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Cross Layer Interaction for Strong Route Selection in AODV for MANET

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Abstract*: *Wireless communication could be a requirement of this era as all industries are approaching for the internet of things and automation. Even supposing multiple choices are ready for wireless communication, Mobile ad hoc Network (MANET) gives wireless communication while not having any infrastructure. MA NET typically adopts a preferred and well fitted routing protocol that is Ad hoc On Demand Distance Vector (AO D V). Stochastic topology inside MANET antecedent link breaks various times in network because of that feeble link quality that appears as packet extinction within the network. In the modern wireless communication study, it is noted that the performance of system deteriorates because of feeble link creation or link wreckage in the network. In this paper, link quality improvement in AODV routing protocol is focused. Link quality concern is proposed to resolve through Cross layer design (C L D) interaction in the OSI communication model. C L D enforced by interacting Physical initial layer and network middle layer of the OSI model, CLD facilitate in robust route formation in AODV named as CLDAO D V. The result exhibits growth within the system Performance in terms of factors like throughput, Packet Delivery Ratio (PDR) and decline in the packet losses and delays in the network. Network simulator used for performance analysis are NS2 and NS3.

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

I. INTRODUCTION

In the modernized era, a wireless network is a viable technology in communication systems. Wireless networks are broadly grouped into two kinds, i. e. infrastructure based and infrastructure less networks. In infrastructure based networks, communication is established by using base stations in which all access point is attached to the base station. These are also called as single hop networks. Infrastructure less networks are distinct from the cellular network in courses of setting communication within the source and destination node. The source gets connected utilizing nearby nodes and sets the connection by the destination node. These are also described as multi hop networks. M A N E T is an example of Infrastructure less networks[1].

The extension and development of mobile computing and portable communication devices are encouraging an innovative modification in the information society. Mobile users have a lot of benefits of accessing information through wireless networks. Mobile devices/nodes are more affordable as they are more relevant and more powerful. They are expert in operating more applications and network services. In contemporary times, new alternative means to send the services have been improving. Mobile devices/nodes link to each other within the transmission range by inevitable configuration, incubating an Ad hoc mobile network that is both flexible and powerful. Mobile nodes not only interact with each other but can also use Internet services across[2].

MANET operate under a collection of two or more than two devices/nodes which are sharing their abilities to interact with each other. Communication in MANET is accomplished with the help of multi hop wireless links using the ISO/OSI reference model, which is quite organized and have a regulated network design using the layered pattern. Uniformity of layered protocol stacks has allowed fast expansion of interoperable systems, but at the same time restricted the performance of the overall architecture, due to the shortage of coordination between layers. This concern is expressly relevant for wireless networks, where the very physical nature of the transmission medium injects several performance limitations[3]. As an outcome, the performance of higher layer protocols, historically intended for wired networks, is seriously restricted. Section-II about related work, Section-III for Proposed method, Section-IV mathematical modeling and Section-V result and discussion.

II. RELATED WORK

MANET proposes fast and one level network setting out in various conditions, where it is not possible otherwise. MANET is kind of an independent system of mobile nodes/devices connected by wireless links; each node operates as an end system and a router for all extra nodes in the network. MANET have mobile nodes with unpredicted topology. Hence, it is hard to maintain a link between the source and destination. Also, link breaking in routing protocol is another issue/challenge in network and causes poor performance of the network. There are some focused issues in M A N E T such as Link break: as discussed in [4][5][6][7].

Route selection in mobility condition [8][9], Routing and congestion control [10][11][12] and for Energy [13][14][15][16]. Many researchers have proposed different methods to overcome the above issues such as route selection based on RSS value [8](El Bazzal et al. 2012)[[18]. Neighbor route discovery methods [19]. Cross layer design approaches: [20][21][22][23]for optimization of network performance. There are many modified version of AODV are proposed by different researchers as discussed in table:1[24]. Many simulators are proposed for MANET performance evaluation as shown in table 2 [25](Siraj, Ajay Kumar Gupta, and Rinku Badgujar 2012).

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Sr. No	Abbreviation	Paper	Purpose
1	TAODV	El-Bazzal et al. (2012)	Performance improvement by link quality
2	AODV-RD	Wang et al. (2012)	Link failure prediction mechanism
3	MRAODV	Mehdi Zarei et al	Reduce the probability of RREP packet loss
4	IAODV	Singh and Dhawan (2015)	Considering RSSI values to find a route among source and destination
5	I -AODV	Mostajeran et al. (2013)	Exploit neighbor discovery and to reduce the overhead of neighbor discovery processes
6	Pro-AODV	Kabir et al. (2015)	Realizing Intelligent Transportation Systems (ITS)
7	CLPC	Sarfaraz Ahmed et al. (2015)	Improve the transmission power by averaging the RSS values
8	CRNS	Alqobaty et al. (2012)	Forwarding nodes selected according to the number of neighbors
9	CLSAODV)	(Nandgave-Usturge 2012)	Losses due to the low signal strength
10	CORMAN	Wang et al. (2012b)	Opportunistic data transfer in MANET
11	CEAODV	Li et al. (2009)	Enhanced AODV routing protocol
12	PMAODV	Anand et al.	Save multiple disjoint routes

Table 1: Various proposed modified-AODV

Name	Granularity Metropolitan	mobility	Interface	Popularity%
ns-2	Finest	Support	C++/OTCL	88
DIANEmu	Application-level	No	Java	less then 0.01
GloMoSiM	Fine	Support	Parsec (C-based)	4
GTNets	Fine	No	C++	0.13
J-Sim	Fine	Support	Java	0.45
Jane	Medium	Application-level	Native Java	less then 0.01
NAB	Medium	Native	OCaml	0.48
OMNet++	Medium	No	C++	1.04
OPNet	Fine	Support	C	2.61
QualNet	Finer	Support	Parsec (C-based)	2.49
SWANS	Medium	No	Java	0.3

Table 2: Comparison Of Simulators

III. PROPOSED METHOD

Ad hoc On Demand Distance Vector (AODV) routing protocol work on its defined rules as explain in algorithm about Route discovery[27]. Advancement in technologies made unpredicted behavior of network in terms of size and location.

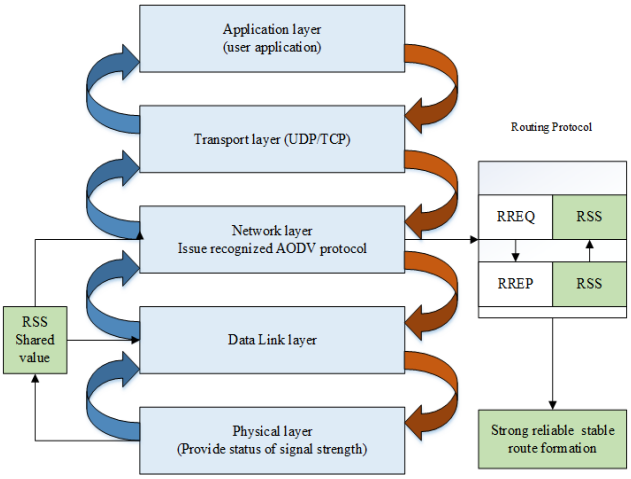

Figure 1: CLD implementation and RSS value sharing

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 2: AODV & CLD-AODV RREQ ,RREP packet format

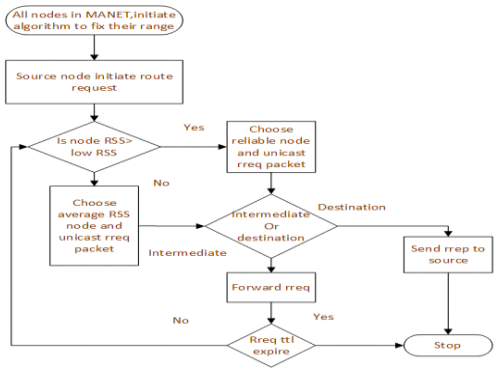

Figure 3: Algorithm to check link quality

Figure 1: shows proposed methods of C L D implementation and Figure 2 is about inclusion of header RSS field in AODV header files. Figure 3 shows how CLD-AODV will select route already in different scenario it was implemented.

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

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Algorithm 2: CLD-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 is normal A O D V route discovery and algorithm 2 is for advanced route discovery using RSS value and interacting in OSI by cross layer interaction. These algorithms are focused to resolve issues of link breaks in A O D V to form strong route.

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 device x and y in given 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,

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

Duration of Path (D P): For a path (m_1, m_2, m_q), with q devices, at time t1, path duration of path can be defined as the length of the largest time interval $[t_1, t_2]$, in which every of the q 1 lines between the devices are 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,

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

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 utilized for transferring 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 real data get transferred takes place at highest rate, t_{repair} be the time required to repair path after braking of path every time, 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. SIMULATION RESULT

In this paper NS 2 and NS 3 simulators are used for execution of proposed algorithms. Network simulator 2 (NS2) is an open source event based simulators specifically. Designed for research and its working model can be understood from Figure 5. [30]. NS 3 is advanced simulator and its working Model explained in Figure 6.

Simulation Scenario:

Parameter	CLD-AODV
Simulator	NS 2.35
Speed	10-40m/s
Packet Size	512 bytes
Packet Rate	4 packets/s
Simulation Area	1000*1000
Max Propagation Range	250 m
Receiver Sensitivity (Low RSS)	-90 dBm
MAC Protocol	IEEE 802.11
Routing Protocol	CLD-AODV, AODV
Traffic Type	CBR
Simulation Time	10 s
Channel Propagation Model	Two Ray Model
Mobility	Random
Transport Layer Protocol	UDP
Antenna	Omni antenna
Nodes	50-200
Initial energy	10 J

Table 3: Simulation Scenario

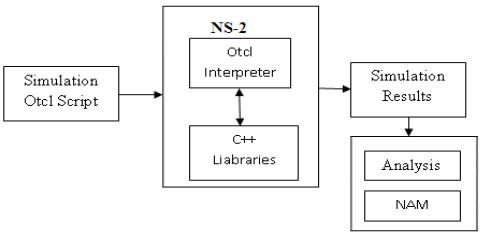

Figure 4: NS 2 working Model

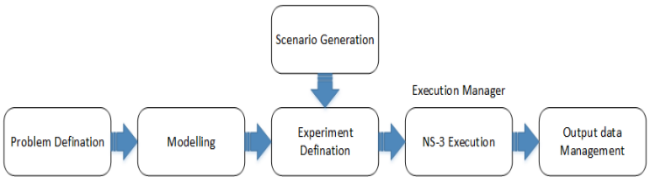

Figure 5: NS 3 working Model

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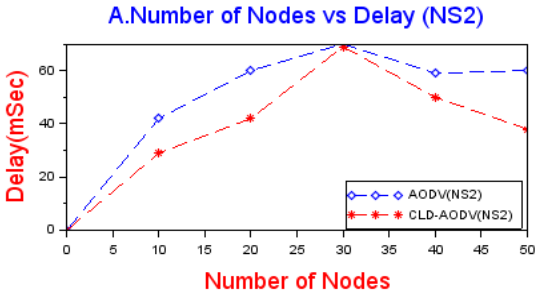


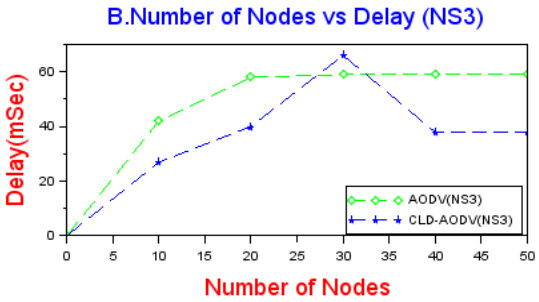
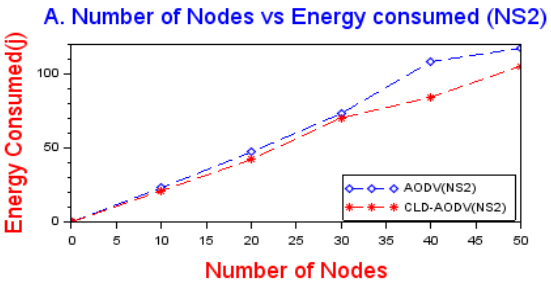


Figure 6: Number of node vs Delay



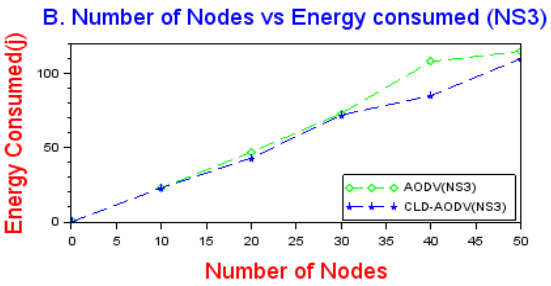
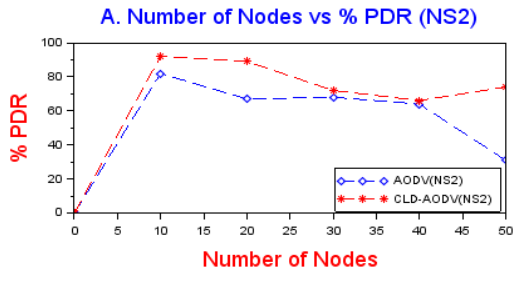


Figure 7: Number of node vs energy consumed



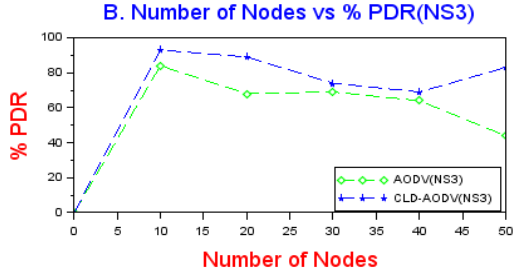
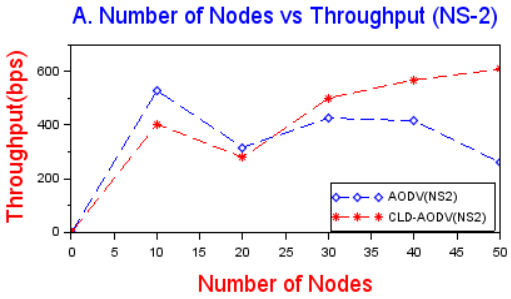


Figure 8: Number of node vs % PDR



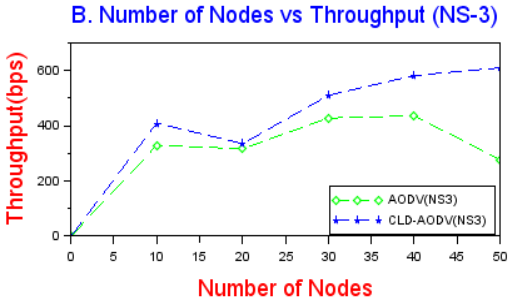
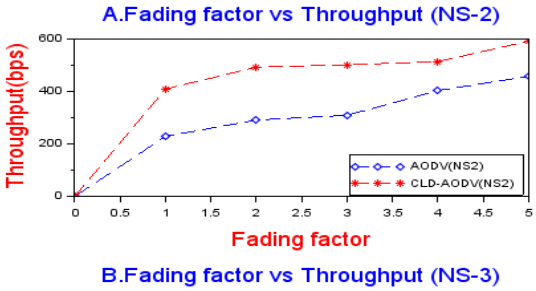


Figure 9 : Number of node vs throughput



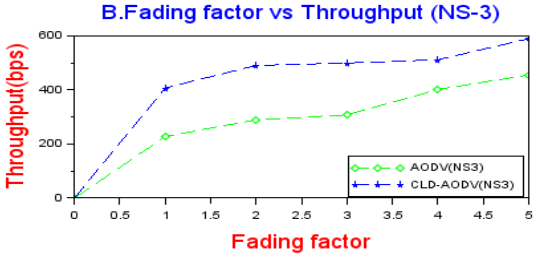
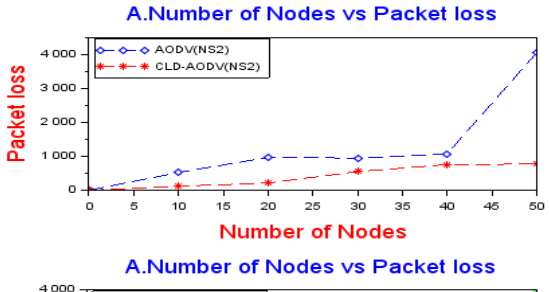


Figure 10 : Fading factor vs Throughput



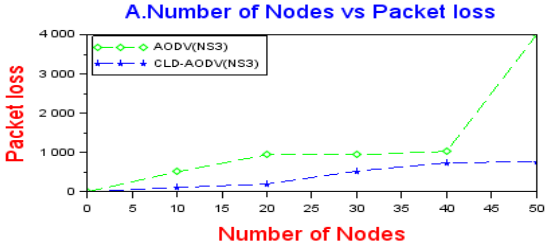


Figure 11 : Number of nodes vs Packet loss

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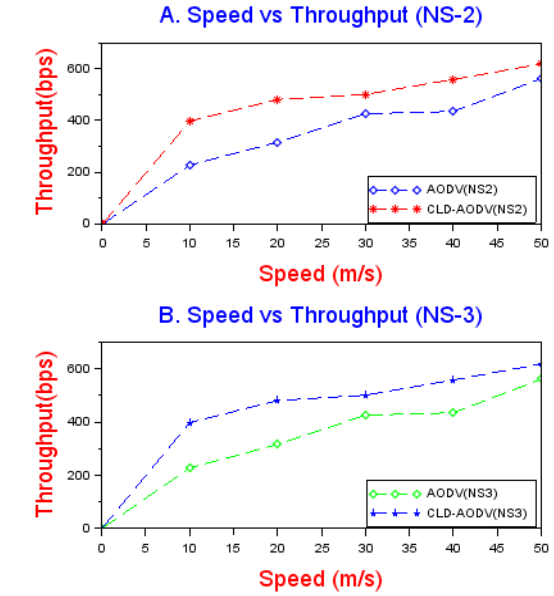

Figure 12: Speed vs Throughput

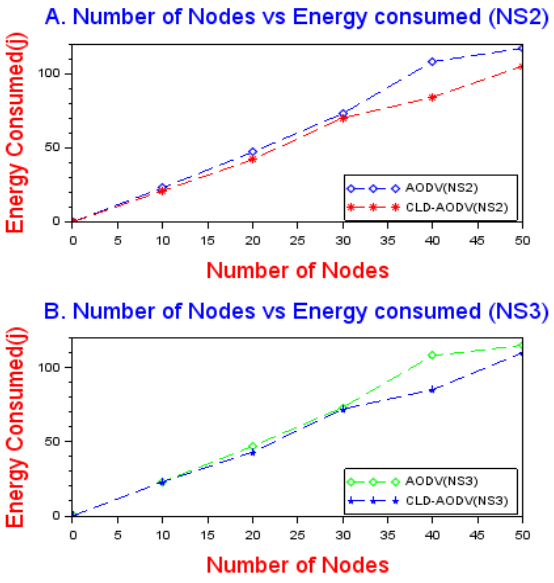

Figure **7**

Network Simulator 3 (NS 3)[31] is the model of evolution for a networked system through discrete events in time. Used for experimentation in research purpose.

Result Discussion:

Figure 6 illustrated response of node variation with network size. Similarly Figure 7 shows energy consumed with network size variation in both simulators. In first part of Figure 9 graph are plotted between number of node vs throughput. NS 2 and NS 3 output are considered in same graph. Firstly, network size variation for throughput under the basic AODV, then cross layer implemented AODV (CLD-AODV) is considered. The Second part of graph in **Figure 9** is plotted for speed variation and its effect on throughput of the system. Speed is varied from 10 m/s to 50 m/s. This proposed method also simulated in both simulators. As observe from **Figure 9** output are approximately same for each algorithm in NS2 and NS3. But the performance of CLD AODV is higher than AODV.

Packet delivery ratio is also one of the important metric in wireless network. Node variation is plotted with %PDR for both simulators in Figure 8 . CLD AODV for both simulator shows better result as compared to normal AODV process flow. NS 3 results are more accurate as compared to NS 2 simulator. But it is also observed from above graph that as number of nodes increases the %PDR decrease in the network and main reason is the congestion in network.

Packet loss in the network are due to more link failure therefore this method is proposed to overcome this problem. In above Figure 11 node variation is considered for packet loss. CLD-AODV shows low data packet loss as compared to AODV in both simulators. Both simulators show approximately same result there for overlapping in the graph. But packet loss increases as number of node increases as shown in above Figure 11**.** Fading is occurring in wireless network due obstructions in path of communication. It is vital factor for evaluating the performance of the network in real time network scenario. Here variation of fading factor is plotted with throughput parameter as shown in Figure 10 .

NS 2 and NS 3 shows same output for CLD AODV as compared to AODV hence the graph is overlapping. But the overall performance of CLD AODV is better than AODV under variable fading factor. As fading factor increases throughput also increases in both simulators. Energy consumed in a network plotted in Figure 5, variation of speed with throughput is plotted in Figure 12 which also shows improved results.

VI. CONCLUSION

In this paper algorithm is designed under AODV for MANE T using CLD approaches. The CLD AODV, is the algorithm which can be used in normal network size and conditions. CLD implementation in route formation of AODV helps to reduce number of link breaks in the network. Now, premeditated algorithms are scripted and simulated in network simulators and output performance is ascertained in terms of metrics such as throughput, %PDR, packet loss and delays. As compared to AODV, CLD AODV shows performance improvement in terms of throughput improved by 10%, %PDR improved by 7%, and reduction in packet loss and delay. 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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