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Study and Analysis of AODV and DSDV Routing Protocol in MANET and Modifications in AODV against Black Hole Attack

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Abstract - MANET stands for Mobile ad hoc network and is an infrastructure-less network and it is having ability to configure itself. The topology of network changes dynamically. It consists of wireless mobile nodes which communicate with each other without any centralized administration. In MANET different types of routing protocols are introduced. These protocols can be categorized into reactive, proactive and hybrid routing protocols. In this paper, AODV and DSDV protocols are analyzed in terms of routing overhead, packet delivery ratio, throughput and end to end delay. The performance of AODV is better than DSDV in terms of throughput, packet delivery ratio and routing overhead. As the DSDV is a proactive routing protocol, it is having a less end to end delay as compare to AODV. The performance of AODV gets affected by black hole attack. This paper gives the modification in AODV which helps to improve the performance of AODV in presence of black hole attack.

Keywords – Black Hole Attack, MANET, AODV, DSDV.

I. INTRODUCTION

MANET consists of dynamically establishing mobile nodes having short-lived networks in the absence of fixed infrastructure. Each mobile node is equipped with wireless transmitter and a receiver with an appropriate antenna. These mobile nodes are connected to other nodes by wireless links and they act as routers for all other mobile nodes in network. Nodes in mobile ad hoc networks are free to move in the network and they can organize themselves in an arbitrary manner. These features make MANETs very practical and its deployment is easy in places where existing infrastructure is not capable enough to allow communication, for instance, in disaster zones, or infeasible to deploy locations. MANETs are the short term temporary spontaneously wireless networks of mobile nodes communicating with each other without intervention of any fixed infrastructure or central control. It is an autonomous system of mobile nodes, mobile terminals, or mobile stations serving as routers interconnected by wireless links. The nodes move or adjust their transmission and reception parameters as MANET topology may change from time to time.

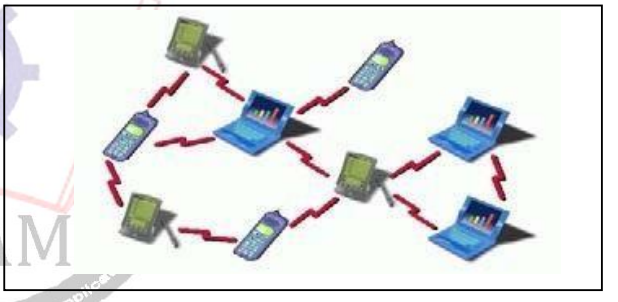

Fig. 1. Mobile ad-hoc network

II. ROUTING PROTOCOLS

An ad-hoc routing protocol controls the routing of packet in MANET. In MANET, initially nodes are not aware of topology of network, they need to discover that. An ad-hoc routing protocol can be classified in reactive (on-demand), proactive (table- driven) protocol, hybrid protocol.

Proactive (table-driven) Routing Protocol

The proactive routing is table-driven routing protocol. In this routing protocol, routing information is broadcasted by mobile nodes to the neighbors. Each node needs to keep their routing table which contains the information of neighborhood nodes, reachable nodes and the number of hops. In other words, all of the nodes have to find their nodes in the neighborhood

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as there is change in network topology. Therefore, the disadvantage of this protocol is when size of network increases, then overhead increases. The most familiar proactive type is destination sequenced distance vector (DSDV) routing protocol.

Destination-Sequenced Distance-Vector (DSDV) Protocol

Destination-Sequenced Distance-Vector (DSDV) Protocols i.e. Table-driven DSDV protocol which is a modification in the Distributed Bellman-Ford (DBF) Algorithm which was used successfully in many of the dynamic packet switched networks. In case of DSDV, every node in the mobile network is required to send a sequence number, which is periodically increased by two and it is transmitted along with other routing update messages to all other neighboring nodes.[8]

Reactive (on-demand) routing protocol

This type of protocol finds routes by using the route request packet. It is a bandwidth efficient on-demand routing protocol for Mobile Ad-Hoc Networks. The protocol deals with two main functions of Route Discovery and Route Maintenance. The discovery of new route is decided by Route Discovery function and the detection of link breaks and repair of an existing route is decided by Route Maintenance function. Reactive or on-demand routing protocols route is discovered when required. Distribution of information is not required in reactive protocols. One of the reactive protocols is AODV. These protocols do not maintain permanent route table. Instead, routes are built by the source on demand.

Ad Hoc On-demand Distance Vector Routing (AODV) protocol

AODV is Ad-hoc On-Demand Distance Vector Routing protocol. In AODV, route establishment takes place only when there is a demand for new route. AODV is capable of unicast, broadcast and multicast routing. AODV is able to react quickly to the changes in the network topology and it updates only the hosts that may be affected by the changes in the network by using the RREQ message. The RREQ and RREP messages are responsible for the route discovery. [7]

1. Black Hole Attack

A Black Hole Attack is a malicious node waits for neighboring nodes to send RREQ messages. When it receives, it replies to them blindly RREQ as if it is the shortest route to the destination. When the data is actually start transferring it absorbs all the packets actually send to the destination. Black Holes are difficult to find if they start using sequence number comparable to the current sequence number of networks.

2. Modifications in AODV in case of black hole attack

Working with single black hole attack

Step 1: Suppose S is a source and D is destination and S wants to send data to D.

Step 2: When S wants to send data to destination then it will send request to destination. If that node is a valid destination then it will send reply to the source.

Step 3: RTRPLYN (Route Reply Node) is the intermediate node between source and destination. Then it will send verify packet to destination node.

Step 4: When S receives RTRPLY (Route Reply), then it will send a CHECKVRF (Check Verification) packet to D via a path suggested by RTRPLYN.

Step 5: When D gets VERIFY packet from intermediate node, it stores its contents in a table to prepare Final reply.

Step 6: When D receives CHECKVRF packet from S, it checks in table if it got any VERIFY packet with matching source ID.

Step 7: If it matches, it sends a FINALREPLY packet.

Step 8: In case of black hole, FINALREPLY packet will not reached the source because VERIFY and CHECKVRF packets are not forwarded to the destination node.

Working with collaborative black hole attack

In case of collaborative black hole, suppose node 5 and 6 are black holes working in collaboration that is node 5 will send data packets received by it to the next node that is node 6 and node 6 will drop all these data packets. In this case, same procedure is used as it is dropping all packets and not allowing to pass to destination then there is no VERIFY and CHECKVRF is received by destination node and hence FINALREPLY is not generated.

Hence those nodes will mark as black holes working in collaboration and routing table is updated. Hence packets are transmitted to destination via intermediate

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nodes except node 5 and node 6. .

3. Performance Analysis of Routing Protocols

Simulation parameters for AODV, DSDV Routing Protocol

This analysis includes the simulation of 10, 30, 40, 50, 60, 70, 80, 90, 100 nodes. Total simulation time is 150 sec. i.e. time between the starting of simulation and ending of the simulation. Traffic type is Constant Bit Rate.

Performance Metrics

1. Packet Delivery Ratio (PDR) – It is a ratio of number of packets received by destination to number of packet sent by source.
2. End to end Delay- End to end delay (seconds) is the time it takes a data packet to reach the destination.
3. Throughput - The rate of successfully transmitted data per second in the network during the simulation.
4. Routing Overhead- Routing overhead is the total number of routing packets divided by total number of delivered data packets.

RH=Total no of routing packets/Total no of delivered data packets.

Comparison of AODV and DSDV routing Protocol

Packet Delivery Ratio and Throughput

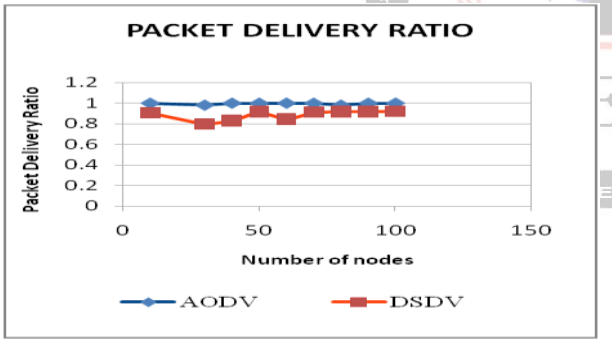

Fig. 3. a) Packet delivery ratio

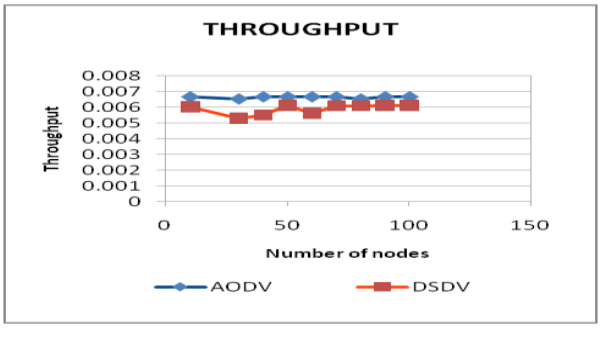

Fig 3 b) throughput of AODV and DSDV

Packet delivery ratio is the ratio of number of packets sent and received. As in case of AODV, destination receives almost all packets send by source. The packet delivery ratio of AODV is between 0.980403-1.00. The packet delivery ratio of DSDV is between 0.79651-0.917584. Hence AODV is having better packet delivery ratio as compare to DSDV.As throughput depends on time and as DSDV is the table driven protocol, it requires extra time to set up routing tables before delivering packets to the next node. Its throughput becomes less than that of AODV. The throughput of AODV is between 0.006536-0.006668 and the throughput of DSDV is between 0.005311-0.006118.Hence, throughput of AODV is better than DSDV.

End to End Delay and Routing Overhead

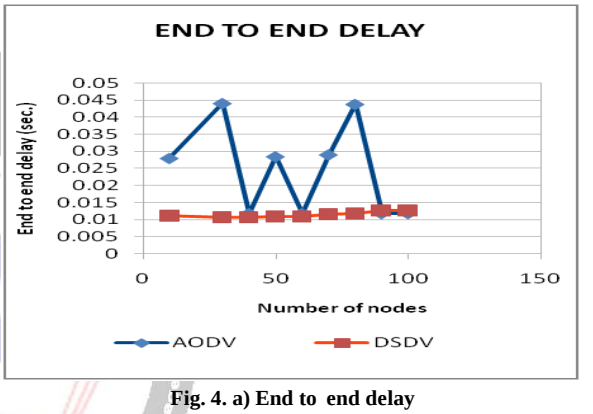

Fig. 4. a) End to end delay

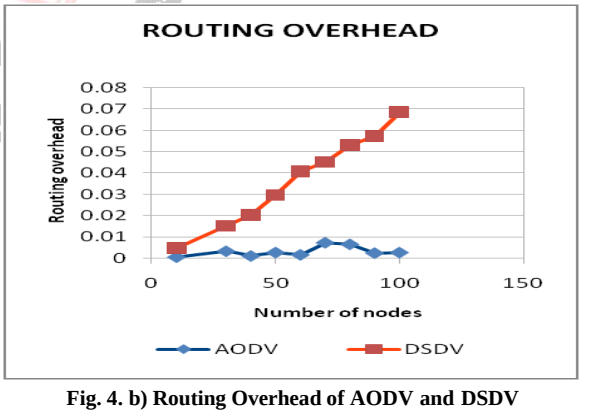

Fig. 4. b) Routing Overhead of AODV and DSDV

As the routing tables are stored in the table-driven protocols, DSDV could avoid the long set up time caused by changes of the network topology. End to end delay of DSDV is less than AODV. End to end delay of AODV is between 0.011701-0.044079 and end to end delay of DSDV is between 0.01068-0.012614.DSDV keep routing tables to deliver packets, and hence it sets up the new routes when

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there is a change in the network topology. On the other hand, AODV is the on-demand protocols, and it has to initiate the routing discovery mechanism whenever a new route is to be established. AODV delivers required packets on demand of communication between the nodes. And hence it reduces the network pressure caused by the heavy overload. DSDV is more likely to cause the heavy overload and congestion problems. Routing Overhead of AODV is between 0.000536 - 0.007216 and that of is DSDV is between 0.004697-0.068614 as it increases with number of nodes. As from the above analysis, the performance of AODV is better as compared to DSDV. But it is affected by black hole attack which absorbs the data packets send by source as it pretends it is a destination or it is having route to the destination. Hence in case of black hole attack, packet delivery ratio and throughput becomes zero. Hence to avoid that modifications in AODV can be done.

Comparison of AODV and Modifications in AODV
Packet Delivery Ratio and Throughput

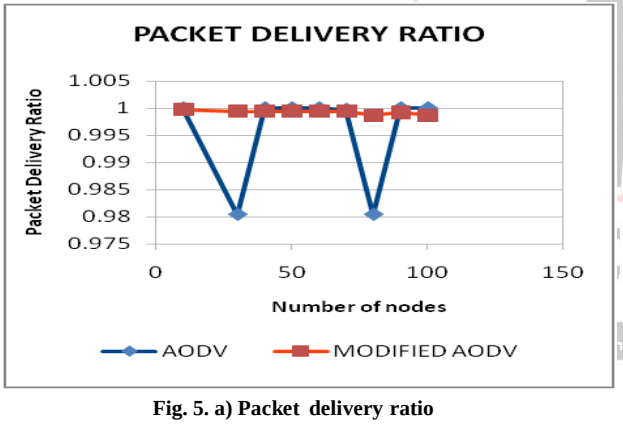

Fig. 5. a) Packet delivery ratio

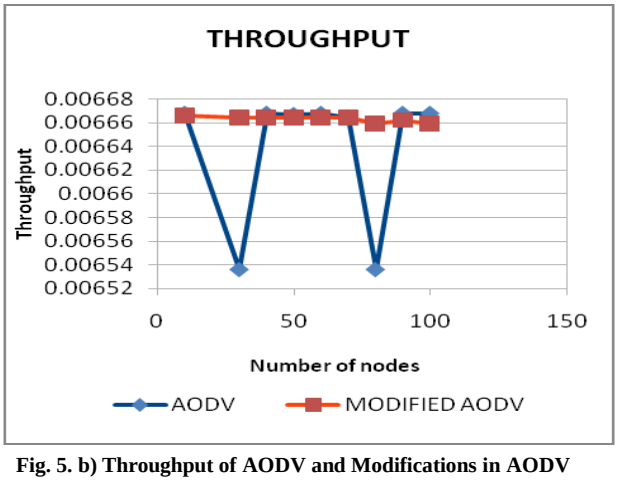

Fig. 5. b) Throughput of AODV and Modifications in AODV

End to End Delay and Routing Overhead

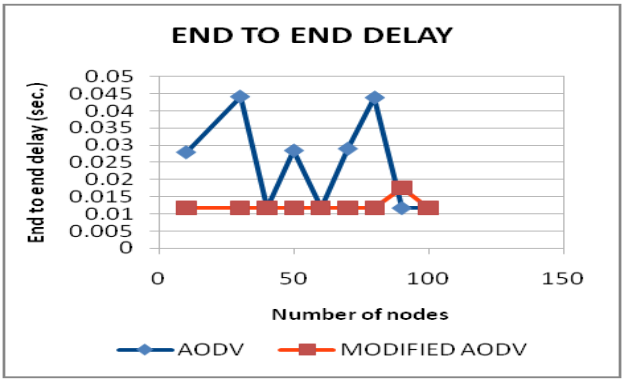

Fig. 6.a) End to end delay

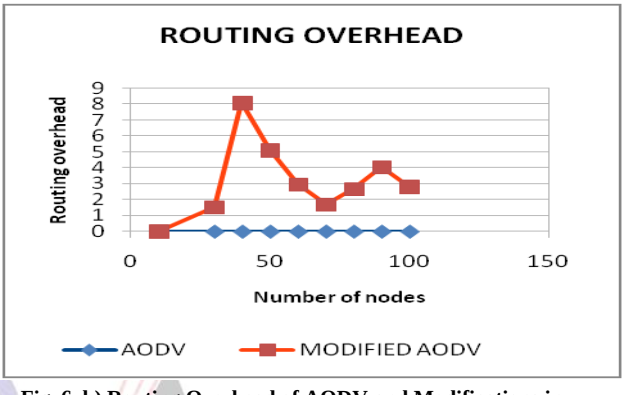

Fig. 6. b) Routing Overhead of AODV and Modifications in AODV

Modified AODV helps to improve the parameters in case of black hole attack. As during black hole, the performance of AODV degraded which gives zero throughput and packet delivery ratio. But modified AODV gives the better results which are close to AODV without black hole attack.

Comparison of AODV and Modifications in AODV with single and collaborative black hole attack
Packet Delivery Ratio and Throughput

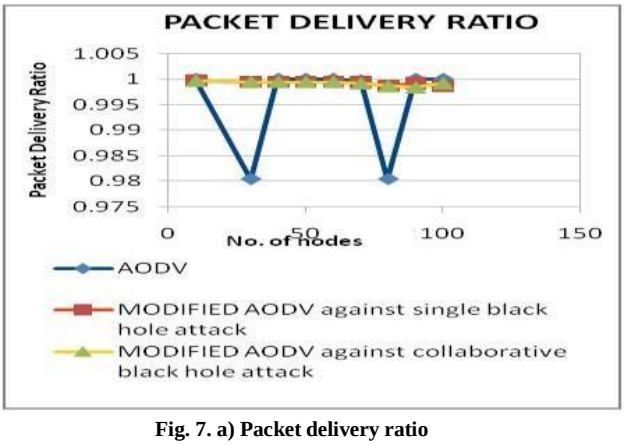

Fig. 7. a) Packet delivery ratio

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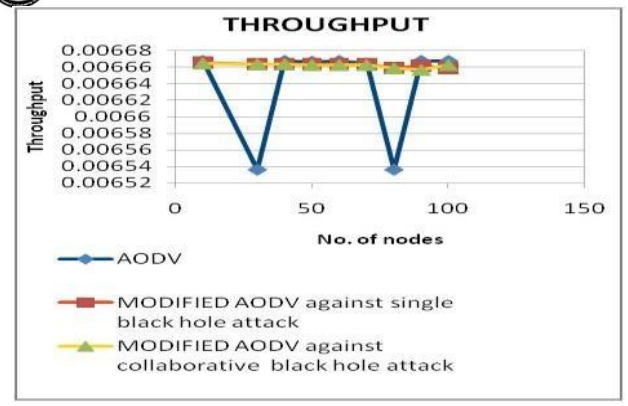

Fig. 7. b) Throughput of AODV, Modifications in AODV with single and collaborative black hole attack

End to End Delay and Routing Overhead

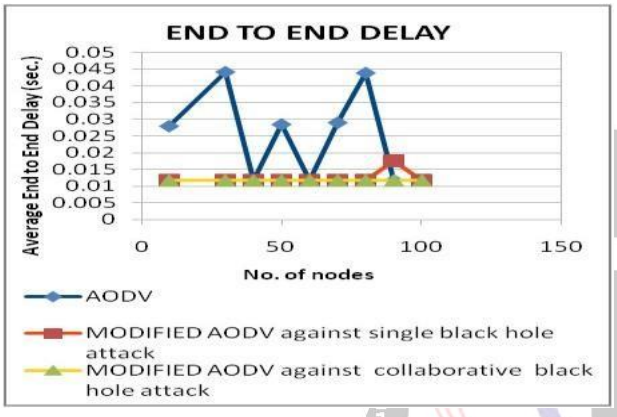

Fig. 8. a) End to end delay

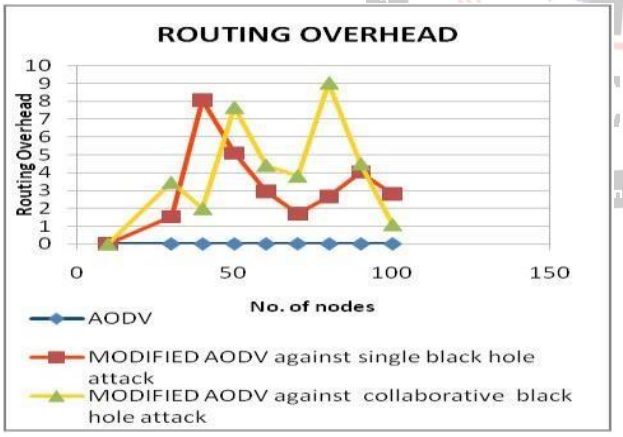

Fig. 8. b) Routing Overhead of AODV, Modifications in AODV with single and collaborative black hole attack

Above figures show the comparison of modified AODV with single and collaborative black hole attack. As in the modified AODV there are packets are added in the routing as VERIFY, RTRPLY, CHECKVRF, FINALREPLY along with RREP and RREQ, therefore routing overhead is more as compare to AODV.

Result Table

Table.01 comparison of AODV and DSDV in terms of PDR, throughput

NO. OF NODES	PACKET DELIVERY RATIO		THROUGHPUT	
	AODV	DSDV	AODV	DSDV
10	1	0.904966	0.006668	0.006034
30	0.980403	0.79651	0.006536	0.005311
40	1	0.826577	0.006668	0.005512
50	1	0.914631	0.006667	0.006099
60	1	0.840805	0.006668	0.005607
70	0.999732	0.913557	0.006665	0.006092
80	0.980403	0.914094	0.006536	0.006095
90	1	0.914899	0.006668	0.006101
100	1	0.917584	0.006668	0.006118

Table.02 comparison of AODV and DSDV in terms of end to end delay and routing overhead

NO. OF NODES	END TO END DELAY		ROUTING OVERHEAD	
	AODV	DSDV	AODV	DSDV
10	0.027915	0.011007	0.000536	0.004697
30	0.044079	0.010753	0.003281	0.015131
40	0.011683	0.01068	0.001071	0.02025
50	0.028415	0.01095	0.002669	0.029603
60	0.011688	0.010876	0.001605	0.040687
70	0.028964	0.011522	0.007216	0.045177
80	0.043806	0.011748	0.00647	0.053088
90	0.011703	0.012568	0.002403	0.057351
100	0.011701	0.012614	0.002669	0.068614

Table.03 comparison of AODV and modifications in AODV in terms of PDR, throughput

NO. OF NODES	ACKET DELIVERY RATIO		THROUGHPUT	
	AODV	Modifications in AODV	AODV	Modifications in AODV
10	1	0.999732	0.00668	0.006665
30	0.980403	0.999463	0.006536	0.006664
40	1	0.999463	0.006668	0.006664
50	1	0.999463	0.006667	0.006663
60	1	0.999463	0.006668	0.006663
70	0.999732	0.999195	0.006665	0.006663
80	0.980403	0.998658	0.006536	0.006659

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90	1	0.998389	0.006668	0.006657
100	1	0.999195	0.006668	0.006653

Table.04 comparison of AODV and modifications in AODV in terms of end to end delay and routing overhead

NO. OF NODES	END TO END DELAY		ROUTING OVERHEAD	
	AODV	Modifications in AODV	AODV	Modifications in AODV
10	0.027915	0.01167	0.000536	0.004584
30	0.044079	0.011668	0.003281	3.465375
40	0.011683	0.011669	0.001071	1.99703
50	0.028415	0.011671	0.002669	7.675404
60	0.011688	0.011688	0.001605	4.424132
70	0.028964	0.011669	0.007216	3.823699
80	0.043806	0.011674	0.00647	9.047757
90	0.011703	0.011672	0.002403	4.508007
100	0.011701	0.011669	0.002669	1.097891

III. CONCLUSION

MANET is a collection of mobile nodes, dynamically establishing short-lived networks in the absence of fixed infrastructure. This paper compares of AODV and DSDV routing protocols which are proposed for ad-hoc mobile networks.

In DSDV routing protocol, mobile nodes periodically broadcast their routing information to the neighbors. Each node requires to maintain their routing table. AODV protocol finds routes by using the route request packet and route is discovered when needed. The comparison of these protocols is done with the parameters packet delivery ratio, throughput, end to end delay, routing overhead. AODV performs better than DSDV in packet delivery ratio, throughput and routing overhead. The delay of AODV is more than DSDV.

The performance of AODV gets affected by black hole attack. It reduces the packet delivery ratio and throughput to zero and hence modifications are done in AODV which gives better results even in the presence of black hole attack. Packet delivery ratio and throughput in case of AODV and AODV after modifications are same. But for modifications, new packets are added in routing and hence routing overhead is more as compare to AODV without modification.

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