Testing Reliable-AODV for Mobile Ad-hoc Network using test-bed architecture

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Abstract*: *Mobile Ad hoc Network(MANET) provides wireless communication withoutany infrastructure. MANET generally uses a most popular and well-suited routing protocolthat is Ad hoc on Demand Distance Vector (AODV). Random topology and mobilityin MANET cause link break multiple times in network due to which poor link quality thatresults in packet losses in the network. In this paper, link quality improvement in AODV routing protocol is focused. Link quality issue can be resolved through Cross-layer design(CLD) interaction in the OSI communication model. This technique called as Reliable-AODV. CLD is implemented by interacting Physical firstlayer and network third layer of the OSI model, CLDinteraction help in strong route formation inAODV for Reliable-AODV. The result shows an improvement in the system Performance in terms of metricslike throughput, Packet Delivery Ratio(PDR) and reduction in the packet losses, delay ofthe network. Network simulator used for performance analysis is NS-2.a Simulation tool that shows improvement in results. Castadiva Emulator with Wi-Fi routers and laptop are used as test bed architecture for validating sample results of simulations. It is observed that some small variation in the simulated and emulated result by using real-time experimental setup.

Index Terms: *AODV, MANET, CLD, NS-2, NS-3*

I. INTRODUCTION

Current developments in wireless communication, especially in infrastructure-less networks, introduced Wi-Fi or Bluetooth as a new type of wireless systems. Such networksare known as Mobile Ad-hoc Networks (MANETs) or short live network. In principle,MANET[1] does not require any fixed infrastructure and operates in the absence ofperpetual infrastructure. Wireless communications and networking are one of the growing areas in research. A vital application area of wireless communication and MANET are disaster management, military applications, business, Wireless sensor network[2] VANET and in FLYNET. The Ad hoc On-Demand Distance Vector (AODV)[3] routing protocol is from the several published routing protocols for mobile ad hoc networking Perkins et al. (2003). Currently AODV is the area of much research among the network community. The AODV protocol for routing is designed for wireless nodes connected in ad hoc network. Features of AODV: includes quick adaption to active link condition, low processing and memory overhead, dynamic self-routing multi-chip routing and AODV routing protocol allows wireless nodes to reply to link breakage and changes in network typologies in timely manner.

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Section-II is about related, Section-III proposed method, section-IV mathematical analysis, Section-V-System development and result analysis and Section-VI conclusion.

Figure 1: MANET practical operation

II. RELATED WORK

Mobile ad-hoc networks propose quick and horizontal network setting out in conditions where it is not possible otherwise. Mobile ad-hoc network is an independent system of mobile nodes linked by wireless links; each node functions as an end system and a router for all additional nodes in the network. MANETs has mobile nodes with random topology. Hence, it is difficult to maintain a link between the source and destination. Also, link breaking in routing protocol is another issue in network and causes poor performance of the network. There are multiple issue in MANET such as Link break: [4][5][6][7].Route selection under mobility [8][9], Routing and congestion control [10][11][12][13] and for Energy [14][15][16][17].Many researchers have proposed different methods to overcome the above issues such as Route selection based on RSS value [8][18][[19]. Neighbor route discovery methods [20]. Cross layer design approaches: [21][22][23][24]for optimization of network performance.

Many AODV improved algorithms are suggested such as Turbo-AODV (TAODV) [18] for performance improvement, AODV with reliable delivery (AODV-RD) [10] for link failure prediction mechanism. Modified Reverse Ad-hoc on Demand Distance Vector (MRAODV) (Mehdi Zaïre et al) to reduce the probability of RREP packet loss and to avoid the source node repeatedly re initiate the route discovery process due to node mobility. Intelligent AODV (IAODV) [[9] and Dhawan (2015) considering RSSI values to find a route among source and destination. Again Intelligent-AODV (I -AODV)[20] to exploit neighbor discovery and reduce the overhead of neighbor discovery processes.

Pro-AODV- [25] to realizing Intelligent Transportation Systems (ITS).

Cross-Layer design method for Power control (CLPC) [4] to improve the transmission power by averaging the RSS values and to obtain a most effective route between the source and the destination. Cross-layer based routing using forwarding node selection (CRNS)[26] in this the forwarding nodes have been selected according to the number of neighbors and their power of received hello message broadcasted by the neighboring nodes.

Cross-Layer Stability based routing mechanism is (CLSAODV) [27] a route is found to get lose due to the low signal strength of a node, it will find another path. Cooperative Opportunistic Routing in Mobile Ad hoc Networks (CORMAN) [Wang et al. (2012b)]- the issue of opportunistic data transfer in MANET can be solved. AODV-2T- [12]for reducing the broken route. Cross-layer design of energy-aware ad hoc on-demand distance vector (CEAODV) [14] to enhanced AODV routing protocol for reduction in the energy consumption and then long life of the entire network. Preemptive Multi-path AODV (PMAODV) to save multiple disjoint routes from source to destination during route discovery phase.

III. PROPOSED METHOD (RELIABLE-AODV)

MANET is a sub-family of wireless communication which can be used in various application. AODV routing protocol is used in MANET as it is very famous and suitable. MANET has random topology and mobility of nodes due to which poor link quality in AODV which degrades the performance of MANET. Wi-Fi (IEEE 802.11) is used in MANET as physical interface under the physical layer of the OSI model, which has collected values of Received Signal Strength(RSS) of each node. This data can be shared with AODV in the network layer to check the link quality in AODV protocol. This sharing of data is possible by cross-layer interaction in the OSI model. Figure 1 shows the process of sharing RSS values across the layers. Figure 1 shows how RSS value can be used to check link quality for strong route formation in AODV, therefore system performance of MANET can be improved by using the above cross-layer design approach

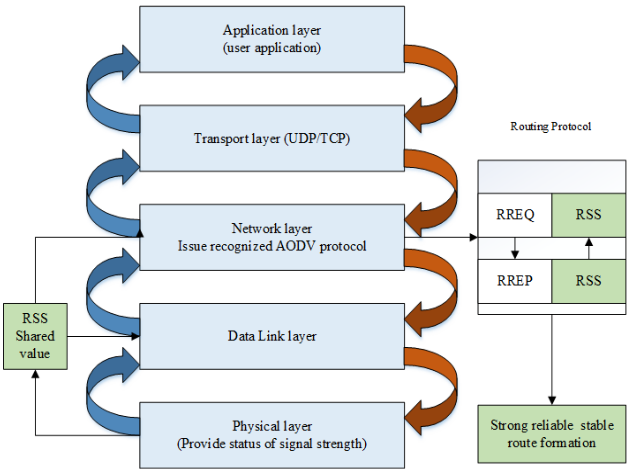

Figure 2: CLD implementation and RSS value sharing

Figure 1 shows about accessing received signal strength RSS parameter from physical layer and it will help AODV route request to select the route on the basis of RSS value. It will stablish the route in between available strong links. Now starting with implementation steps first need to understand header format of AODV as shown in Figure 3.9.It includes the information about destination IP address, sequence number, source address, type of message and life time of message. Figure 2 shows about packet format and the way in which RSS value added in packet formats of route request and route reply.

A.AODV RREQ Packet Format (192 bits)

Source Address	Source Sequence	Broadcast ID	Destination Address	Destination Sequence	Hop Count

B. AODV RREP Packet Format (160 bits)

Source Address	Destination Address	Destination Sequence	Hop Count	Lifetime

C. AODV RREQ Packet Format with RSS (198 bits)

Source Address	Source Sequence	Broadcast ID	Destination Address	Destination Sequence	Hop Count	RSS Values

D. AODV RREP Packet Format with RSS (166 bits)

Source Address	Destination Address	Destination Sequence	Hop Count	Lifetime	RSS Values

Figure 3: AODV &Reliable-AODV RREQ ,RREP packet format

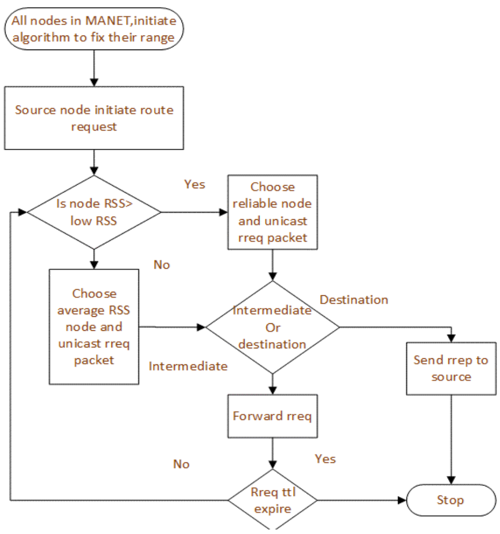

Figure 4: Algorithm to check link quality

RSS value shared between OSI layers therefore AODV use this value while updating routing tables. Now updated routing table are with RSS values and it will help to form strong route in Mobile ad hoc network. AODV uses the following fields with each route table entry: Destination IP Address, Destination Sequence Number, Valid Destination Sequence Number flag, Other state and routing flags (e.g., valid, invalid, repairable, being repaired) Network Interface, Hop Count.

Algorithm-1: AODV Route Discovery

When a node requires to find a route to a destination node,

1. Sends the network with a Route Request (RREQ) message.
2. The starting node broadcasts a RREQ message to its nearby nodes, which broadcast
3. the message to their neighbors, and so on.
4. To keep going this cycles, every ‘node remembers currently forwarded route requests

5. in a route request buffer.
6. As these requests spread in whole the network, in between nodes save reverse
7. routes back to the starting node.
8. Intermediate node may have many reverse routes.
9. It always picks the route with the smallest hop count.
10. The destination node produces a Route Reply (RREP) message.
11. Sends RREP message with the reverse path back towards the source node.
12. The RREP move through in between nodes, nodes update routing tables, so that
13. in the next, messages can be routed though these nodes to the destination.
14. If RREQ source to get a RREP message from multiple node.
15. The RREQ source will update its routing table with the most newly routing information

Algorithm 2: Reliable-AODV Route discovery algorithm

1. Every Node start Hello message for collecting Nearby node RSS values
2. Count neighbor nodes with its RSS value
3. Each intermediate node verifies its routing table for RSS value of nearby nodes
4. Is value available then Update routing table
5. Otherwise save as a fresh RSS value
6. Specify threshold-RSS value
7. If neighbors RSS value< threshold-RSS
8. Else Checkout other nodes with higher RSS values and update table
9. Determine most appropriate path for data transmission.

Algorithm-1 shows basic operation of AODV routing protocol, while algorithm-2 shows modified algorithm in which RSS value is checked. Hence, using RSS value to check link quality will improve the performance of network.

IV. MATHEMATICAL MODELLING

The link duration and path duration parameter decide the quality of link. It shows parameters on which strong route or link can be established[28]. Duration for link (DL): Two devicex and y ingiven time t, duration of link (x, y) can be defined as the length of the largest time interval [t_1, t_2]in which the two devices are within range of each other, These two devices are not in the range at time t1-ε and time t2+ε for ε>0. Formally,

$$DL(x, y, t) = t_2 - t_1$$

Durationof Path (DP): For a path (m_1, m_2,m_q), withqdevices, at time t1, path duration of pathcan be defined as the length of the largest time interval [t_1, t_2], in which every of the q-1 lines between the devicesare available,at time t, Duration of path is the least of the duration of the q-1 links (m_1, m_2), (m_2, m_3), (m_{q-1}, mq) at time t1. Formally,

$$DP(P, t_1) = \min_{1\le z\le q-1} (DL(m_z, m_{z+1}, t_1)$$

Distribution for each duration of path$\boldsymbol{\alpha_{path}}$

Properties of α_{path}

$\alpha_{path} \propto h$, $\alpha_{path} \propto V$,$\alpha_{path} \propto \frac{1}{R}$

According to the α_{path} properties we get,

$$\alpha_{path} = \alpha_0 h \left(\frac{V}{R}\right)$$

where $\alpha_0$is constant of proportionality.

In given model, the average duration for path is $1/\alpha_{path}$ since the duration of path is considered as exponentially distributed with metric α_{path}

Average duration of path with reference to analysis to reactive protocols metrics: Throughput: - Now, how the protocol performance is related to the duration of path.For every source device and destination device, the time T is considered with two parts: the time utilizedfortransferring data and to repair/maintenance of break paths.

Considering, M total number of devices, T the total time for simulation, T flow be the time in which realdata gettransferred takes place at highestrate, t_{repair} be the time required to repair path after braking of path everytime, T_{repair} total time required for repairing broken paths in the time T, A_{PD} is the average path duration.f is defined as frequency of path breaking, f=1/A_{PD}, D is total data to be transfer during simulation.r is the rate of data transfer [28],[29].

$$T = T_{flow} + T_{repair}\ ,\ \ T = T_{flow} + t_{repair} + fT\ \ ,\ \ DP = \frac{1}{f}$$

$$T = \frac{T_{flow}}{(1-\frac{t_{repair}}{PD})}\ \ ,\ \ Throughput = \left(1 - \frac{t_{repair}}{Dp}\right) r$$

Where, $r = \frac{D}{T_{flow}}$

The major problem of AODV in MANET is route failure and link breakage that affects the performance of wireless communication. New methods and algorithm should be developed to avoid this problem in future technology. Cross layer design is one of the methods that may avoid these problems and increase the performance of system. Throughput of system dependent on path duration and path duration is depends on link repairing time. It is formulated by mathematical expression that performance of wireless ad hoc network depends on path or rout feature of network

V. SYSTEM DEVELOPMENT

Implementation of proposed system is simulated in NS 2.35 Simulator and Castadiva Emulator.

A. Network Simulator NS-2

NS-2 is under open source software, it is event driven simulators precisely designed for research in the field of computer and wirelesscommunication networks, NS2 have various modules for network component like routing in network layer, transport layer protocol, application layer etc., to examine network performance, NS2 frequently used open source network simulator and one of the most almost used network simulator. Simulation Performance measure include Mean waiting time, Mean Packet transmission latency and Mean server utilization.

Element of simulation consists of Entities of model, Resources in Model, Activities and Events, Scheduler, Global variables, Random Sequence Generator, Statistics Gatherer [30].

B. CastadivaEmulator

It has a construction that enables forming a test bed experimentation. It is cost effective and off the shelf type of devices used with Linux based system. It permits designing and making network typologies,exporting them to real devices/nodes and gaining the testresultitalsogeneratevarioustypesoftraffic in between wireless nodes/devices and it proposal support for ad hoc routing protocol. Ithas maintwotypesnetworksuch as,Wirednetwork (Connection Network) that connects the main core with group of attached wireless nodes/devices. Second is wireless network where the real test bedtest is executed. Castadiva main application is in JAVA to control all devices/nodes and it keep managing all links according to some defined network parameters. Castadiva main core has dual functions, to permit a user (node) to managewiththesystemsoastodefinealltheexperimentationparameters needed and to manage the wireless nodes/nodes during an testing [31].Castadiva Feature includes, Easy use and configure, Permit the user to generate different number of network typologies, Emulates all node mobility, generates different traffic connections among available nodes, can allow generating random scenarios, combines with different routing protocols and it allows connecting external devices like webcams [32].

C. OpenWrt

OpenWrt is also open source project specially for embedded operating system that are based on Linux, it used on embedded devices/nodes to route network traffic. Command line interface (ash shell) with a web interface (Luci) is used to defined OpenWrt, there are about many available optional software packages for installation.

1) Check Table of Hardware (OpenWrt)
2) Download OpenWrt Firmware
3) Update Firmware to OpenWrt
4) Access OpenWrt @ 192.168.1.1
5) Required Model of Router (16MB RAM)

D. Test-bed architecture

1. Server: Hp Laptop with Linux operating System is used as Server for installation of Castadiva Server.
2. Switch: Digi sol with 16 Ethernet port is used.

The Generating Simulation Scenario for NS2 and Castadiva

1) Analyzing Simulation Results
2) Installing Castadiva in PC
3) Installing OpenWrt in Wi-Fi routers
4) Communicating nodes with server PC
5) Installing Access Point on every node
6) Developing Wired and Wireless Network connection
7) Comparing result of Simulator and Emulator

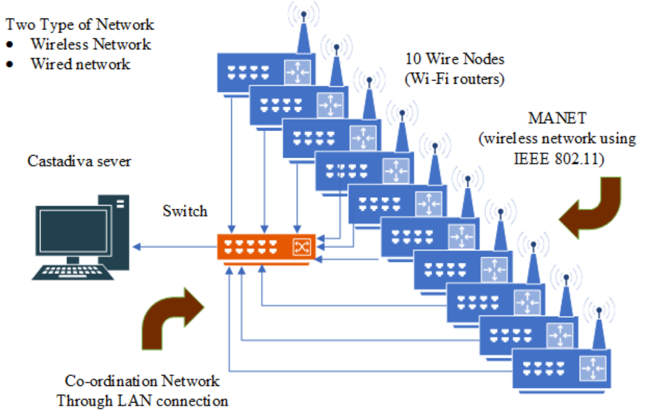

Figure 5: Setup for emulation

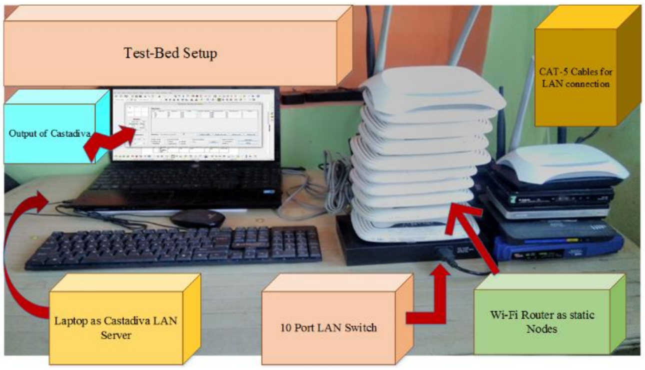

Figure 6: Test bed Setup

VI. RESULTS

Simulation and emulation results Comparison for AODV and Reliable-AODV are shown in Figures 10, 11, 12 and 13. As per observation from Simulation and test bed output result are less in emulator as it deals with real time network. Castadiva is compatible with NS-2 . It provides facility to compare results. Graph are plotted in combine with ns-2 results and emulator results. In above graph simulation and emulation results of AODV with and without CLD implementation are compared. Figure 10 Shows the result of AODV and Reliable-AODV on the basis of Number of Node Vs Throughput. Each iteration throughput of simulator is higher than emulation butCLD implemented AODV is showing always better result in both simulation and emulator. Similarly, in Figures 11, 12 and 13 showing improved result of CLD implemented AODV in simulator and emulator. Packet loss and losses are minimized in CLD implemented AODV. Throughput 10 % improvement for Reliable-AODV and % PDR 7 % as compared to AODV. But emulations results are 5% less than simulation results in Castadiva emulator

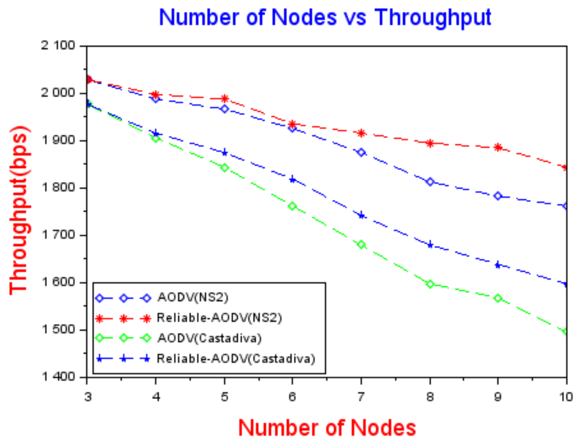

Figure 7:Nodes vs Throughput

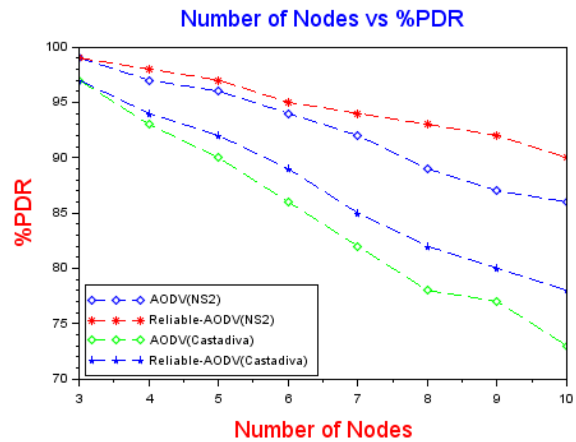

Figure 8: Nodes vs %PDR

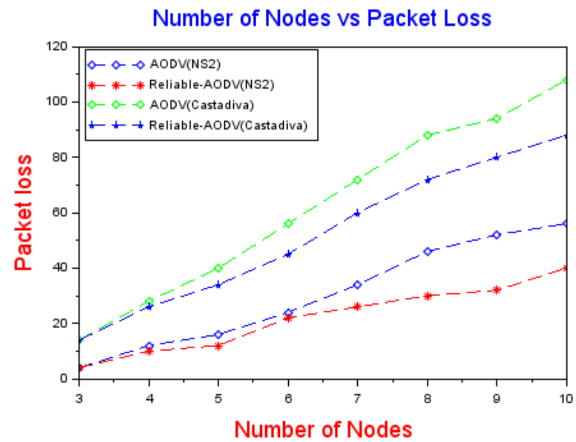

Figure 9: Nodes vs Packet loss

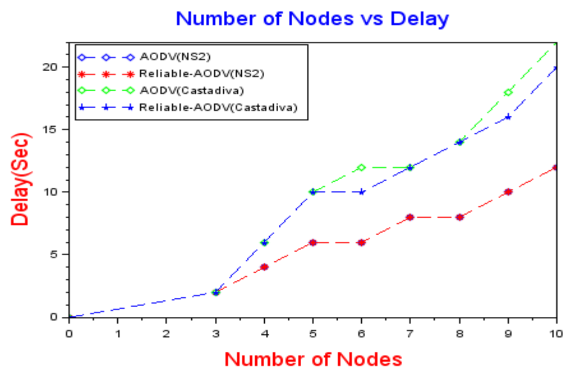

Figure 10:Nodes vs Delay

VII. CONCLUSION

The MANET forms wireless ad-hoc network which phases the problem of link breaks. Implementation of CLD improve the performance. Received Signal strength is the major factor for CLD implementation. In this paper algorithm is designed under AODV isReliable-AODV, in which CLD implementation is used in route formation of AODV to reduce number of link breaks in the network.Now, premeditated algorithms are scripted under simulator, emulator and output performance is ascertained in terms of metrics such as throughput, %PDR, packet loss and delays. As compared to AODV, Reliable-AODV shows performance improvement in terms of throughput improved by 10%, %PDR improved by 7%, and reduction in packet loss and delay. Further A test-bed results using Castadiva Emulator shows real time output. Emulation setup with test bed architecture considered for testing. As compared to simulation results emulation results are accurate. There is 5 % change in output observe under emulation. Most of research works are done under simulations but that need to be verified with emulator. In future MANET with improved result will be need of wireless communicationNS2 and Castadiva can be used for Mobile ad-hoc network research simulation and emulation. Hence, MANET along CLD implemented AODV (improved performance) can be usedinmilitaryanddisasterplaces.In this age most of the work is in progress on advanced technologies such as Internet of things, wireless sensor network, flying ad-hoc network, machine learning and artificial intelligence. This all technologies are advanced and need of future. It should be independent of network infrastructure that will make it more power full. Therefore, CLD-AODV can used for mentioned application for better performance of wireless network.

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