# An Enhance Mechanism for PRoPHET ROUTING PROTOCOL to Achieve Qos in DTN

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T. Ahmad, S. Irfanullah, W.U. khan

***Abstract* — *In DTN Routing of network traffic is the key challenge. The main goal of routing in a network is to succeed the best performance in terms of reliability and delay with limited network resources. The Delay Tolerant Network (DTN) is a sparse network. In DTN no end-to-end connectivity exists which is mandatory for a network [1]. in this mechanism whole message is forwarded from a node storage buffer to another node storage buffer, traveling to the Destination path. In customary Network, if the source forwards a message there exists a complete link from sender to receiver, but in DTN it is not guaranteed. To fulfill the network requirements intermediary nodes are used to complete this process [2]. In this paper we make enhancement in PRoPHET Routing protocol to improve message delivery ratio and to minimize the delay of message delivery. We use cluster movement model where the coordinates are restricted to circular area defined by a central point and range. Our simulation results shows that this enhancement in PRoPHET Routing Protocol give better result than original PRoPHET Routing Protocol in the term of message delivery ratio and minimum delay.***

***Inspect Classification:  D5020***

***Keywords—Delay Tolerant Networks; Routing; Routing Protocols; PRoPHET Routing Protocol*.**

## I. INTRODUCTION

In 2003, Kevin Fall presented DTN for computer networks with limited connectivity and resources. The researcher interest in DTNs encouraged discussions about different aspects of DTNs such as security, routing, and many others. In Internet network a complete route from one node to another is necessary. When sending a message from one node to another. If a complete route does not exist, after time-to-live the message will be discarded. The Delay Tolerant Network (DTN) is a sparse network. In DTN no end-to-end connectivity exists which is mandatory for a network [1]. In this mechanism whole message is forwarded from a node storage buffer to another node storage buffer, traveling towards Target path. The PRoPHET routing scheme [4] uses the information of encountered nodes and transitivity. If node X regularly sends messages to node Y and node B regularly sends messages to node Z so node X can also send the message to node Z. The protocol used a first in first out (FIFO) queue. When a replacement message reaches to a full queue that message will ultimately wait for the longest time. The straight forward forwarding strategy utilized by PRoPHET worked fairly well and outperformed Epidemic Routing. PRoPHET is the enhanced version of Epidemic routing Scheme.

In this paper, we enhance the PRoPHET routing Protocol and Compare with original PRoPHET routing Protocol. The remaining part of paper is sectioned as following. Literature review in section 2. Our Proposed Scheme in section 3. Conclusion and Future work in section 4.

## II. LITERATURE REVIEW

### *1. Epidemic routing protocol*

Epidemic routing protocol [11] uses flooding based mechanism. In which a node sends the message to all or any node it encounters. This routing scheme is reflected the best scheme because it transmits the message on all the paths from source to destination. The drawback of Epidemic routing protocol is that it does not consider the buffer constraint when sending the message.

Each node has limited buffer, and may not be able to store all the messages and in due course will result in the reduction of delivery probability. This scheme is not energy efficient as it forwards message to all nodes without carefulness which results in energy consumption and short time span of networks.

### *2. PRoPHET Routing*

The PRoPHET routing scheme [7] uses the information of encountered nodes. If node X regularly sends messages to node Y and node B regularly sends messages to node Z so node X can also send the message to node Z. The protocol used a first in first out (FIFO) queue. When a replacement message reaches to a full queue that message will ultimately wait for the longest time.

The straight forward forwarding strategy utilized by PRoPHET worked fairly well and outperformed Epidemic Routing. PRoPHET is the enhanced version of Epidemic routing Scheme. In PRoPHET Routing Protocol [12] if node A wants to sends message to node D, but no complete path exists between node A to node D. So node A transmits message to node B, C respectively if delivery predictability value is high. Then node C forwards message to node D. after this process node B, C already save a copy of delivered message

T. Ahmad, S. Irfanullah, Dept: Department of Computing Abasyn University Peshawar Pakistan

W.U. khan, Dept: Department of Computing Abasyn University Peshawar Pakistan

in buffer.

If the TTL is expired the copies will be discarding otherwise duplicates will save in buffer. If high delivery ratio is mandatory then TTL of messages must be long. Therefore the message duplicates remain live in Node buffer for Long time. This is not needed and wastes the buffer. In PRoPHET Routing Protocol FIFO is used.

The first node does not drop the message when forward. If the buffer storage is full and new message is arrived. So it wait until the message in the queue is dropped on it TTL expired.

There are three equation of this protocol.

a. PRoPHET Routing Protocol uses history of faced nodes. So

$$P(A,B) = P(A,B)old + (1-P(A,B)old) \times Penc$$

b. Transitive Property

$$P(A, i)=P(A, i)old+(1-P(A,i)old) \times P(B,i) \times P(A,B)$$

c. Aging Property of Routing Protocol

$$P(A, i) = P(A, i)\ old \times \gamma T$$

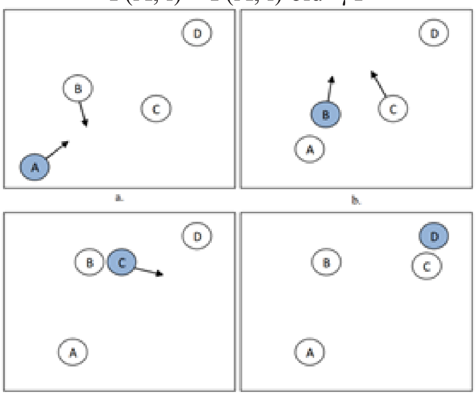


Figure 2.1: Node Encounters in PRoPHET [14]

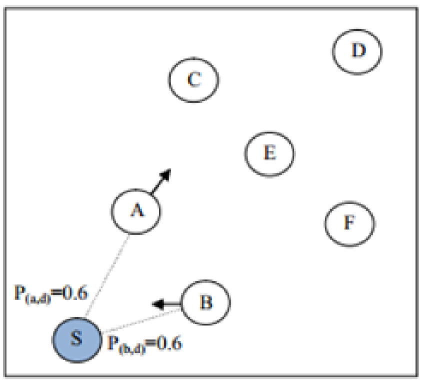


Figure 2.2: PRoPHET Draw back Scenario 1 [14]

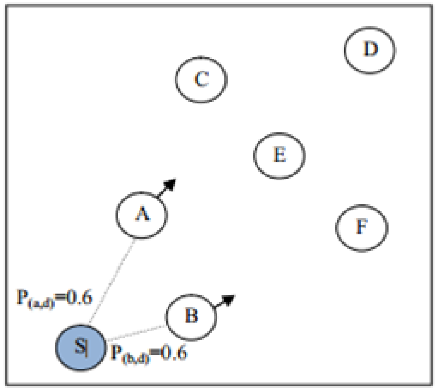


Figure 2.3: Draw back Scenario 2 [7]

In Figure 2.2 and 2.3, node A has an equal probabilistic metric value as that of node B. Hence, when these encountered nodes carry the equal metric and without distance consideration, the node S, following the traditional PRoPHET, will forward its messages to both nodes A and B. This will result resource consumption, leading to message spread and duplication over the network [14].

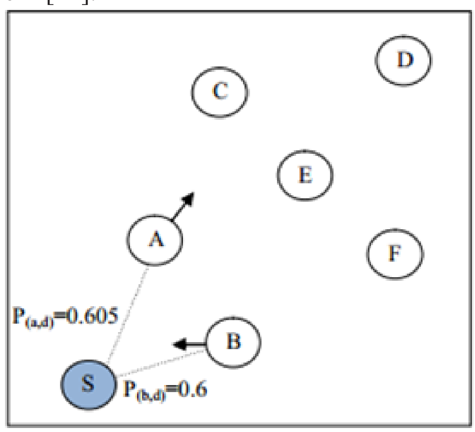


Figure 2.4: Draw back Scenario 3 [14]

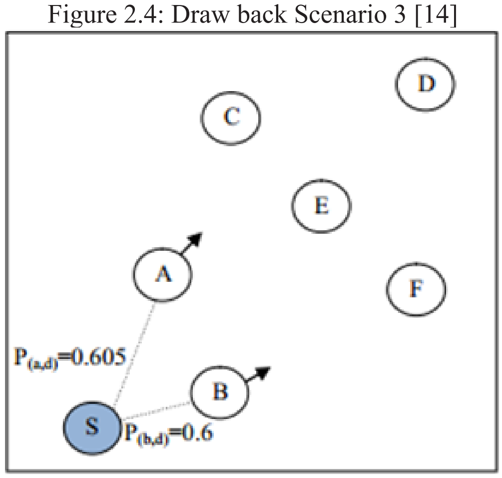


Figure 2.5: Draw back Scenario 4 [14]

Similarly, Fig2.4 and 2.5 illustrate that node A carries a near-equal delivery predictability value compared to node B's delivery predictability. Thus, as in the theory, the source node S selects node A as a forwarder of messages to the destination D [14].

The PRoPHET Protocol uses Map based with shortest path mobility model. Map based mobility [9] model uses Dijkstra algorithm [28] for shortest path. Here nodes are randomly positioned on the map area. When the nodes hit destination, wait for some time and look for a new destination.

*3. IPRA*

IPRA [13] works on weighted forwarding metrics for a node to choose the best forwarder according to the situation. Improved PRoPHET Scheme gives high chance to convey messages to the target node due to an algorithm used known as improved probabilistic routing algorithm (IPRA). The improve PRoPHET Uses contact information of the two hope neighbors. This result in well delivery rates and reduces average overhead. To compare Improved PROPHET the following protocols are taken for simulation, PRoPHET, PRoPHETv2, and PRoPHET-A.

*4. Di PROPHET*

Di PROPHET [14] is a neighbor node distance based PRoPHET protocol considering a distance metric between the neighbor's nodes. Di PROPHET works on bundle protocol mechanism. Di PRoPHET counts the distance between two nodes. Di PRoPHET nodes have knowledge of the directions of their neighbor's. These nodes can determine a nearer and better forwarder node according to their distance.

The aim of Di PROPHET is to solve the problem if there is no path available for delivery. In the PRoPHET protocol if two of the nodes have the same delivery probability, hence no path will exist for communication. At that moment Di PRoPHET can be used.

*5. Advanced PRoPHET Routing Protocol*

Advanced PRoPHET Routing Protocol [15] uses Average delivery predictabilities mechanism to forward messages. This solves the jitter problem in routing. Jitter problem appears due to the fluctuant probability value. The main goal of this routing protocol is to solve the jitter problem.

*6. Ferry Enhanced Improved PRoPHET*

Ferry Enhanced Improved PRoPHET [16] is a ferry node based Routing Protocol. The ferry node has the capability of deleting the duplicate messages. The main goal of this protocol is to delete the unused duplicated messages that have been already received by destination nodes. The ferry node, tasks of deleting duplicated messages, increases the delivery ratio and message delivery probability.

*7. PRoPHET +*

PRoPHET + [17] is a weighted function based routing protocol. This routing protocol is designed to improve data delivery rate and minimize delay in transmission. PRoPHET+ performance depends on weighted function. If the weighted function is best then the performance will be best. The weighted function consists of the following.

1. Communication opportunities.
2. Buffer
3. Power
4. Bandwidth
5. Popularity
6. Predictability value from PRoPHET.

*8. Enhanced PRoPHET Protocol*

Enhanced PRoPHET Protocol [18] is an enhanced DTN routing protocol works on Message Delivery Predictability (MDP). Sending multiple duplicates of a message can rise the delivery ratio and reduce the delay also result in communication overhead. MDP is used to controls the spread of messages in this protocol.

*9. Enhanced PRoPHETv2*

Enhanced PRoPHETv2 [19] works on message delivery predictability and history information of an encounter node. Sending multiple copies of a message can increase the delivery ratio and reduce the delay also result in communication overhead. The main purpose of using of message delivery predictability is to increase delivery ratio. Time to Live (TTL) also control the message overhead ratio.

*10. Improved PRoPHET routing protocol*

Improved PRoPHET Routing protocol [20] works in underwater communication. In the communication process with the wireless network traditional PRoPHET Protocol is used. This improves the message delivery in the underwater communication. This protocol calculates all the information about the network/path before the transmission. It has two states.

1st State: If the last encounter node is near to the old node according to the environment, then it takes old node value.

2nd State: In case opposite the 1st state it takes new node value.

*11. PRoPHET for crime detection:*

This PRoPHET protocol [21] works on Kiosk. The Kiosk is employed to send the crime information in the high rate transportation areas to detect crimes. If a vehicle with high rate transportation is detected the sensor habitually senses the network. The aforementioned protocol advances the buffer size and has less delay ratio.

*12.. Delivery Probability Routing Protocol*

Delivery Probability Routing Protocol [22] is the modified version of Spray and Wait Protocol. Spray and Wait Protocol works in two phases. First "sprays" variety of copies into the network, Second "waits" until one node meets the destination. The modified version includes PRoPHET Methodology and new routing algorithm Delivery probability routing (DPR).

*13. F.G PRoPHET*

F.G PRoPHET [23] works on contact patterns in the network between two nodes. The sliding window mechanism is used by all nodes to keep contact information history in the network. This Information about contact information history is maintained by the size of the sliding window. Message forwarding strategy to nodes is based on the greedy approach.

*14. Wise PRoPHET*

Wise PRoPHET [24] Works on trust-based Watchdog technique. The aforementioned protocol monitors its neighboring nodes to set a local opinion about their sending scheme. The message delay is determined by finite-state Markov chain. This information is shared with alternative nodes. The goal of this sharing is to set a global opinion for detecting selfish nodes in the network. The Watchdog also detects the nodes that act as either gentle node or a selfish node.

Table 2.1 show the details related to the above discussed protocols. In this table the internal mechanism, advantages and disadvantage are given.

| Protocols | Year | Mechanism | Advantages | Disadvantages |
|---|---|---|---|---|
| Improve PRoPHET (IPRA) [13] | 2015 | weighted forwarding metric | "Average delivery/ delay rate " | "Provide High performance when resource are boundless" |
| Di- PRoPHET [14] | 2013 | Distance based delivery | Delivery ratio increased. | Delivery ratio can be fewer dilemmas of Messages more in transmission. |
| Advance PRoPHET [15] | 2009 | advance delivery probability for jitter problem | Avoid jitter problem. | Results are not better when higher average delivery rates and shorter average delay are not in the network. |
| PRoPHET [16] | 2015 | Ferry node mechanism | Better message delivery. | A lot of duplicates can occur delay |
| PRoPHET +[17] | 2010 | delivery probability used weighted function | Better performance in other environment. | Performance is poor if weights are not used. |
| PRoPHET [18] | 2015 | Message delivery predictable | Controls the spreading of messages. | Not good for future use messages. |
| PRoPHET v2[19] | 2013 | Contact duration time between intermediate node | Provides a better delivery ratio and Less overhead. | Better performance only when contact duration time considers in the network. |
| PRoPHET [٢٠] | ٢٠١٥ | Opportunistic network & MDP | better message delivery Less overhead | Only better in low communication environment |
| Enhance PRoPHET [21] | 2016 | Enhance PRoPHET for high frequency ratio | Provides trump efficiency Additional the buffer size. | Detection of crime in rural area becomes complex. |
| Improve Spray and wait[22] PRoPHET | 2014 | Delivery probability routing | Good message delivery ratio Low latency. | Only good for the vehicle network scenario. |
| FG- PRoPH-ET [23] | 2013 | Fine grained contact, sliding window | Good delivery rate Low overhead. | sliding window size adjustment is easy if there are less messages |
| Wise- PRoPH-ET [24] | 2018 | trust based data forwarding | improving the delivery ratio Low delay | Due to (fragile network) network partitions some messages cannot reach in time period. |

TABLE 2.1: Details of PRoPHET based Routing Protocols

Table 2.2 show the comparison properties related to the above discussed protocols. In this table the compared protocol and the compared parameters are given.

| Protocols | Year | Mechanism | Advantages | Disadvantages |
|---|---|---|---|---|
| ImprovePRoPHET (IPRA) [13] | 2015 | weighted forwarding metric | "Average delivery/delay rate " | "Provide High performance when resource are boundless" |
| Di- PRoPHET [14] | 2013 | Distance based delivery | Delivery ratio increased. | Delivery ratio can be fewer dilemmas of Messages more in transmission. |
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| PRoPHET [20] | 2015 | Opportunistic network & MDP | better message delivery Less overhead | Only better in low communication environment |
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| Wise- PRoPHET [24] | 2018 | trust based data forwarding | improving the delivery ratio Low delay | Due to (fragile network) network partitions some messages cannot reach in time period. |

TABLE 2.2: PRoPHET based Routing Protocols Comparison Details

## 2.2 Movement Models

Many mobility [21] models have been developed by researcher. Following models are considered in this section.

### 2.2.1 Map based with shortest path mobility model

Map based mobility [21] model uses Dijkstra algorithm for shortest path. Here nodes are randomly positioned on the map area. When the nodes hit destination, wait for some time and look for a new destination.

### 1.2.2 Random waypoint (RWP)

Random Waypoint [21] Movement model uses random paths for nodes for movement. It adds the break time's concept between the node movements. A node takes a break before changing its speed and direction.

### 2.2.3 Random walk

In Random Walk mobility model [21], the nodes go on randomly and freely
without any restriction. In Random Walk mobility model, every node continues his movement towards a new destination. This destination chooses randomly by node.

### 2.2.4 Working Day Movement Model (WDM)

Working Day movement [20] model uses real life scenario where people awaken within the morning, going to offices by bus or will walk to their operating place. After office work they attend meeting spot wherever they can have the possibility of forwarding the message to the acceptable node. When the meeting spot they're return to their home. Nodes are assigned Homes, offices and meeting spots within map exploitation the Geographic Information System software. This scheme can be enhance using Mobile Nodes to connect different communities. Using mobile nodes different communities can be communicated.

### 2.2.5 Village Mobility

Village [20] mobility uses scenario like the villages and people who live in them. The villages are spread in the landscape, with villages which directly connected by roads with each other. Transportation network is provided by these roads. These roads are the pathways for people movement between.

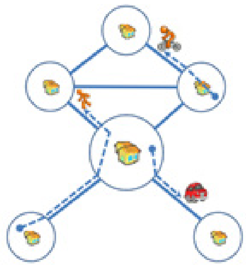

Figure 2.6: Village Mobility example

## 2. Proposed PRoPHET Routing protocol:

In this Paper we implement Cluster Movement model in PRoPHET Routing Protocol. In Cluster movement Model is like Random waypoint Model but the coordinates are restricted to circular area defined by a central point and range. In any situation nodes moves in two different ways like in predictable path or move randomly.

In the ONE Simulator the nodes are Pedestrians, Cars, buses, Trams and trains. The trams and trains have a predictable path using Map-based Mobility model for movement. Pedestrians and the cars/buses moves is random way. So they can take any route on the road. Pedestrians and cars/buses use Shortest Path Map-based movements. They follow specific route.

## 3. Simulation Setting:

| Constant | Value |
|---|---|
| Pinit | 0.95 |
| B | 0.25 |
| Y | 0.98 |

Table 3.1: Protocol Constant

| Parameter | Value |
|---|---|
| Simulator | One Simulator |
| Movement Model | Cluster Movement model |
| Area | 1000m x 1000m |
| Number of nodes | 2, 4, 10,20 |
| Buffer size | 2 Mb, 5Mb, 10Mb |
| Simulation time | 1000 sec |

Table 3.2: Setting

## 4. Simulation Results:

The PRoPHET and the Improved PRoPHET performance are shown in the figures. We compare both protocols with respect to delay and message delivery ratio. The detail graphs and tables are taken from one simulator and implemented in origin pro.

Table 4.1 shows the delivery ratio of PRoPHET routing protocol and Improved

PRoPHET routing protocol with 2 Mb, 5 Mb and 10 Mb of buffer size. The PRoPHET gives 73.4% message delivery ratio while the Improved PRoPHET Protocol gives 83% message delivery ratio with 2 Mb. Here again PRoPHET gives 73.4% message delivery ratio while the Improved PRoPHET Protocol gives 82% message delivery ratio with 5 Mb and also gives 84% message delivery ratio when buffer size is 10 Mb. So the simulation results shows that the improved PRoPHET protocol gives better result than compared one.

| Buffer Size (Mb) | Message delivery ratio | |
|---|---|---|
| | PRoPHET Protocol | Improved PRoPHET Protocol |
| 2 | 73% | 82% |
| 5 | 73.4% | 83% |
| 10 | 73.4% | 84% |

Table 4.1: Message delivery ratio with various buffer sizes

Figure 4.1 and 4.2 shows the comparison of message Delivery ratio with 2 Mb, 5 Mb and 10 Mb of buffer size. The PRoPHET gives 73.4% message delivery ratio while the Improved PRoPHET Protocol gives 83% message delivery ratio with 2 Mb. Here again PRoPHET gives 73.4% message delivery ratio while the Improved PRoPHET Protocol gives 82% message delivery ratio with 5 Mb and also gives 84% message delivery ratio when buffer size is 10 Mb. So it is clear that improved PRoPHET gives better results for Message Delivery.

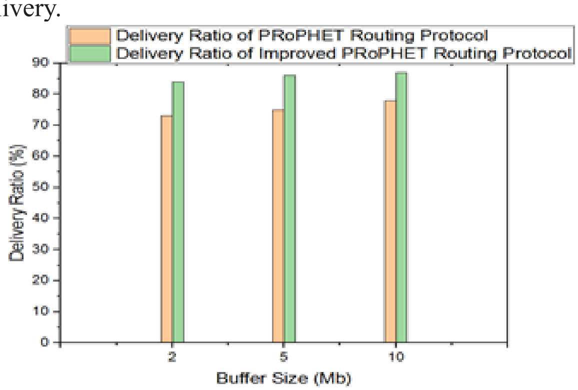


Figure 4.1: Message delivery ratio with various buffer sizes

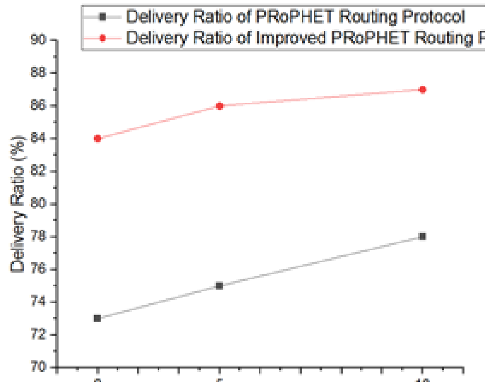


Table 4.2 shows the delay of PRoPHET routing protocol and improved PRoPHET routing protocol with different size of buffer storage. PRoPHET Protocol gives 25 sec delay with 2 MB of buffer storage while improved PRoPHET Protocol gives 22 sec delay. PRoPHET Protocol gives 55 sec delay with 5 MB of buffer storage while improved PRoPHET Protocol gives 50 sec delay. In the last one PRoPHET Protocol gives 110 sec delay with 10 MB of buffer storage while improved PRoPHET Protocol gives 100 sec delay. So the simulation results shows that the improved PRoPHET protocol gives better result than compared one.

| Delay with different size of buffer memory | Buffer Size | PRoPHET Protocol | improved PRoPHET Protocol |
|---|---|---|---|
| | | Delay ratio in sec | Delay ratio in sec |
| | 2MB | 25 | 22 |
| | 5MB | 55 | 50 |
| | 10MB | 110 | 100 |

Table 4.2: Delay comparison with various buffer sizes

Figure 4.3 shows the message delay with all 2 Mb, 5 Mb, 10 Mb buffer size. The results shows that improved PRoPHET out formed the PRoPHET Protocol.

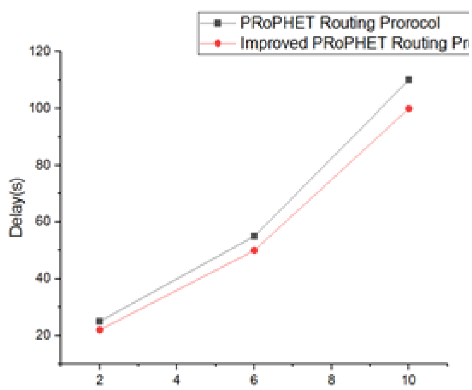


Figure 4.3: Delay comparison with various buffer sizes

## V. CONCLUSION

In this paper we make enhancement in PRoPHET Routing protocol to improve message delivery ratio and to minimize the delay of message delivery. We use cluster movement model where the coordinates are restricted to circular area defined by a central point and range. Our simulation results shows that this enhancement in PRoPHET Routing Protocol give better result than original PRoPHET Routing Protocol in the term of message delivery ratio and minimum delay.

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