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Drop of RERR Leads Routing Loop in AODV

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Abstract— Ad-hoc networks are infrastructure less multihop wireless network. In ad-hoc network routes are provided by wireless nodes. Wireless nodes are free to move randomly on any direction with random speed. Ad-hoc networks with mobility are considered as MANETs. In ad-hoc network each node can act as a hop and router itself or both at the same time. Which make routing difficult, to deal with this problem routing protocol required. Ad-hoc On-Demand Distance Vector (AODV) is one of the simplest, efficient, and effective reactive routing protocol developed for MANETs. To maintain routes in wireless ad-hoc networks. AODV use some control messages to manage communication in between nodes. Route Request Message (RREQ) disseminated along with source sequence number through a node to discover a route, Route Reply Message (RREP) uni-casted along with destination sequence number back to source node, HELLO message used to detect and monitor link and Route Error Message (RERR) disseminated to inform all nodes when link failure occur in the network. To keep route information readily available and low routing overhead, AODV maintain route caching but some times cache not removed due to drop, collision and failure of control messages and route cache become stale. This stale cache leads routing loop in ad-hoc network. After detailed study of RFC 3561 & most of the research work done in past. It is commonly known in AODV routing protocol that sequence number are sufficient to protect networks from count to infinity problem. But in this research work implementation to be done to provide a valid proof of routing loop on the simulator. The purpose of this research is to identify flaw so in future we can get more reliable routing protocol.

Keywords— AODV; MANETs; REQ; RREP; RERR; Loop Formation; Routing Protocols

I. INTRODUCTION

In the research paper published by Nagham H. Saeed [1], explained that MANETs is a infrastructure less network consisting of various wireless mobile nodes which can organize dynamically into temporary or Ad-hoc network topologies without any centralized management. Fig. 1 illustrate the basic mobile ad-hoc networks.

To manage efficient communication in between nodes of Mobile Ad-hoc Network we needed routing protocols [2,3]. AODV is one of the mostly world wide used reactive routing protocol [4].

protocol for wireless mobile ad-hoc networks (MANETs) and other wireless ad-hoc networks [5]. It was developed in July 2003 in Nokia Research Center, University of California, Santa Barbara and University of Cincinnati by C. Perkins, E. Belding-Royer and this is mostly used routing protocol in MANETs [4,5].Ad-hoc On-Demand Distance Vector(AODV) is a routing

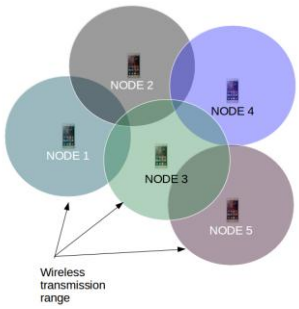

Fig. 1. Mobile ad-hoc network

After study of RFC 3561 [4] and most of the related research on AODV done in past [6-9]. It is founded that this protocol does not work properly. When route error not disseminated properly at all nodes in the network during the link failure. Which leads routing loop in the network.

Here this research work is carried out to introduce some flaws. So in future we can get more reliable routing protocol.

II. PROBLEM STATEMENT

A. *Problem description*

In a detailed study of AODV routing protocol. It is founded that this protocol does not work properly when Route Error (RERR) message not reach at all nodes in the network. On the detection of movement of next neighbor node go away from the range and link failure occur due to node mobility. Due to loss of RERR message route table entry become stale [10]. If responding node consecutively send stale route entry as a route reply(RREP) for particular destination node. Than this may lead routing loop problem in the wireless ad-hoc networks.

Another major problem in AODV is also shown during the implementation of routing loop based on this research work. When any node have stale route entry through any another node in the network. Than that node sending stale route as a RREP to that node from which it have stale route for any destination.

"A routing loop is a path specified in the nodes routing table. Which may cause at a particular point of time that data packet visit the same node more than once before reaching the intended destination."[11,12].

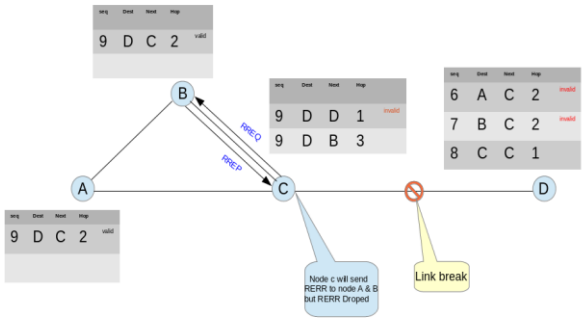

Fig. 2. Loop Formation Diagram

Fig. 2 describing network topology in which routing loop is forming. Which using AODV as a routing protocol.

- Source node B wants to send data packets to destination node D.
- There will be route for destination node D through node C to D.
- Suppose link in between C & D no more exists.
- Then node C will detect break route and node C will disseminate RERR message to all nodes in the network.
- Suppose RERR message not reached at node B due to link failure.
- Now node B have stale route entry for destination node D.
- If node B sends stale route as a RREP on the RREQ initiated by node C for destination node D.
- Transmission of data packets initiated from B & C but packet comes to travel in the routing loop.

III. ROUTE ERROR MESSAGE IN AODV

Any time in a network, in active route if a link break or link down detected by any node who is the part of active route will disseminate route error to all of its affected nodes [3,4]. RERR message format illustrate in fig.3.

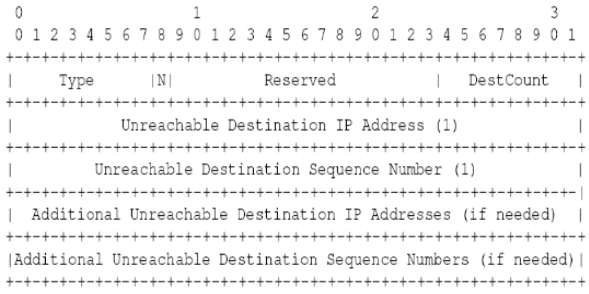

Fig. 3. Route Error Message Format [4]

IV. NS-2 SIMULATION

A. *About NS-2*

Network simulator-2 is a real time network simulator used to simulate network traffic and wireless network infrastructure [13,14]. For researcher and network analyst it is well known simulator. NS2 developed in C++ and TCL programming languages. Otcl is object oriented TCL, also used in NS2. To simulate real time network TCL programming is used and to made some changes in existing protocol C++ is used [14].

TABLE I
SIMULATION PARAMETERS[2]

Parameter	value
Number of nodes	6
ART(Active Route Timeout	3 sec
WLAN protocol	802.11g
Bit rate	11 Mbps
Station Range	100 meter
Packet Inter-Arrival time	0.25 second
Packet size	128 byte (1024 bits)
Data transmission protocol	TCP/UDP
Antenna type	Omni directional
Environment size	400*400
Queue length	30

B. Trace File

The file generated by an simulator to keep coverage information of network in NS-2, is called Trace File. In NS-2 simulation result stored in trace files. Trace file formats need to be understand for analyzing results [14].

Event	Time	From node	To node	Pkt type	Pkt size	Flags	Flow id	Src addr	Seq num	Pkt id

Fig. 4. Sample Trace File Format

```
+ 0.1        0 1 TCP 1000 --------- 2 1.0 5.0 0 0
- 0.1        0 1 TCP 1000 --------- 2 1.0 5.0 0 0
r 0.114      0 1 TCP 1000 --------- 2 1.0 5.0 0 0
+ 0.114      1 2 TCP 1000 --------- 2 1.0 5.0 0 0
- 0.114      1 2 TCP 1000 --------- 2 1.0 5.0 0 0
r 0.240667   2 3 TCP 1000 --------- 2 1.0 5.0 0 0
+ 0.280667   3 1 TCP 1000 --------- 2 1.0 5.0 0 0
- 0.280667   3 1 TCP 1000 --------- 2 1.0 5.0 0 0
d 0.289667   3 1 TCP 1000 --------- 2 1.0 5.0 0 0
r 0.320667   1 0 TCP 1000 --------- 2 1.0 5.0 0 0
+ 0.320667   1 0 TCP 1000 --------- 2 1.0 5.0 0 0
```

Fig. 5. Sample Trace File

V. RELATED WORK

The work in this research project to test AODV for detecting routing loop and to identifying stale cache entries which are creating routing loop. After analyzing simulation trace file some flaws are identified they leads routing loop in AODV routing protocol.

Analyzing and verifying all possible scenario in AODV which may leads routing loop is not a new tradition. it is commonly known in AODV routing protocol that sequence number are sufficient to protect from count to infinity problem [3,4,15]. If sequence number are progressively increase over time. Most of the research work done in past, this is common belief that AODV is loop free.

In [11] authors explain that AODV is not priori loop free. However, RFC 3561 [4] claiming that count to infinity problem are avoided in all possible scenarios by the use of sequence number has been proven incorrect in this research work, to prove routing loop in AODV. Different route request have to be initiated simultaneously and afterwards handle by different neighbor node is really not common situation but it creates routing loops. And the fact is that example exist for that and have valid proof that AODV still have problem of routing loop.

VI. RESULT ANALYSIS

To consider above problem description of routing loop under AODV routing protocol and described simulation parameters. The analysis of AODV routing protocol in MANETs is performed in a simulation environment. NS-2 under linux Ubuntu 16.04 LTS platform.

Analysis of proposed problem description consider under trace file and Network Animator (NAM), and result shows that AODV having that problem of routing loop. Fig 6 illustrate routing loop in NS-2 Network Animator.

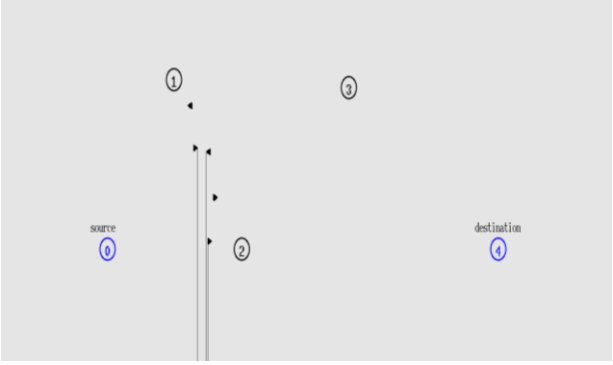

Fig. 6. NAM Analysis of Final Result

VII. CONCLUSION

On the basis of proposed research work analysis. We have shown that, AODV do not guarantee loop freedom, AODV fail when node maintain stale cache over time and this is possible when node losses route error message(RERR) and same stale entry forwarded to any other node as a consecutive route reply (RREP). This is mainly achieved that Ad-hoc On-demand Distance Vector (AODV) still have problem of routing loop. Analysis of routing loop performed on the basis of detailed analysis the network simulator trace file.

As we know some of the research work done in past on AODV. Told that AODV does not have any routing loop problem this has been proven to be incorrect in this research work. Here, it does not matter how often this scenario working to create routing loop . The fact that the AODV still have count to infinity problem, makes the protocol disproves the fact that when RERR message loss so node unable to clear stale cache so this entry still maintain in table as a route entry for invalid route. When stale cache forward as a consecutive route reply to other nodes. So this problematic situation leads routing loop in AODV.

VIII. FUTURE WORK

After detailed study of existing AODV routing protocol it is founded that this protocol still have lots of research pending which help to make protocol more effective and efficient. But in future on the basis of this research work

there may be some work on effective, efficient algorithm which help to deal with loss of route error message this will help to overcome the problem. Which introduced in this research work.

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