaches a predefine threshold, the node stops broadcasting the packet. The authors in [31] used a counter threshold (C) and (c) to keep track of the number of times the broadcast message is received. When $c \geq C$ the broadcast is inhibited. The hybrid based schema combines the above schemes (probability and counter). The researchers in [32] have proposed a new counter-based scheme called efficient counter-based scheme. In this scheme, the authors combine the probability- based and counter- based algorithms to enhance performance.

- **Area-based scheme**: This scheme is comprised of distance and location-based approaches. The authors in [9, 31] have proposed a new algorithm to reduce the propagation of RREQ packets using a distance-based approach. When a node receives a packet it initiates a timer, and uses a special positioning device. Before the timer expires, the node checks the location of the sender of each received packet. If any sender is closer than a threshold distance value, the node will be silent (no broadcasting). Otherwise, the node rebroadcasts the packet. In [33], a new suggested algorithm is proposed using the location-based approach. There are two parameters: a waiting timer and the coverage of the received packet. Two states are defined: rebroadcast and do not rebroadcast the RREQ packet. The first state is used if the accumulated coverage area is less than a threshold. Otherwise, the second state is

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used. The main limitation of this algorithm is the high computation complexity needed for calculating the additional coverage area.

- **Neighbourhood-based schemes:** This type of schemes maintains the state of neighborhood, which is used in the decision to rebroadcast. In [34], the researchers have proposed a cluster-based scheme that is used with AODV. In this scheme, the network is divided into clusters. Each cluster has a cluster head and several gateways. This scheme is based on graph modelling and uses a cluster formation algorithm. In this scheme, each cluster head describes the cluster which will rebroadcast, and the gateway can then communicate with other clusters [17]. Figure 2.3 shows how this method divides network:

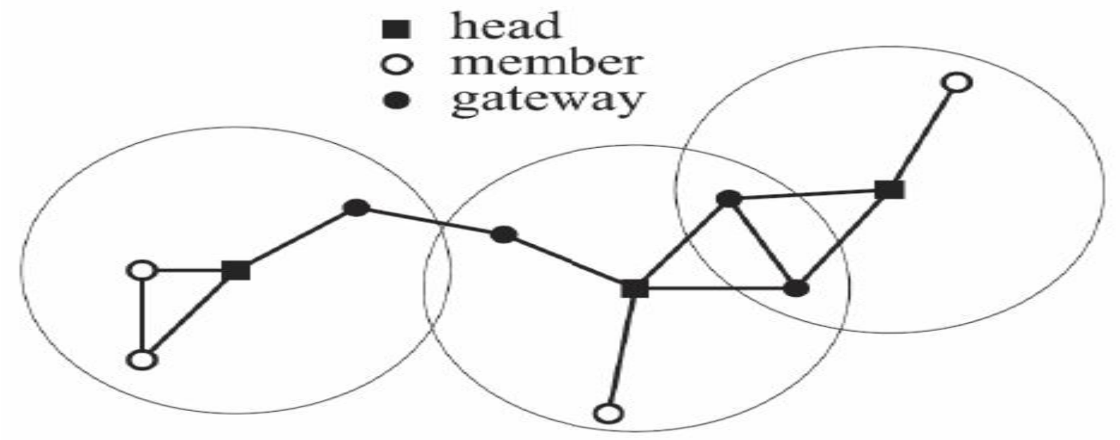

Figure 2.11: A divided network using neighbourhood-based scheme

Using chase packets is another method for reducing the number of rebroadcasts [1]. It uses a control packet called chase packet to stop the propagation of RREQ packets when the destination is found. Using chase packets aims to prevent future nodes in the network from broadcasting RREQ packets. In [35], the authors create two virtual channels in the network. The channels use time slots to match their given speeds. The time slots will be divided among these channels. These channels are used to distribute time among RREQ, RREP and chase packets. For example, if channel one is given the

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speed 0.25 and channel two is given the speed 0.75 then channel one uses 25% of the time slots in each period whereas the other channels use the rest of the time slots in each period. The first channel is used for RREQ packets, whereas the other channel used for RREP and chase packets. Using this method, the chase packets propagation is faster than the propagation of route discovery. This gives a chance to chase packets to stop the propagation of RREQ packets. The main disadvantage of this method is that route requests are delayed, which would delay all route discoveries. Moreover, bandwidth may be wasted to the allocation to RREP and chase packets.

The authors in [36] have used the idea of Expanding Ring Search (ERS) in a new algorithm referred to as Blocking Expanding Ring Search (B-ERS).

B-ERS aims to reduce the energy consumption during the discovery by using a new control packet called stop-instruction that is used to control the flooding of route request packets.

The authors in [37] have proposed a new algorithm that uses chase packets with AODV. When the source node tries to discover a route (using RREQ packets) it will send with it parallel chase packets that have two modes: inactive or active mode. When the RREQ packet is initiated by the source node, the state of chase packets is inactive and it will propagate in the network up to the target node. When that is done, the target node will change the state of chase packets it receives to the active mode and it will broadcast them in the network to stop RREQ packets. The main disadvantage of this method loading the network with additional packets which affects the network performance.

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Chapter Three: Proposed Scheme

3.1 Overview:

Several schemes have been added to AODV protocol to enhance its performance. In this chapter, a new scheme for improving AODV protocol is presented. The proposed scheme is named Trimming Broadcasting Approach (TBA) due to its goal of trimming the redundant RREQ broadcasts. Thus, reducing the effect of the broadcast storm problem while achieving high reachability of data packets to their destinations with reduced delay and overhead.

3.2 Trimming Broadcasting Approach in Mobile Ad Hoc Networks

This section describes a new broadcasting trimming scheme in which the destination node plays a significant role in stopping the propagations of redundant RREQ packets. The destination is responsible first for sending RREP packet to the source node, and second it broadcasts a control packet that stops the search for a route to the destination since one has been found.

We use the RREQ packet as trimming control packet to stop the propagation of RREQ packet. Figure 3.1 shows the format of the RREQ message.

```
0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |R|A|    Reserved     |Prefix Sz|   Hop Count   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Destination IP address                    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Destination Sequence Number                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Originator IP address                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           Lifetime                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3.1:RREQ message format.

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In our proposal, we use the reserved field in the RREQ header for representing the two modes of operation as shown in Figure 3.2.

```
0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |R|A| Reserved        |M|Prefix Sz|   Hop Count   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Destination IP address                    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Destination Sequence Number                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Originator IP address                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           Lifetime                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3.2: New RREQ packet structure.

The first Mode (M) value is called *found* and it is equal to 1, and the second Mode value is called *in-progress* and it is equal to 0, which is also the default state.

Figure 3.3 explains the steps that are taken by each intermediate node when the route request packet is received.

```
If RREQ is a duplicate
   Drop it
Else
   If the route request is in found mode then
       Drop the route request
   Else
       Continue as in AODV
   End if
End if
```

Figure 3.3: Behavior of an intermediate node when receiving a route request in TBA.

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The first step examines the route request that is received. If it is a duplicate, the node will drop it (line 2). Otherwise, the route request that is received is new and it is received for the first time (line3).

The node determines the mode of the packet received line (4). If it is in the *found* state, then drop it (line 5). Otherwise (line 7), the route request will be processed according to the AODV routing protocol.

Figure 3.4 shows the steps that are performed by a destination node upon receiving a route request. If the route request is a duplicate (line 1), the destination drops the packet (line 2). Otherwise, (lines 4-6), the destination is found and the mode will be changed to *found* mode and the destination will propagate this TBA packet to other nodes to prevent them from searching for a route to the destination since a route has been found.

In TBA, the destination node is always the initiator of the trimming packet. This enables TBA to avoid initiating many trimming packets for the same route request.

```
1. If the RREQ  is duplicate
2.    Drop it
3. Else
4.    If the current node is the destination
5.       Change the RREQ state to found mode
6.       Send RREP and Broadcast the modified RREQ
7.    End if
8. End if
```

Figure 3.4: Behavior of a destination node when receiving a route request packets

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Figure 3.4 shows an example of the propagation of RREQ in TBA. In the figure, the target node T broadcasts a trimming packet that is received by the nodes F, D and E, and these nodes drop the RREQ packets that they receive later. In the figure, the nodes G through O do not receive RREQ packets.

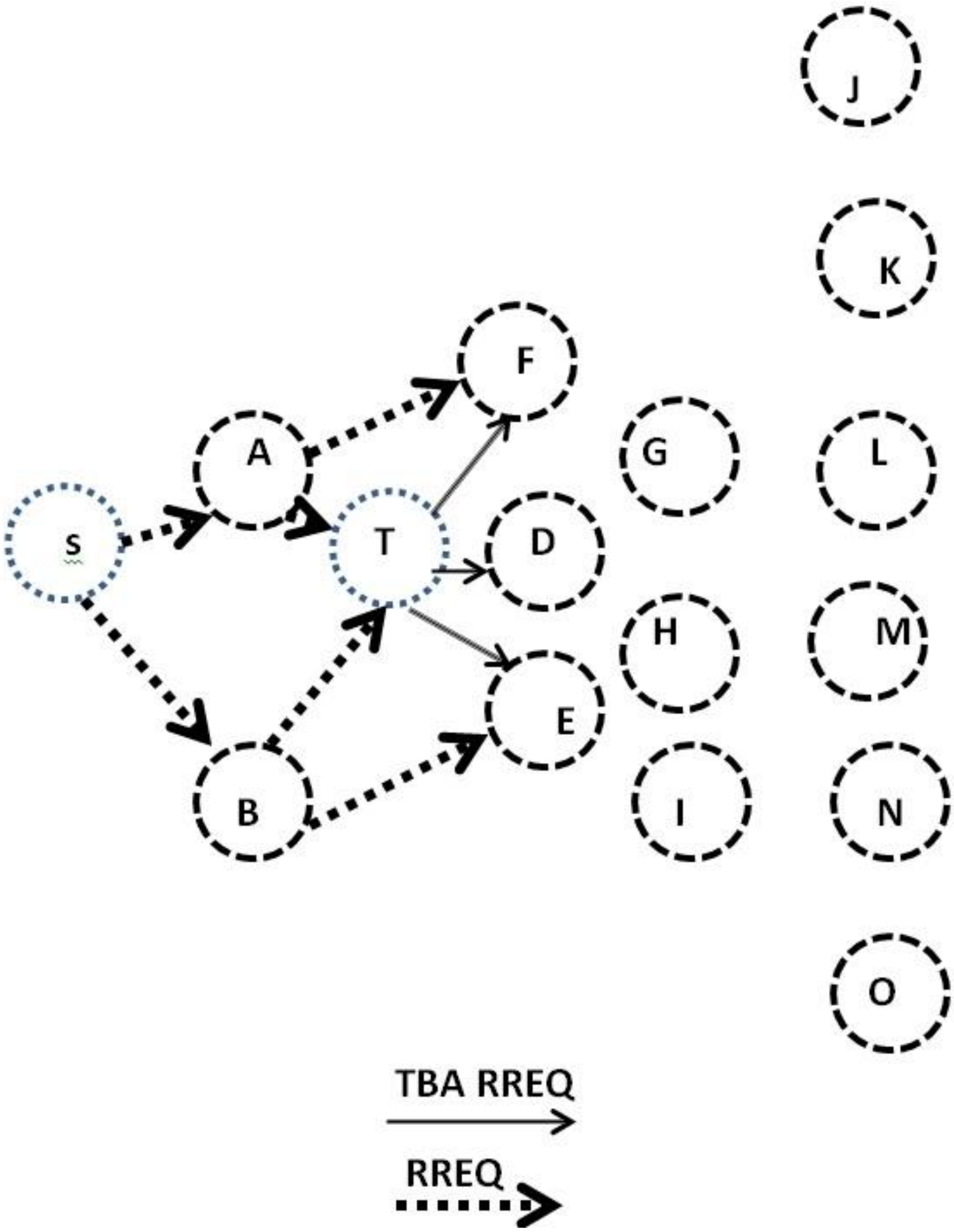

Figure 3.5: An example of propagation RREQ using TBA

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Chapter Four: Simulation Results and Analysis

4.1 Overview

This chapter presents the simulation methodology that is used to evaluate the proposed algorithm. The new trimming mobile scheme was added to AODV, which is a popular reactive routing protocol for mobile ad hoc networks.

4.2 Simulation Environment and Parameters

An accurate observation taken from a real life implementation is potentially very costly and needs a long time. Simulation can save time and efforts. It is the imitation of the operation of a real-world process or system. It provides a way of predicting performance in the absence of a real network that can be used for performance measurement.

Many simulators have been used for performance analysis in Mobile Ad Hoc Networks, such as NS2, NS3, OPNET, Net Sim, OMNET+, REAL , J-Sim and QualNet. Some of them are commercial like QUALNET and others are free as shown in Table 4.1.

The NS2 simulator is one of the most popular discrete event network simulation tools and it is organized according to the OSI reference model. The popularity of NS2 is due to the fact that it is freely available, freely downloaded, open source, and is heavily used in research studies on MANETs [38]. The network simulator NS2 2.35 has been chosen as a simulation tool in this research.

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Table 4.1: Networks simulator and availability

Simulator Name	Availability
NS2	Free http://www.tutorialsweb.com/ns2/NS2-2.htm, visited 7/8/2015
NS3	Free https://www.nsnam.org/, visited 10/8/2015
OPNET	Commercial http://www.opnet.com/university_program/itguru_academic_edition/, visited 12/8/2015
NetSim	Commercial http://network-simulator.software.informer.com/0.9/ visited 12/8/2015
OMNeT++	Free for academic and non-profit use https://omnetpp.org/, visited 12/8/2015
REAL	Free http://www.cs.cornell.edu/skeshav/real/overview.html, visited 12/8/2015
J-Sim	Free http://www.kiv.zcu.cz/j-sim/Download/download.html, visited 12/8/2015
QualNet	Commercial http://web.scalable-networks.com/content/qualnet, visited 12/8/2015

Two scenario files are adopted in our simulation model, which are the mobility and traffic files. In MANETs, nodes can move at any time without notice, and the topologies are generated using different mobility scenarios. These scenarios correspond to how nodes are distributed over the simulation area and to their movement during simulation. Traffic scenario files contain information such as traffic rate, connection type, and packet size.

In general, mobility models used in the simulation of MANETs are based on real trace or synthetic models [38]. Trace-driven models are useful and accurate if they are

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obtained through long observations in the field of particular scenarios involving real user participants.

One frequently used mobility model in MANET simulations is the Random Waypoint (RWP) model [38], in which nodes move independently to a randomly chosen destination with a randomly selected velocity. The Random Waypoint model is used as the mobility model in our simulations. In this model, each node starts at the beginning of the simulation by being stationary for a pause time, then it selects a random destination within the simulation area and moves towards it. The speed of the node is randomly chosen between a minimum and a maximum speed specified in the configuration file. After the node reaches its destination, it stops a gain for a pause time. Then, it chooses another location and starts moving towards it with a new speed. This process continues until the end of the simulation time.

In many previous works, the simulation model includes the following main components: number of nodes, routing protocol and packet size, all nodes are mobile within a square area of 700m×700m, nodes have a transmission range of 250 meters, and communication bandwidth is 2 Mpbs. The IEEE 820.11 is used as the underlying MAC layer communication model. The packet generation rate is 6 packet/second and the packet size is 512 bytes.

In our simulations, we vary the number of nodes in the simulated area as follows: 25, 50, 75, 100, 125 and 150 nodes distributed randomly in this area. Node speed is chosen randomly between minimum and maximum speeds. In this thesis, the minimum speed is set to 0 and the maximum speed is set to 17, unless specified otherwise, and the pause time is set to 10 seconds. Table 4.2 summarizes the simulation parameters.

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Table 4.2: Summary of parameters used in simulations

Parameters	**Value**
Simulator	NS 2.35
Transmission Range	250 m
Topology Size	700m*700m
Simulation Time	700s
Packet Size	512bytes
Packet Rate	6 pkts/s
Traffic Load	10, 20, 30 and 40 data sessions
Traffic Type	Control Bit Rate (CBR)
Number of Nodes	25, 50, 75, 100, 125 and150 nodes
MAC Protocol	IEEE 802.11
Maximum speed	5,7,11,14 and17 m/s
Minimum speed	0 m/s
Pause time	10 s
Mobility model	Random Way Point model

In this work, we focus on three major parameters: network size, maximum speed and traffic load by changing one parameter while keeping the other two constant, as we will see in the next section.

4.3 Simulation Results and Analysis

In this section, various simulation experiments are presented to evaluate the performance of the proposed scheme.

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Several evaluation metrics are used to evaluate network performance, in comparison with the performance of the basic AODV protocol. These metrics are the end-to-end delay, packet loss, routing overhead and collision rate.

- **End-to-End Delay:**

This measures the time that elapses between the start of packet transmission and its reception. This delay includes processing, propagation and MAC transmission time. The transmitted packets need to be identified at source and destination in order to handle packet loss or packet reordering**.** The average end-to-end delay is the division of the total end-to-end duration by the total number of packets received. To improve network performance, we aim to achieve lower average end-to-end.

- **Packet loss:**

In MANETs, congestion and mobility are the main reasons of packet loss. Packet loss is the number of dropped packets in the whole network. It is calculated by subtracting the number of received data packets from the number of data packets sent.

- **Routing Message Overhead (RMO**):

Represents the total number of routing messages generated and transmitted throughout the network. The increase in the routing message overhead reduces the performance of the network as it consumes portions of the bandwidth available.

- **Collision Rate:**

Represents the total number of RREQ packets that are deleted by the MAC layer as a result of collisions, per simulation time unit.

4.3.1 Effects of Network Size Experiments In these simulation experiments, the maximum speed is set to 13 m/s , the pause time is set to 10 s, and the network size is

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increased. When the number of participating nodes is set to 30 nodes, we will say that the network is small. In contrast, when the number of nodes is between 80 and 150, we say that the network is large. The table 4.2 below summarizes these values.

Table 4.3: Simulation parameters for network size used.

Tested	Simulation parameters			
	Network Size	Traffic load	Maximum speed	Pause Time
	25,50,75,100,125 and150 nodes	20 sessions	13 m/s	10s

End-to-end Delay:

Figure 4.1 displays the end-to-end delays as a function of the number of network nodes. When the network is larger the number of duplicate RREQ packets increases. The figure shows that AODV has higher end-to-end delay values. This is because of flooding (higher number of redundant rebroadcasts of RREQ packets with contention and collisions), which increases the end-to-end delays. The new method, as shown in figure, improves the end-to-end delays by over 25% for most number of nodes, compared with AODV. This improvement is due to the lower number of RREQ packets that are generated by the nodes.

Route request overhead:

Figure 4.2 shows the route request overhead of our proposed algorithm compared to AODV for different network sizes. The proposed algorithm reduces the route request packets since it attempt to halt the broadcasting of RREQ packets once the destination is reached.

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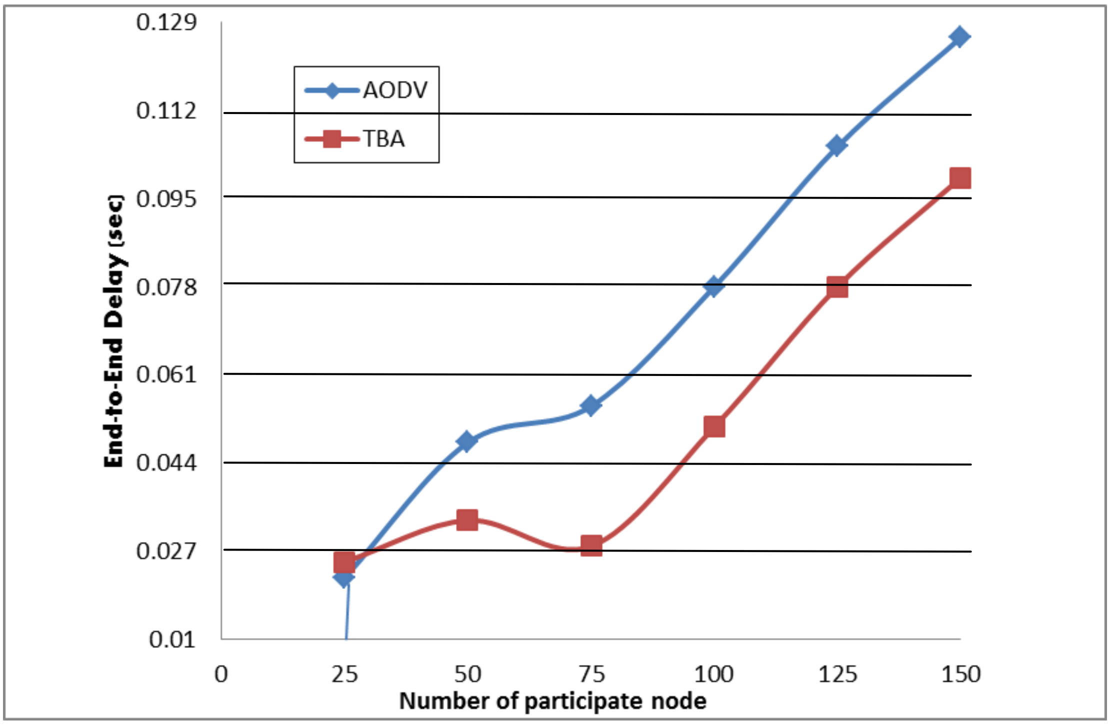

Figure 4.1: End-to-end delay against network size**.**

Collision Rate:

The average collision rate measures the average collision rate for RREQ packets. The result displayed in Figure 4.3 shows that TBA decreases the collision rate substantially, especially when number of nodes is 75 or more. For example, using our algorithm and a number of nodes of 100 or 150 will reduce the collision rate by about 50% compared to AODV. In other words, TBA can improve scalability.

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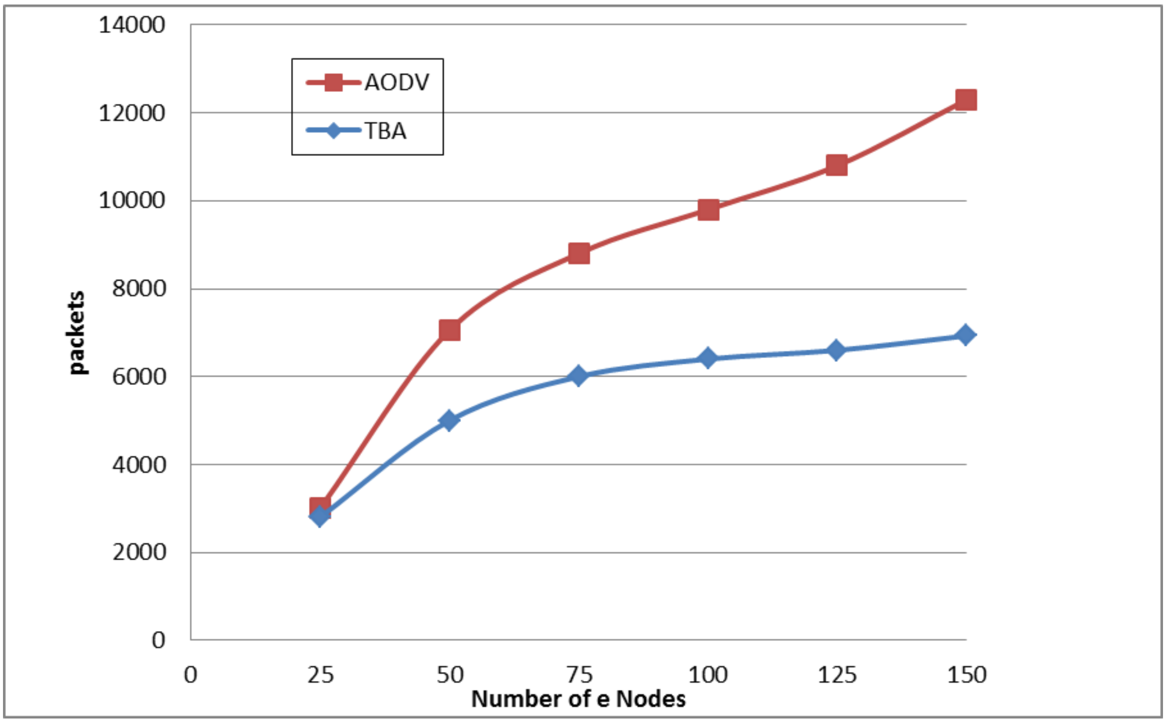

Figure 4.2: Route request overhead verse network.

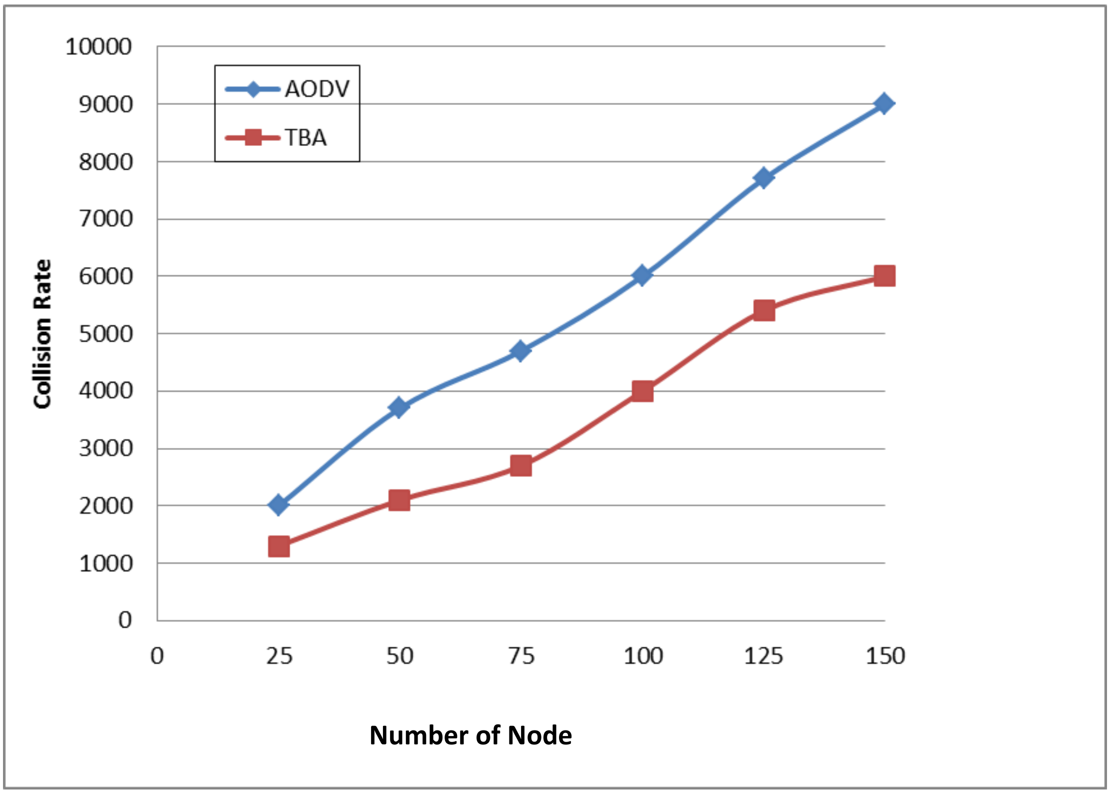

Figure 4.3: The effect of network on the collision rate.

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Packet Loss:

Packet loss represents the number of dropped data packets. Figure 4.4 shows the number of packets lost as a function of network size. TBA has low packet loss compared with AODV. This is due to the impact of trimming broadcasting that our algorithm carries out.

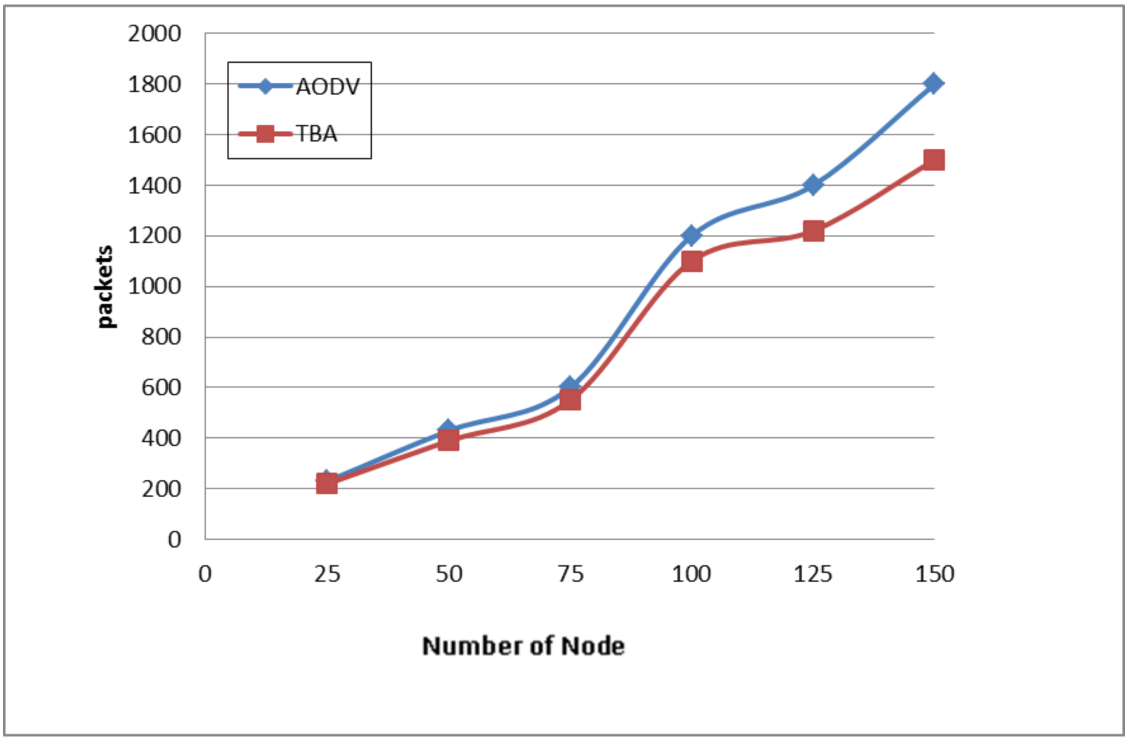

Figure 4.4: The effect of network size on packet loss.

The figure also shows that any increment to the number of nodes will increase the dropped packets. This is because of congestion and mobility in the network. In summary, our proposed schema is expected to reduce the packet loss by up to about 15% .

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4.3.2 Effect of Traffic Load

Traffic load experiments are meant to study the effect of different traffic loads. The offered traffic load simulation is done by changing the number of CBR sources. The numbers of CBR sources in the experiments are represented by 10, 20, 30 and 40 data sessions for 80 nodes that have a max speed of 13 m/s, as summarized in Table 3.2 below:

Table 4.4: Simulation Parameters for traffic load used.

	Simulation parameters			
Tested	Network Size	Traffic load	Max speed	pause Time
	80 nodes	10, 20, 30 and 40 sessions	13 m/s	10 s

End-to-End Delay:

Figure 4.5 represents the delay of the two algorithms for different traffic loads for a network of size 80 nodes. The delay increases with the traffic load. Using our algorithm improves end-to-end delay substantially, as shown in Figure 4.5. The number of packets transmitted on the network has substantial impact on delay. So, when the number of CBR sources increase, this will increase network contention and increase the delay. improves the end-to-end delays by over 27% for most number of nodes

Route Request Overhead:

When the traffic load increases, the total number of packets sent (data and control packets) increases. The Figure 4.6 shows that our scheme achieves substantially better results in comparison with AODV in terms of routing overhead under heavy loads.

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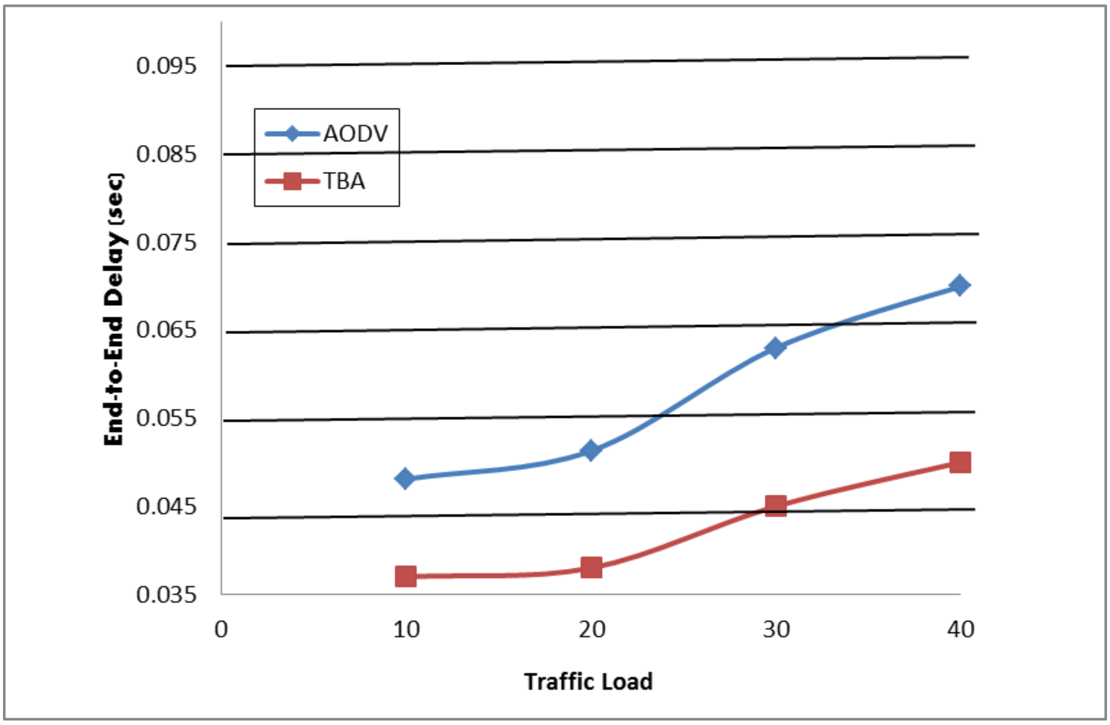

Figure 4.5: End-to-end delay against traffic load.

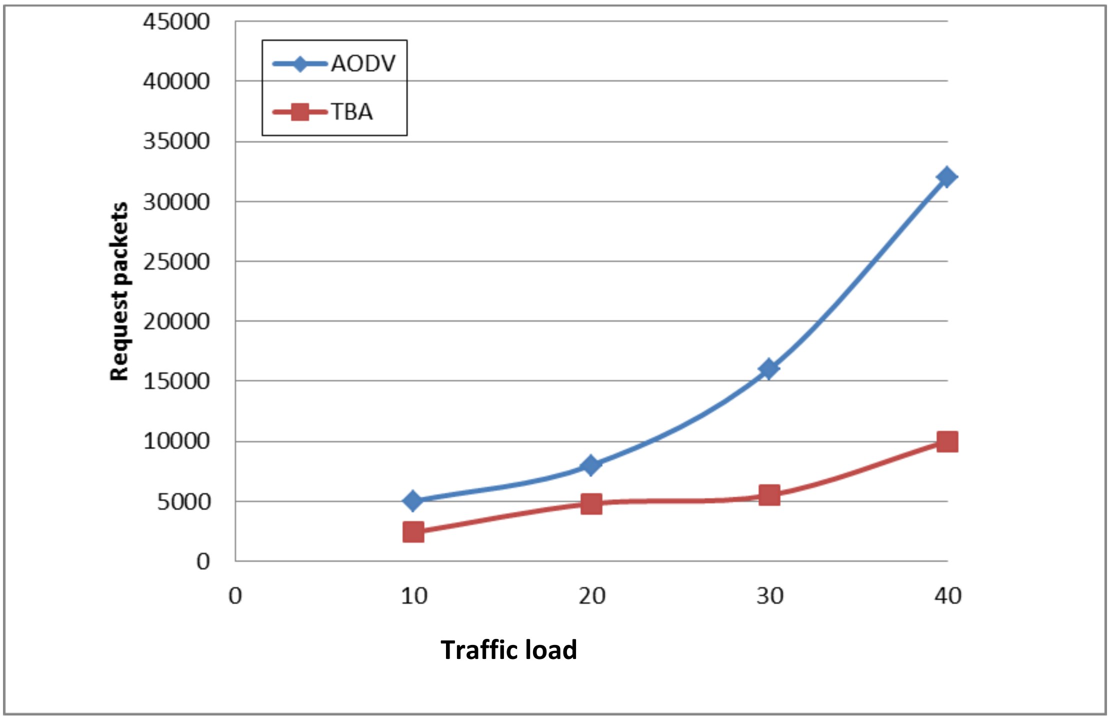

Figure 4.6: Route request overhead verse traffic Load.

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Collision Rate:

The effect of traffic load on the collision rate is investigated again for 10, 20, 30 and 40 sessions, and the results are shown in Figure 4.7. The number of collisions increases with offered. This is because the number of RREQ packets generated increases with the load, and so do data packets. Again, TBA outperforms AODV substantially.The improvement as shown form figure is over than 30% compared with AODV.

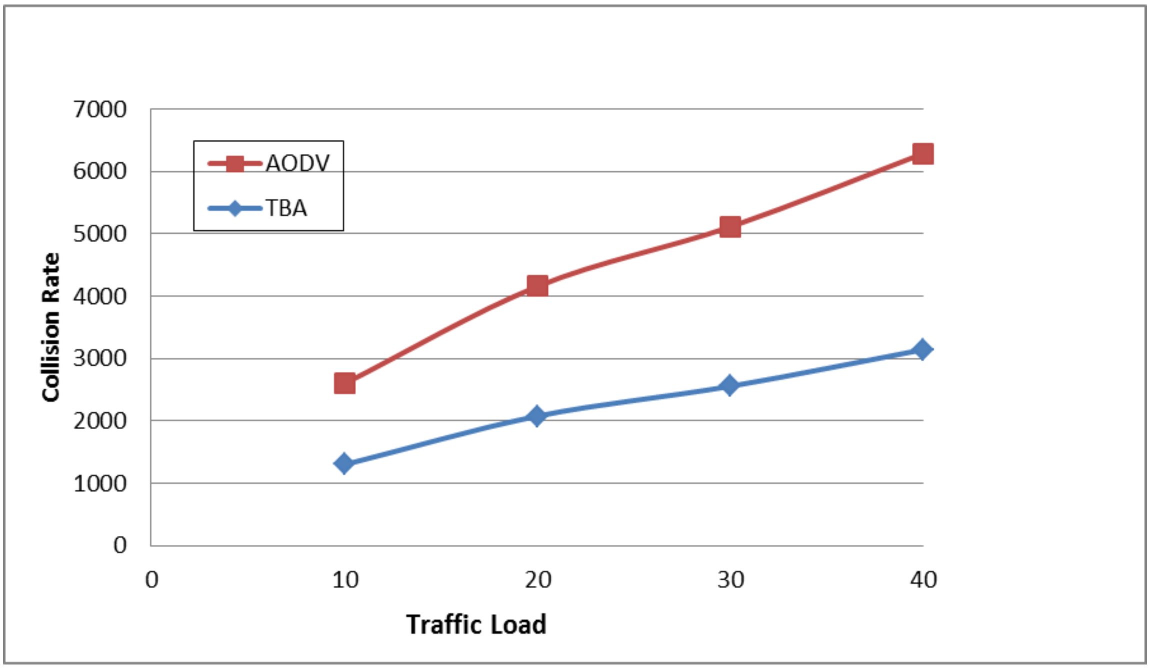

Figure 4.7: The effect of traffic load on the collision rate.

Packet loss

Figure 4.8 depicts the packet loss results. The figure shows that our proposed algorithm reduces packet loss in comparison with AODV, which suffers from high collision and contention. As shown in the figure, TBA reduces the packet loss by up to about 25% compared with AODV.

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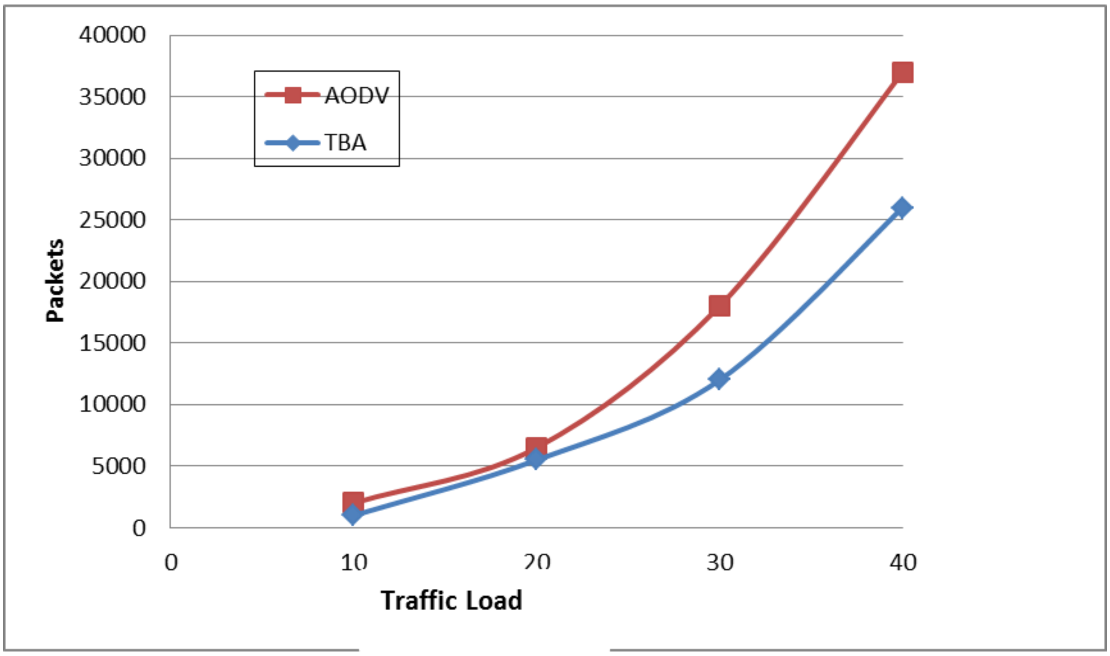

Figure 4.8: The effect of traffic load on packet loss.

4.3.3 Effect of Node Mobility

In these simulation experiments, the maximum node speed is varied from 1 m/s up to 17 m/s, so we use six different speeds where the actual speed is randomly selected from 1 to max speed. The six maximum speeds take the following values: 2, 5, 7, 11, 14 and 17 m/s, respectively. The traffic load is fixed at 20 data sessions, and the network size also is fixed at 80 nodes. The Table 4.5 summarizes these values.

Table 4.5: Simulation parameters used for mobility.

Tested	Simulation parameters			
	Network Size	Traffic Load	Max speed	Pause Time
	80	20 sessions	2, 5, 7, 11, 14, and 17 m/s	10s

End to End Delay:

Figure 4.9 displays the results of the two routing protocols in terms of end-to-end delay for different speeds. For both protocols, when the speed increases the end-to-end delay

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also increases. This is due to the increase in the number of broken links that occurs when the speed increases.The figure also shows that AODV has higher end-to-end delay values. The new method improves the end-end delays by nearly 25% for most speeds, compared with AODV. This improvement is due to lower number of RREQ packets that TBA achieves.

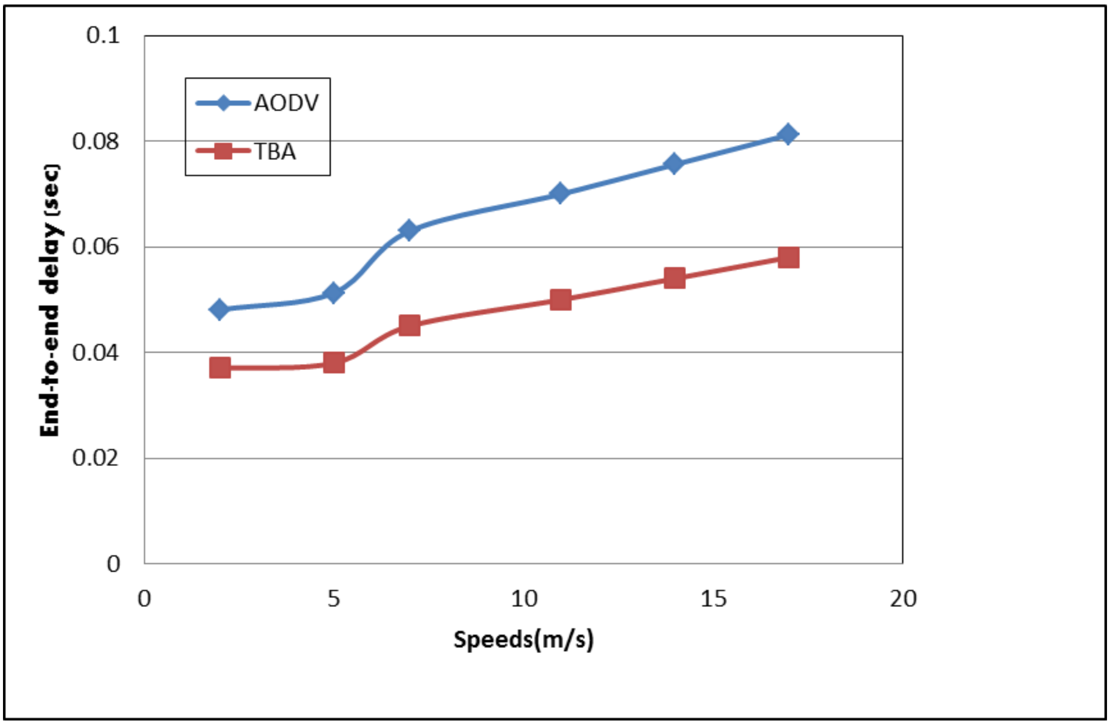

Figure 4.9: End-to-end delay against speed.

Route Request Overhead:

The route request of TBA and AODV for different mobile speeds is reported in Figure 4.10. The figure shows that the proposed algorithm reduces the route request packets since it attempts to halt the broadcasting of RREQ packets once the destination is reached. It can be seen in the figure that the performance of TBA is substantially better than AODV for relatively high mobility (e.g., 13 m/s).

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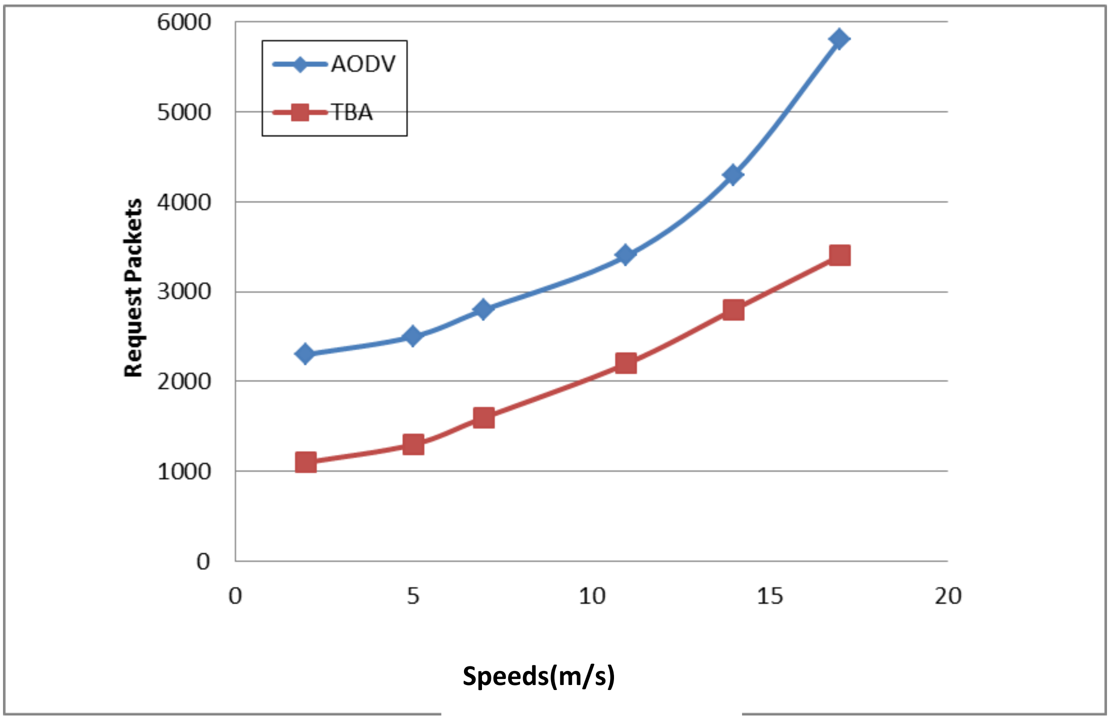

Figure 4.10: Route request overhead verse speed.

Collision Rate:

Figure 4.11 depicts the performance of the two routing protocols in terms of collision rate for different mobile speeds. The results show that the collision rate increases substantially with the speed. The figure also shows that the performance of the two protocols is comparable for low mobility (e.g., 2 m/sec), but the relative advantage of TBA increases as the speed increases.

Packet loss:

Figure 4.12 shows the packet loss of AODV and TBA for the different speeds considered. The results show that the performance of TBA is better than that of AODV, especially for high mobility. The relative advantage of TBA increases as the speed increases. The increase in the packet loss of TBA is slower than that of AODV.

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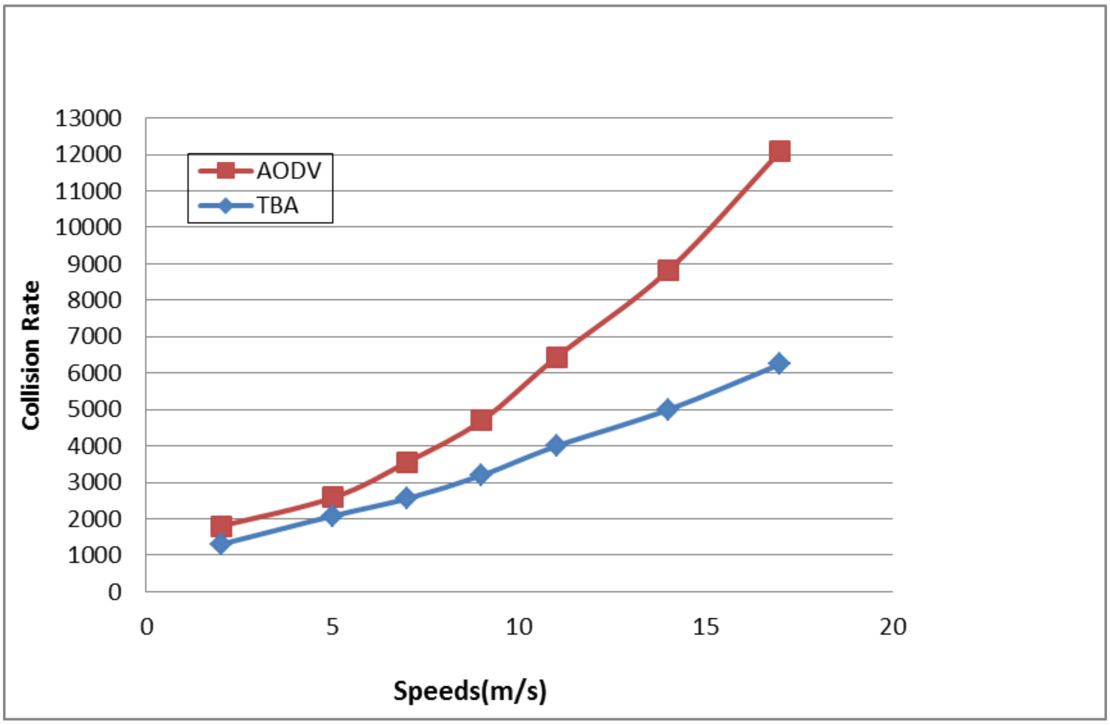

Figure 4.11: The effect of node speeds on the collision rate.

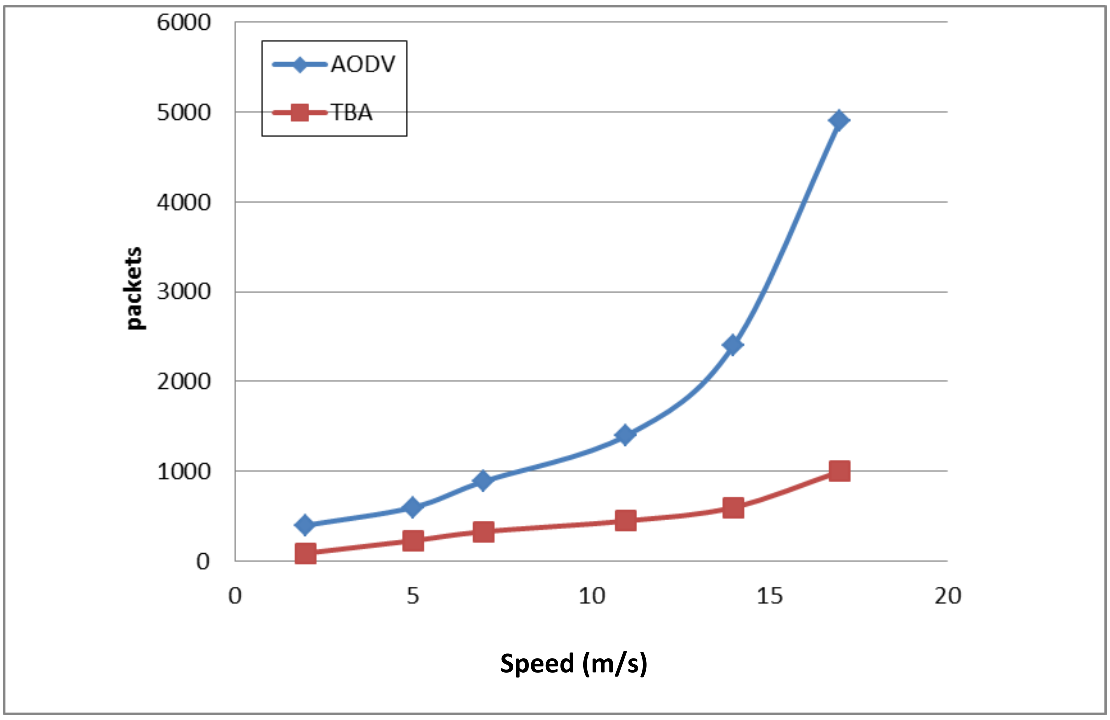

Figure 4.12: The effect of node speed on packet loss.

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Chapter Five: Conclusions and Future Work

5.1 Conclusions

MANETs are used in many fields, such as mobile computing devices, communication in the battlefield, emergency situations, and commercial applications. Researchers in MANETs face many problems because of the characteristics of MANETs. In this thesis, a new scheme that has a destination node trim the surplus of RREQ packets has been suggested. The scheme has a substantially positive impact on network performance.

Unlike schemes that use chase packets, the new scheme does not load the network with additional packets. We modify the RREQ message by adding a new field, namely a mode field that has two modes: *in progress* and *found*. The destination node in our scheme plays an important role in reducing the number of RREQ packets by propagating a RREQ packets with the mode set to *found*. When a node receives this packet, it will drop normal RREQ packets that it will receive.

In this thesis, we evaluated our scheme and compared it with AODV using extensive simulations. In the simulations, we have considered different network scenarios for different parameters. We found that our scheme is more beneficial when the network is dense and when the speed is high. When varying the network size the end-to-end delay improvement was up to 25%. Furthermore, the improvement in route request overhead was up to approximately 20%.

5.2 Future Works

As possible future work, we propose the following:

- It would be a good idea to implement our algorithm in real systems.

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- It would be a good idea to extend the simulation experiments using additional input parameter values.

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التقليم في عملية البث الشامل في الشبكات المتحركة الخاصة

إعداد: طارق محمد العموش

الملخص

الشبكه وليدة اللحظه هي نوع خاص من الشبكات، وهي تحتوي مجموعه من العقد المتفاعلة مع بعضها البعض لاسلكيا دون الحاجه الى محطة أساسية او بنيه تحتيه. هنالك العديد من المزايا لاستخدام الشبكات الخاصه، كما يوجد العديد من الخصائص التي تميز هذا النوع من الشبكات عن غيرها كالبنية الديناميكية، والطاقة المحدودة التي تشغلها بالإضافة الى مدى ارسال محدود.

أجريت العديد من الدراسات والبحوث لتطوير الشبكات الخاصة، وفي هذه الأطروحة نركز على بروتوكول التوجيه عند الطلب المستخدم في العديد من الخوارزميات مثل (AODV).

في مقترحنا تقوم العقدة الهدف بعمليه التشذيب لحزم طلبات الطريق الزائدة عن الحاجه من خلال بث حزمه تشذيب البحث عن مسار، وذلك بهدف وقف عمليه البحث عن المسار، لان العقدة الهدف قد تم العثور عليها.

تمت دراسه اداء وسلوكيات النموذج الجديد من خلال المحاكاة، وأظهرت النتائج بان النموذج الجديد يعطي نتائج جيدة، فقد قلل من الوقت اللازم لإيصال حزم البيانات للعقدة الهدف، وقلل من حزم اكتشاف الطريق بالمقارنة مع البروتوكول (AODV).

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