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Timed Petri Net Modeling of AODV Protocol

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Abstract: The development of intrigue and research on versatile specially appointed systems is exponentially lately. In a Mobile Ad hoc NETwork (MANET), remote transmission happens where one versatile hub can send messages specifically to other portable hub. One of the responsive convention (the convention which makes course in an on-request premise) characterized for MANETs is AODV (Ad hoc On-request Distance Vector) directing convention. The hub development in the dynamic condition causes visit topology changes in the system. Along these lines it is especially vital for each hub in the system to monitor change so that an efficient parcel transmission should be possible. In this proposition, the deferral related with a parcel is computed utilizing planned petri net by giving the sources of info physically. The same steering convention is again approved using understood NS2 instrument. Execution in CPN instruments requires time esteems to be fused among the states (i.e. places and advances) which shows the defer taken by a switch or postponement related over a connection or it might be delay because of lining of parcel. This esteem can be separated for a specific course and defer esteem related with it can be gotten. We have expected that every one of the hubs have sufficient vitality while taking an interest in the steering procedure.

I. INTRODUCTION

Mobile ad hoc network (MANET) is an autonomous system with no pre existing infrastructure or centralized administration. In MANET, a node can send packet directly to another node or packet transmission can be mutlihop. Network topology changes rapidly due to arbitrary movement of nodes. MANETs are also characterized by a random, dynamic and rapidly changing topology. This makes the routing algorithms fail to perform correctly, since they are not robust enough to accommodate such a changing environment. Hence a topology approximation mechanism, known as Ad hoc On-demand Distance Vector (AODV) routing protocol, is used to perform simulation of a typical routing protocol which addresses the problem of mobility [1]. AODV routing protocol [2] is a reactive routing protocol, which means that route from source node is created in an on demand basis.

A timed CPN [3] can model how much time certain activities require and how much time passes between other activities. In most cases,its insufficient to model the average amount of time a certain activity takes- it is necessary to include a more precise representation of timing of the system. Introducing time conception into the CPNs can be redefined as timed CPNs. This introduces the concept of global clock. The clock value which is either discrete or continuous represent the model time. In the timed CPNs, each token carries a time value called the time stamp. The time stamp describes the earliest model time at which the token can be used, that is it can be removed by the occurrence of a binding element. In a timed CPNs a binding element is said to be color enabled when it satisfies the enabling rule for un-timed CPNs.

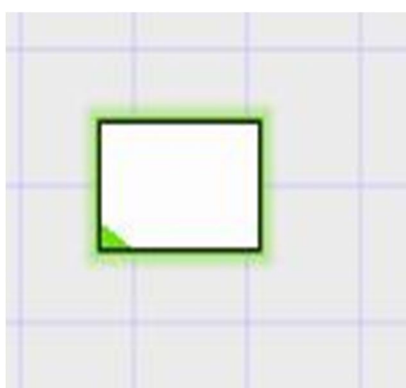

Fig 1.1: Enabling of a transition

However, to be enabled, the time stamps of the tokens to be removed must be less than or equal to the current model time. Figure 1.7 shows how timing values are incorporated in a transition.

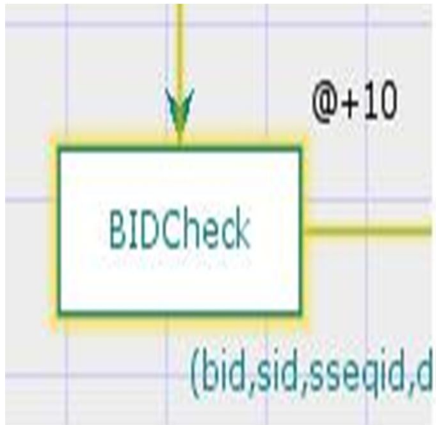

Fig 1.2: Adding timing values to a transition

The marking of a place where the tokens carry a time stamp becomes a timed multi-set specifying the elements in the multi set together with their number of appearances and their time stamps. The timed color sets are declared as : colset INTDATA =product INT*STRING timed; and the possible marking of a place with timed token is as: 2'(1,"colour")@[19,45] This indicates the marking contains two tokens with value (1, "colour") and time stamps 19 and 45 respectively. The @ symbol can be read as "at" and the symbol [ ] is used to specify the time stamps.

II. ADHOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL

AODV is a routing protocol defined for MANETs and other wireless ad-hoc networks. Mobile nodes in MANET quickly discovers route for new destinations and responds to link breakages and changes in network topology [5]. AODV makes use of a destination sequence number in order to identify the most recent path [6]. Route request and route reply query cycle [7] is used in order to build the routes in AODV routing protocol. Whenever there is a link breakage, affected nodes are notified so that they invalidate the routes using that link. As has been done in (Gordon 2001), one approach to ensure the correctness of an existing routing protocol is to create a formal model for the routing protocol and analyze the model to determine if the protocol provides the defined services correctly.

III. AODV PROCESS

As AODV is reactive protocol i.e. the route is created only when it is required. Packet transmission in AODV routing protocol can be multi hop [8] i.e. A node can send packet to another node beyond its transmission range using other nodes as relay point and thus a node can function as a router. Each node in the network maintains its own neighbor table. If a node N wants to send a data packet, it first checks its routing table to find whether there is an existing path to the destination node or not. If it has, it sends the data packet along this route immediately. Otherwise the route discovery procedure starts which is as follows:

A. Route Discovery

If the route between source and destination is not available, a RREQ (Route Request) packet is broadcasted throughout the network. As soon as a node receives a RREQ packet, it first checks whether it has received this packet earlier. If yes then the node simply discards the packet and if not, a reverse routing entry towards the originator of RREQ packet is created. This route can be used to forward route reply later on. If any intermediate node has a valid route towards the destination node, it unicasts a RREP (Route REPly) packet towards the source node. A node on receiving RREP packet creates a reverse route entry towards the originator of RREP packet .

B. Route Maintenance

Every node in the network periodically broadcasts HELLO messages to its neighbors to indicate its presence. If the node does not receive a HELLO message from its neighbor then it marks that particular route as invalid and the node is considered to be exhausted or moved away from the network. Hence route table is updated and a RERR (Route Error) packet is sent to all the affected nodes linked with that particular node . Every node in the network maintains a sequence number to ensure that no loop exists among the nodes. This sequence number is incremented by the node every time a packet is sent and is stored along with the route information in the route table. It is sent along with RREQ (for source) and RREP (for destination). A node with larger sequence number is always preferred since it indicates the most recent path to the destination.

Whenever a source node was to send data packet, routing table is checked for an unexpired entry, which if exists, packet is transmitted directly by using that route otherwise RREQ packet is broadcasted. This packet contains source ID, broadcast ID, sequence number of source, sequence number of destination, previous ID, hop count and destination ID. The purpose of destination sequence number is to prevent the loop in the route discovery process. Every node has its own sequence number which is increment by one every time there is a link breakage . A node upon receiving this packet checks whether it has received this packet earlier, if it has it simply discards the packet otherwise a RREP packet is uni casted to the source along the reverse path to that of RREQ packet [9]. When an intermediate node receives this RREP packet, it sets a forward path entry to the destination.

C. AODV Protocol Has Following 4 States

1) *Routcheck:* check the routing table to find if the source node has an unexpired path to the destination node. This is done using the guard has validRoute().
2) RREQInit: Initiate RREQ message when necessary. Its main function is to direct the RREQ message and rebroadcast it using the function arc rebroadcast() if necessary.
3) *RREQProcess:* Process the RREQ message received and output proper results. Its function is to initiate RREP message if possible or forward RREQ message if necessary. This functionality is achieved by arc newBID() and arc initiateRREP().
4) *RREPProcess:* Process the incoming RREP message and output proper result. The main function of this subpage is to update the route table and forward the RREP message if necessary. To achieve these functionalities, two functions arc updateRoute() and arc forwardRREP() are used. RREQInit, RREQProcess and RREPProcess are three substitution transitions. If a node wants to send data packet, it first enters Routcheck state to check for an existing path. If there is no existing route in the routing table, the node enters RREQInit state and initiates route discovery process i.e Broadcasting of RREQ packet . Because protocol design is not yet an exact science, designers should take advantage of those tools which may aid them in validating the operation of their protocols. The use of design verification tools can aid in the examination of each possible usage case, and can validate the operation of a protocol in each of these situations. Because of the difficulty in enumerating all possible usage cases and node failure scenarios, these tools should be considered an important part of the protocol design process.

IV. SIMULATING AODV IN TIMED PETRI NET

The simulation of AODV routing protocol in Timed petri net is done with the help of hierarchical colored petri nets. Codes are written in arc, place and transition, which are known as arc inscription, place inscription and transition inscription. These all inscription are written in CPN ML programming language. The Fig 4.5 shows the first module of AODV. This page contains a set of information which send to the next level. It contains: (Destination ID, Source ID, Lifetime, Source Sequence No, Broadcast id, Destination Sequence No).

The transition NODE is associated with a timing delay of 10 time units which indicates the delay. The packet containing all this information moves to the next page where the path is selected. As shown in Fig 4. 5, firstly routing table is checked for an existing path between pair of source and destination node. If path exists, the packet is sent using that route only. If the route doesn't exist then it enters RREQInit state and route discovery process starts. The source node sends RREQ packet to its neighboring nodes. Some of the transitions are associated with timing values like RoutCheck, BIDCheck, AddRout, etc. A node, upon receiving the RREQ packet enters into a RREQProcess state and checks whether it is destination node or not. If it's not the destination node then guard_broadcast is enabled and RREQ packet is forwarded until it reaches the destination node. If it is the destination node then guard_sendRREP is enabled and RREP packet is initiated from the destination node using the function arc_initiateRREP().

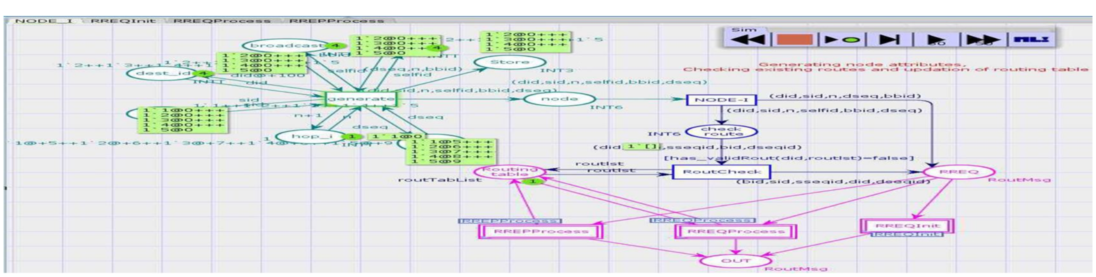

Fig 4.1 The main page of the simulation

A. RREQInit sub page

It simply broadcasts the RREQ packets received. This forwarding of RREQ packet to its neighboring nodes is done until it reaches the destination node as shown in Figure 4.2. The place RREQ transmits the packet to the transition Broadcast which takes 10units of time delay to send the packet to the place OUT.

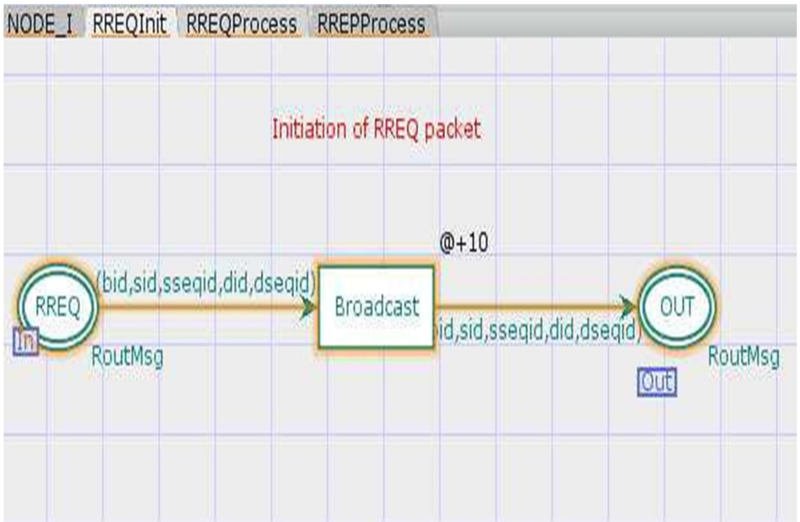

Fig 4. 2 RREQInit subpage

B. Rreqprocess Sub Page

Whenever a node receives RREQ packet, it checks whether it is the destination node or not (looking upon the destination field in the packet header). Hence two paths are shown in Fig 4.3. This page contains the following transitions:

BIDcheck: this transition checks whether the broadcast_id received is fresh one or not. It takes 10units of time delay.

Broadcast: If the current node is not the destination node then it simply forwards the RREQ packet recieved to its neighbors. This condition is checked using the guard function guard_broadcast(). It takes 2 units of time delay.

Send RREP: This transition initiates the RREP packet when the node itself is the destintion node. This functionality is checked using the guard function guard_sendRREP() and the RREP packet is initiated using the function arc_initiateRREP() as shown in fig 4. 3.

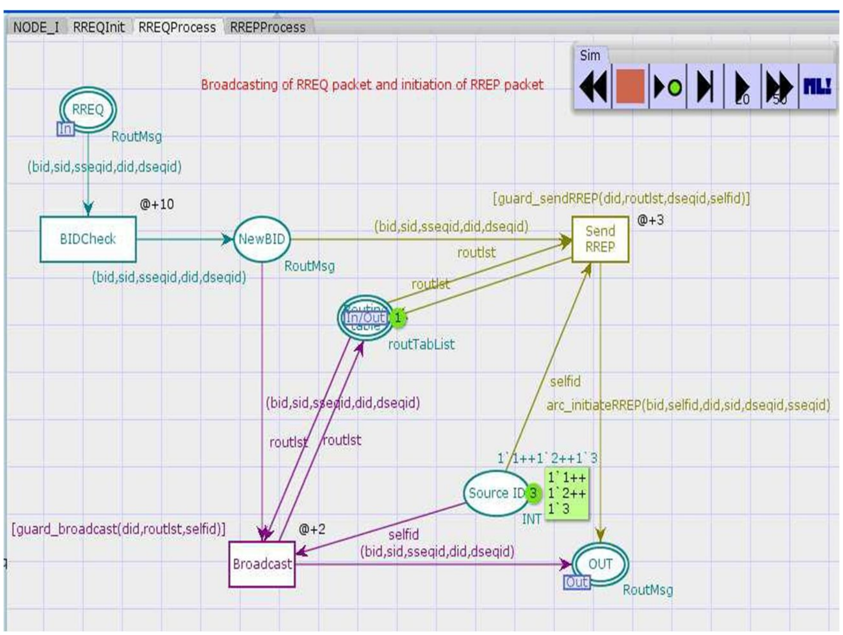

Fig 4. 3 RREQProcess sub page

This page also contains the following places:

1) RREQ: It transmits the packet received from RREQInit page to this page.
2) NewBID: Contains all the tokens which havent received earlier.
3) Routing table: provides the routes using the list routlst to transitions Broadcast and Send RREP.\
4) Source ID: provides the source id to both the transitions(Broadcast and Send RREP)
5) OUT: contains all the tokens.
6) *RREPProcess sub page*: RREP packet is unicasted along the route reverse to that of RREQ packet. The page shown in Fig 4. 4

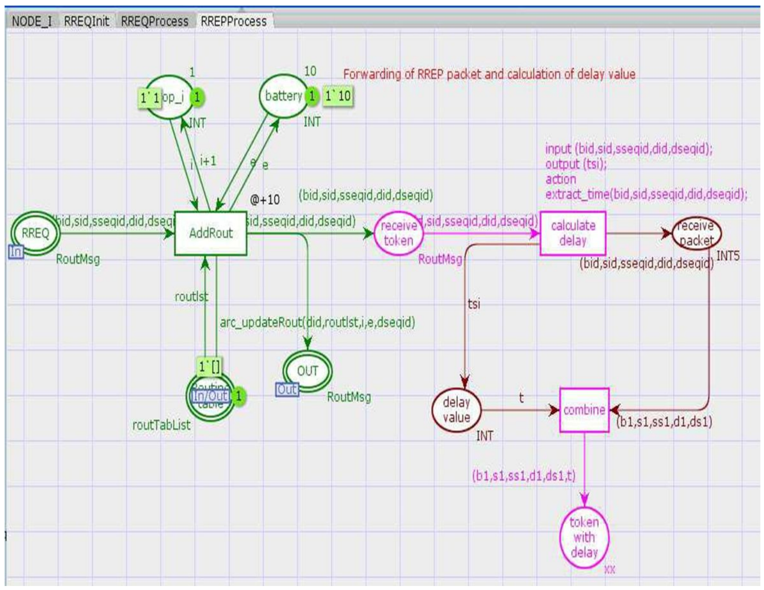

Fig 4. 4 RREPProcess sub page

The simulation process can be explained as follows: Initially the transition generate contains all the attributes of a packet i.e. source id, destination id, braodcast id, destination sequence id and hop count as shown in Fig 4. 5.

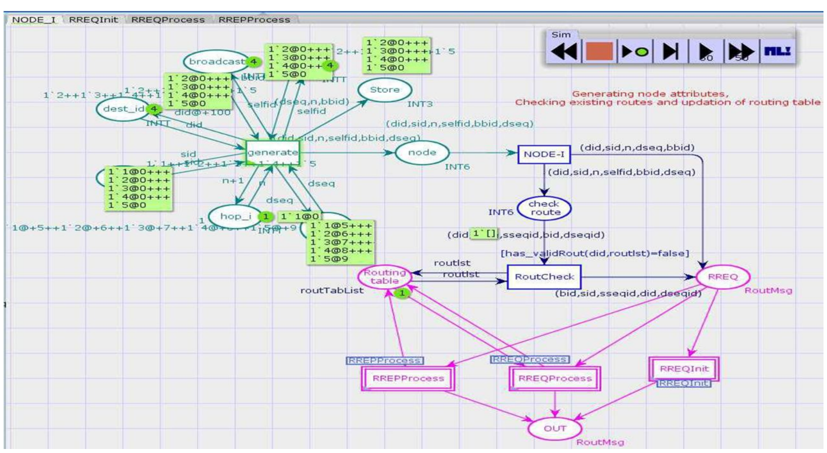

Fig 4.5 Start of simulation process

IV. CONCLUSION

In this paper, AODV routing protocol is modeled using Timed petri net and the delay associated with a packet is calculated. The delay can be processing delay, queuing delay,transmission delay or propagation delay. Implementation in CPN tools require timing values to be incorporated amongst the states which represents any of these delays. The addition of all these values for a particular token gives the delay associated with a packet which is termed as end to end delay. The simulation is done using CPN tools by providing the inputs manually and similar kind of result is obtained. Moreover the simulation values are imported from NS2 tool. The future work includes the validation of the protocol by taking the inputs from well known simulator NS2.

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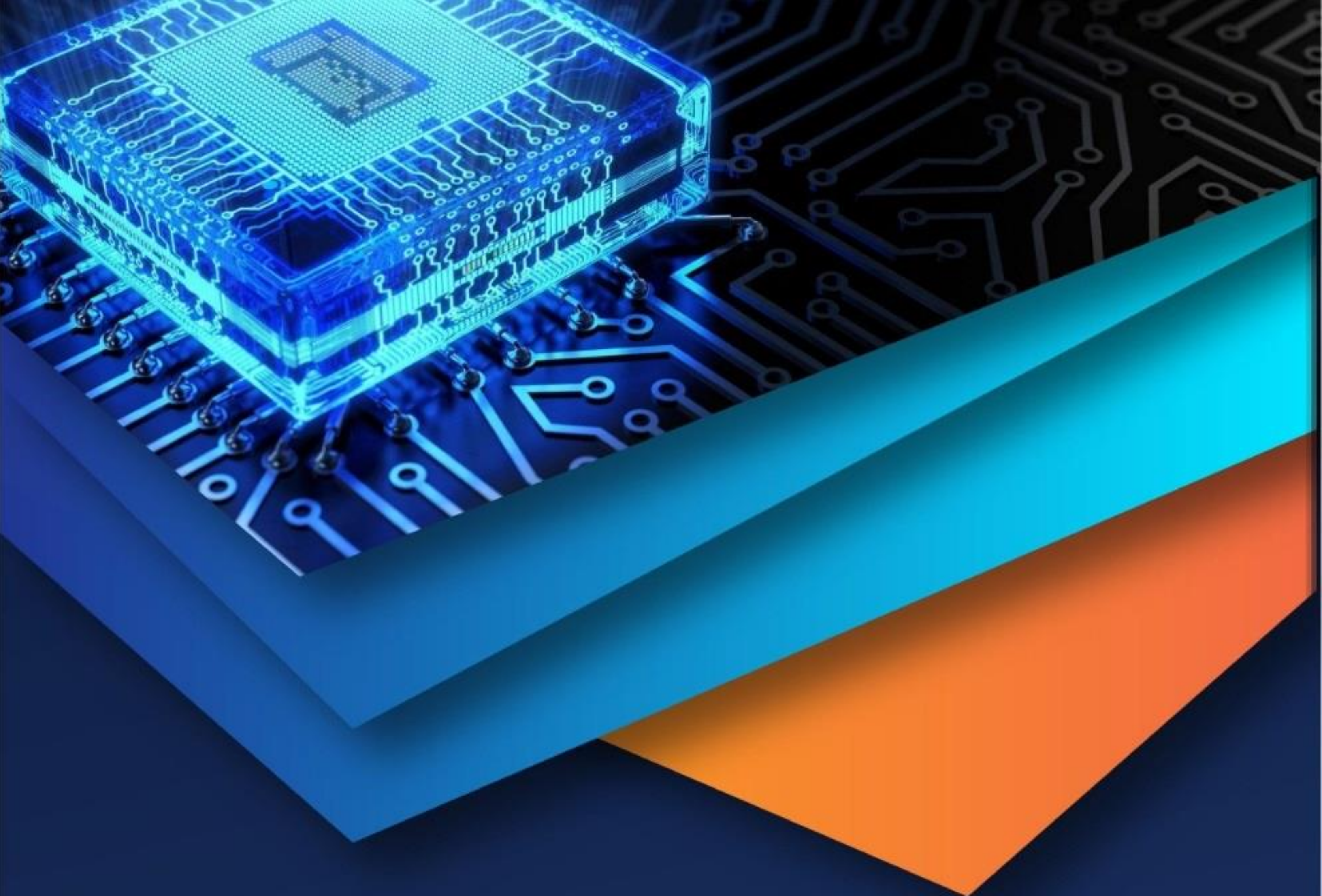

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