Traffic Based Analysis of Efficient & Dynamic Probabilistic Broadcasting Algorithm in MANETs Routing Protocols

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Abstract

A mobile adhoc network is a collection of autonomous mobile nodes that that communicate with each other over wireless links. Hosts need to specify the requirements of the neighbors for efficient routing outside their transmission range. However, since there is no stationary infrastructure such as base stations, each host has to act as a router in itself and hence, a routing protocol runs on every host and is therefore subject to the limit of the resources at each mobile host. This paper proposes a new Efficient and dynamic probabilistic broadcasting (EDPB) approach, which solves the broadcast storm problem of AODV. Global Mobile Simulator is used to run simulations. The main performance metrics considered in simulations are routing overhead and end-to-end delays. The results show that, the normalized routing load is reduced to around 35% to 40% compared with AODV-blind flooding and AODV-fixed probability model, at a very heavy traffic load, when used with AODV-EDPB. The results show that AODV-EDPB algorithm performs better than AODV-blind flooding and AODV- fixed probability in terms of packet delivery ratio, end-to-end delay etc. especially in dense networks.

Keywords

MANET, GloMoSim, AODV, flooding, broadcast.

1. INTRODUCTION

An adhoc wireless network is a collection of two or more devices which are equipped with wireless communication and networking capability which can communicate within their radio transmission range. Adhoc networks can be categorized in two ways i.e fixed and mobile adhoc networks. MANETs are self-organizing i.e. nodes in the network move randomly with dynamic topologies and are autonomous in nature. In fixed adhoc networks are also called infrastructure mobile networks, in which all the nodes in the network are connected to base stations within their radio range. Multihop routing technique is implemented in MANETs and every node in mobile ad hoc networks act as a router. All on-demand MANETs routing protocols implement a simple abd generic form of broadcasting known as flooding to find out the routes and whenever a source has data to send to a destination, but does not have the route to the same, it will initiate a route-query process. In blind flooding, technique, the source node broadcasts a Route Request Query packet to its neighbors. Each node broadcast this RREQ packet exactly once if it is found for the first time and the destination node receives the this packets along several different paths, chooses the best route as per the to the route selection policies of the particular routing protocol and notifies the source node about the route selected through a

Route-Reply packet. In broadcasting process, a source node sends a message to all other nodes in the mobile adhoc network. Many routing protocols and applications are operated based on broadcast, such as AODV, DSR routing protocols, and data dissemination to all nodes in network. Therefore, a robust and efficient broadcasting algorithm is necessary in an ad hoc network environment. Flooding technique delivers the data to every node in the network but the topological information needs to be maintained or known in advance. In networks, where node mobility is so high that a given unicast routing protocol may fail to keep up with the rate of topology changes, flooding may become the good alternative for routing data. However, in other scenarios where node mobility is tractable by a routing protocol, flooding can be a inefficient option because the total number of transmissions to deliver a single message to a destination.is N (network size), and in blind flooding, a node transmits a packet, which is received by all neighbor nodes that are within the radio transmission range. Upon receiving the broadcast packet, each node determines if it has transmitted the packet before. If not, then the packet is retransmitted. This process allows for a broadcast packet to be disseminated through the adhoc network. Blind flooding automatically stops when all nodes have received and transmitted the packet being sent at least once. As all the nodes participate in the broadcast, blind flooding suffers from broadcast storm problem, which leads to redundant rebroadcasts, contention and packet collision.

The simplest and most trivial broadcasting algorithm is pure flooding. Every node that receives the broadcast message retransmits it to all its neighbors. The problem of pure flooding is that it produces many redundant messages, which may consume scarce radio and energy resources, and cause collision that is called broadcast storm problem. Therefore, the basic principle of designing an efficient and resource conservative broadcast algorithm is trying to reduce the redundant messages, which means to inhibit some nodes from rebroadcasting and the message can still be disseminated to all nodes in the network. Broadcasting is important in MANETs for routing information discovery, for instance, protocols such as dynamic source routing (DSR), Adhoc on demand distance vector (AODV) , zone routing protocol (ZRP) and location aided routing (LAR) use broadcasting to establish routes. The techniques for efficient broadcasting can be grouped into four families' e.g. simple flooding method, probability-based methods, area-based methods and the neighbor knowledge-based methods. In simple flooding [5], source node initiates flooding by broadcasting a packet to all its neighbors and in turn, neighbor nodes rebroadcast the packet exactly once and the process continues until each node in the network has retransmitted the packet. Finally, all the nodes reachable from the source receive the packet. But, flooding causes broadcast storm problem. In probability-based methods [6], each node is assigned a probability for retransmission depending upon the topology of the network. A common range is assumed in area based technique, wherein, a node will rebroadcast if only sufficient new area can be covered with the retransmission range. Each node stores neighborhood state information and uses it to decide whether to retransmit or not, in neighbor knowledge based methods [7] The main aim behind all approaches is to minimize the number of retransmission messages and the number of nodes transmitting the message.

2. RELATED STUDY

AODV does not maintain the topological information about the whole network and constructs a route when it is required. When a source node needs a route to some destination , it broadcasts a RREQ packet to its immediate neighbors. Each neighboring node rebroadcasts the received RREQ packet only once if it has no valid route to the destination. Each intermediate node that forwards the RREQ packet creates a reverse route pointing towards the source node S. When the destination node or an intermediate node with a valid route to the destination receives this packet, it replies by sending a route reply packet. The route reply packet RREP packet is unicast towards the source node S along the reverse path set-up by the forwarded packet. Each intermediate node that participates in forwarding the RREP packet creates a forward route pointing towards the destination.

Zhang and Agrawal [12] proposed a probabilistic scheme for AODV route discovery process, where the probability to forward an RREQ packet is determine by the number of duplicate RREQ packets received at a node. Because some packets may be lost due to collisions, the number of duplicate packets at the receiver, is not a good criterion to get the local attributes of the forwarded node.

M. Bani Yassein et. al.[13], proposed an a adaptive routing algorithm based on probabilistic approach in which different medium are used for flooding based on number of average number of neighbors nodes multiple criteria i.e. high, medium and low. These values are set according to the local neighbors' information.

Qi.Zhang and Dharma [14] have implemented approach that uses the concept of gossip, but the construct minimal dominating set is not required. Instead of that, categorizes mobile hosts into four groups according to their neighborhood information. For each group, there is a specified value of probability so the nodes with more neighbors are given higher probability, while the nodes with less neighbors are given lower probability of forwarding the route request packets. Probabilistic routing approaches [10] [11] have been proposed to help control the forwarding of the routing controls packets.

Cartigny and Simplot [15] proposed an technique which combines the advantages of both probability based and distance based schemes for retransmitting the route requests by neighbor nodes which are in the border transmission range of sender nodes. The value of probability is determined by the information collected from the nods neighbors.

3. PROPOSED MODEL (EDPB SCHEME)

The probabilistic scheme is similar to ordinary flooding, except that the nodes only rebroadcast with a predetermined probability. In dense network, it is much likely that multiple nodes share similar transmission coverage. Thus, having some random nodes not to rebroadcast saves network resources without harming packet delivery effectiveness. In sparse network, there is much less shared network coverage and, therefore, not all nodes will receive all the broadcast packets with this scheme unless the probability parameter is high and when the probability is 100%, this scheme is identical to ordinary flooding scheme. The proposed algorithm is a combination of the probability based schemes and knowledge based schemes and automatically adjusts the re- broadcast probability at each mobile node according to the value of the immediate number of neighbors in its transmission range.

The value of probability changes when the host node moves to a different location in the neighborhood. The rebroadcast probability is higher in sparse networks as compared to denser networks. EDPB algorithm achieves higher saved rebroadcast as compared with the probabilistic approach where probability is fixed and in this scheme, the node rebroadcasts a message according to a high probability if the message is received for the first time, and the number of neighbors of node A is less than average number of neighbours on hearing a broadcast message m at node A, and if node A has a low degree, retransmission will be done accordingly, otherwise, if A has a high degree and its rebroadcast probability is set at low. In probabilistic scheme, a node rebroadcasts the message with a fixed probability so that every node has the same probability to rebroadcast the message, when receiving a broadcast message for the first time. In dense networks, multiple nodes share similar transmission ranges.

These probabilities control the frequency of rebroadcasts requests and thus save network resources. In sparse networks, there is much less shared coverage, thus some nodes will not receive all the broadcast packets unless the probability is high. So if the rebroadcast probability is set to a far smaller value. On the other hand, if probability is set to a far larger value, many duplicate rebroadcast packets will be generated which arises the need for automatic adjustment.

To select the value of probability p, the average neighbor number is analyzed. Let X be the area of the adhoc network, N is the total no. of mobile nodes in the network and R is the radio transmission range then, average number of nodes (n bar) can be computed from the formula n bar = $(n-1)(p)(\pi r^2)/X$. The value of fixed probability that used in AODV-FP is set at p= 0.8. It has been shown that this probability value enable fixed probabilistic flooding to achieve a good performance. The brief outline of the proposed algorithm is shown in figure1. The rebroadcast probability is set high at the hosts in sparser areas where number of neighbor nodes is less and low at the hosts in denser areas where the number of nodes is high. This scheme for density based rebroadcasting implementation analysis requires mobile hosts which periodically exchange "HELLO" messages between neighbors to and construct a one hop neighbor list in routing table at each host. A high number of neighbours imply that the host is in a dense area and a low number of neighbors imply that the host is situated in a sparser area.

On hearing a broadcast packet m at node A
Get the broadcast ID from the message: n bar, average number of neighbor(threshold)
Get degree n of node X (no. of neighbors of node X)
If packet m received for the first time then
If n<n bar then
Node X has a low degree
Set high rebroadcast probability p=p1;
Else
n>=n bar
Node A has a high degree
Set low rebroadcast probability p=p2;
Endif
Endif
Generate a random number RN over [0,1]
If RN <= p
then rebroadcast the received message;
else
drop the message
endif

Figure 1. EDPB algorithm

4. SIMULATION MODEL

GloMoSim is used as the simulation tool. Performance evaluation of the protocols is done on parameters such as routing overhead and end-to-end delay in different network density, normalized routing load, etc. The simulation, different mobile nodes are moving in different network area. Each node has 250 meter radio transmission range. The node mobility model used is random-waypoint model [21]. In which each node at the beginning of the simulation remains stationary for a pause time, then chooses a random destination and starts moving towards it with a speed selected from a uniform distribution range between 0 to maximum speed. The speed varies from 5 to 20 m/sec. The simulation parameters used, are as per Table 1.

Table1. Simulation Parameters

Parameter	Value
Pause time	0,10,20,40,600 sec
Number of nodes	25,50,75,100
Traffic load	5,10,15,20,25 connections
Mobility model	Random waypoint model

No. of trials	30
Data Traffic	CBR
Transmission range	250 meters
Bandwidth	2Mbps
Simulation time	1100 secs
Packet size	512 bytes
Topology size	800x800 m2
Node speed	5,10,15,20, m/sec

5. PERFORMANCE METRICS AND RESULTS ANALYSIS

AODV is already implemented in GloMoSim simulator and analysis is done and the results are obtained for AODV in which traditional blind flooding scheme of route discovery operation is followed and implemented for route rebroadcast request packets. Now, the aim is to reduce the flooding of route request packets during the rout discovery process, and as a result it reduces the broadcast storm problem and net effect is that overall network is improved by the reduced average end-to-end delay and also routing overhead.

Traffic Load Analysis: The performance of three protocols in terms of routing overhead vs. offered traffic load is shown below in figure 2. It is found that at a very heavy traffic load, the normalized routing load is reduced to 35% to 40% as compared with AODV blind flooding and AODV fixed probability scheme, at a very heavy traffic load as depicted in below mentioned figure no.3, when used with AODV-EDPB. The delays for different traffic loads is also shown in below mentined figure no.3. The packet transmission load has a direct impact on latency and if the number of packets is high, than the number of collisions is high, and in turn leads to more retransmissions. As a result, packet experiences more latency and because of higher number of duplicate route request packets of rebroadcasts, AODV-EDPB experiences lower latencies than AODV-Blind Flooding and AODV-Fixed Probability.

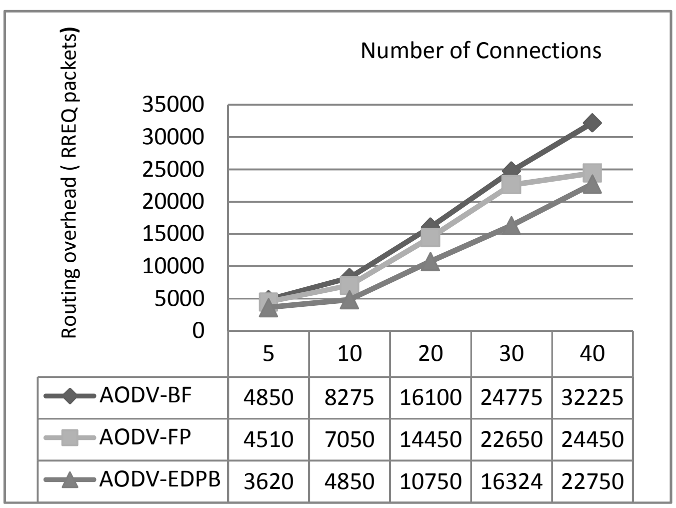
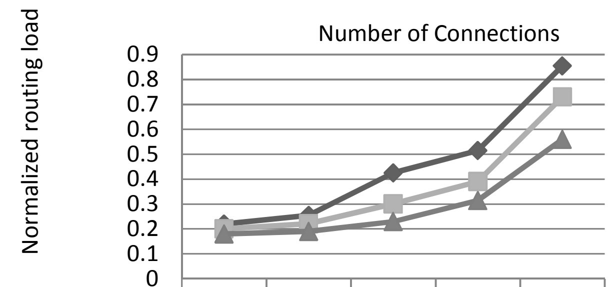
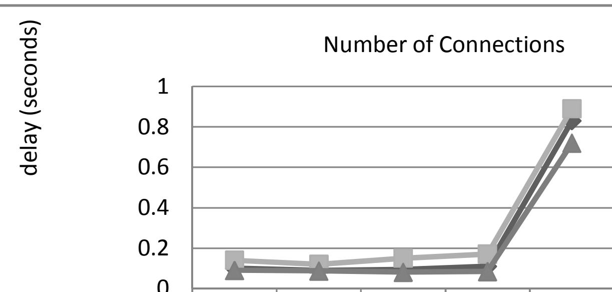


Figure 2**:** Routing Overhead vs. Traffic load (no. of Connections)



	5	10	20	30	40
AODV-BF	0.22	0.255	0.425	0.515	0.855
AODV-FP	0.2	0.22	0.3	0.39	0.73
AODV-EDPB	0.18	0.19	0.23	0.314	0.56

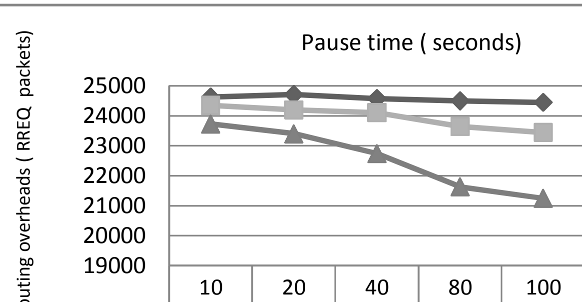
Figure 3. Routing load vs. Traffic load (no. of connections)



	5	10	20	30	40
AODV-BF	0.1	0.09	0.095	0.11	0.83
AODV-FP	0.14	0.12	0.15	0.17	0.89
AODV-EDPB	0.09	0.087	0.081	0.084	0.72

Figure 4. Delay vs. Traffic load (No. of Connections)

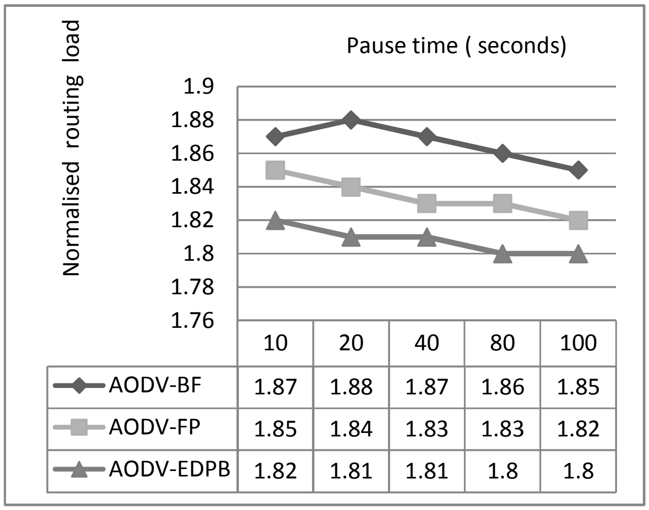
Network pause time load analysis: The results in figure 5 show the routing overhead generated by three protocols when the pause time is increased from 10 to 100 sec.



	10	20	40	80	100
AODV-BF	24625	24710	24575	24500	24450
AODV-FP	24350	24200	24110	23650	23450
AODV-EDPB	23725	23400	22740	21635	21250

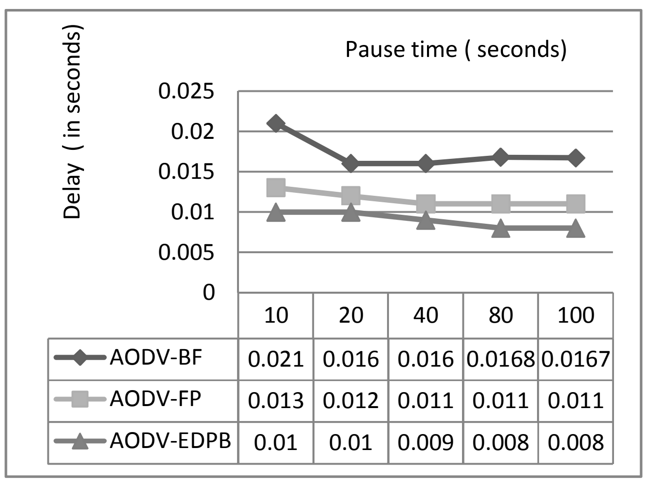
Figure 5. Routing overhead vs. pause time.

The normalized routing load generated by all the three protocols with different network pause times and the number of constant bit rate is set at 30 as shown in figure 6. The results reveal that when the network pause time is increased, the mobility of nodes is decreased which leads to decrease in normalized routing load. It shows that AODV-EDPB has better performance over the other two protocols. The delays incurred by all the three protocols for different network pause time as shown in figure 7. The longer the average pause time is, the less is the node movement within the network, and this means that the nodes look like fixed rather than mobile, so the number of generated RREQ packets will be low at network with high pause time.



	10	20	40	80	100
AODV-BF	1.87	1.88	1.87	1.86	1.85
AODV-FP	1.85	1.84	1.83	1.83	1.82
AODV-EDPB	1.82	1.81	1.81	1.8	1.8

Figure 6. Routing load vs. pause time.



	10	20	40	80	100
AODV-BF	0.021	0.016	0.016	0.0168	0.0167
AODV-FP	0.013	0.012	0.011	0.011	0.011
AODV-EDPB	0.01	0.01	0.009	0.008	0.008

Figure 7. Delay vs. pause time.

6. CONCLUSION

The simulation results show that new proposed algorithm i.e. EDPB algorithm has definitely superior performance over traditional AODV Blind flooding and AODV fixed probability versions of routing protocols and generates much lower routing overhead and end-to-end delay, as a consequence, the packet collisions and contention in the network is reduced. The proposed algorithm is a combination of the probabilistic and knowledge based approaches and automatically adjusts the rebroadcast probability at each mobile node according to the knowledge of the number of neighbours. The value of probability changes when the nodes move to a different neighborhood nodes. In a sparse regions, the rebroadcast probability is high as compared to probability in dense regions where no. of local neighbors is high. Compared with the probabilistic approach where p is fixed, EDPB algorithm achieves higher saved rebroadcast. The new proposed algorithm determines the rebroadcast probability by taking in to account the network density. The results also show that although the traffic load is increased, the normalized routing load is still low. As a continuation of this research in the future, a plan to combine the EDPB with different approaches is formulated this suggests solving the broadcast storm problem, and will analyze the effect of this improvement on the performance of DSR and other on demand routing protocols.

REFERENCES

1. K. Viswanath, and K Obraczka. “Modeling the performance of flooding in wireless multi-hop Adhoc n/w”. In Comp Comm 29, 949-956, 2006.
2. C. Perkins, E. Beldig-Royer and S. Das. “Adhoc on Demand Distance Vector (AODV) Routing”. Request for Comments 3561,July2003,http://www.ietf.org/rfc/rfc3561.txt.,RFC, 2007.
3. B. Williams and T. Camp, “Comparison of Broadcasting Techniques for Mobile Adhoc Networks”, Proc. of the 3rd ACM International Symposium on Mobile Adhoc N/W and Comp, pp. 194 – 205 (2002).
4. K. Viswanath, and K Obraczka. “Modeling the performance of flooding in wireless multi-hop Adhoc networks”. Comp Comm, 949-956, 2006.
5. G. Lim, K. Shin, S. Lee, H. Yoon and J. S. Ma, “ Link Stability and Route Lifetime in Adhoc Wireless Networks”, Proc. of International Conference on Parallel Processing Workshops, pp. 116 – 123 (2002).
6. Mohammed, M. Ould-Khaoua, L. M. Mackenzie, and J. Abdulai, "An Adjusted Counter-Based Broadcast Scheme for Mobile Adhoc Networks," in Proc. of the Tenth International Conference on Computer Modeling and Simulation, 2008, pp. 441 - 446.
7. J. Barritt, B. Malakooti, Z. Guo. Intelligent Multiple- Criteria Broadcasting in Mobile Ad-hoc Networks. In Performance and Management of Wireless and Mobile Networks, LCN, pp 761-768, 2006
8. Perkins, E. Belding-Royer, and S. Das, "Adhoc On- Demand Distance Vector (AODV) Routing," IETF Mobile Adhoc Networking Working Group INTERNET DRAFT, RFC 3561, July 2003, http://www.ietf.org/rfc/rfc3561.txt, RFC, 2007.
9. Johnson, Y. Hu, and D. Maltz, "The Dynamic Source Routing Protocol (DSR) for Mobile Adhoc Networks," IETF MANET Working Group INTERNET DRAFT, http://www.ietf.org/rfc/rfc4728.txt.
10. Sasson Y, Cavin D, Schiper A. “Probabilistic broadcast for flooding in wireless mobile Adhoc networks.” In Proc. of IEEE wireless communication and networking conference (WCNC), March 2003.
11. Dimitrios Liarokapis, Ali Shahrabi, Andreas Komninos. “DibA:An Adaptive Broadcasting Scheme in Mobile Adhoc Networks”. In Communication N/W and Services Research, CNSR, 224-231, 2009.
12. Q. Zhang and D. P. Agrawal, "Dynamic probabilistic broadcast in MANETs," J of Parallel and Dist Comp, vol. 65, pp. 220-233, 2005.
13. Bani-Yassein M, Ould-Khaoua M, Mackenzei LM, Papanastasiou S. “Performance analysis of adjusted probabilistic broadcasting in mobile Adhoc networks”. Int. J. Wireless Inform N/W, pp:127–40,2006.

14. Qi Zhang and Dharma P. Agrawal, “Analysis of Leveled probabilistic Routing in Mobile Adhoc Networks”, OBR Center for distributed and Mobile Computing, ECECS, Uniy Cincinnati incinnati, OH 45221-0030.

15. J. Cartigny, D. Simplot. “Border node retransmission based probabilistic broadcast protocols in ad-hoc networks”, Telecommunication Systems, vol. 22, no 1–4, pp. 204, 2003.

16. Y.-C. Tseng, S.-Y. Ni, E.-Y. Shih, “Adaptive approaches to relieving broadcast vol.storm in a wireless multihop mobile Adhoc network” ,IEEE Transactions on Computers, 52, no 5,2003.

17. M.B.yassin, M.Ould Khaoua, L.M.Mackenzie et. al “Improving Route Discovery in on demand routing protocol using Local Topology Information in MANETs” ACM 2006.

18. M. D. Colagrosso, "Intelligent broadcasting in mobile Adhoc networks: Three classes of adaptive protocols," EURASIP Journal on Wireless Communication and Networking, vol. 2007, pp. 16, 2007.

19. Perkins C.E. “Ad Hoc networking”, Adison Wesley, ISBN – 0-201-30976-9, 2001.

20. C-K. Toh, Ad Hoc Mobile Wireless Networks: Protocols and Systems (Prentice-Hall, New York, 2002).

21. C. Bettstetter, H. Hartenstein and P. Costa: Stochastic properties of the random-waypoint mobility model, Wireless Networks, Vol.10, no. 5, pp. 555-567 (2004).

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