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Modelling and Analysing of Performance of an AODV Routing Protocol Using CPN

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Abstract: Now a days there are various researches and developments are done in the wireless networks. MANET is the most commonly used wireless network. In mobile ad-hoc network, abbreviated as MANET, transmission can be takes place without any use of wires. Wireless transmission takes place when one mobile node can send message to other mobile node. In this network, nodes are mobile and free to move in any directions. They send their messages to any other mobile nodes in the network. One of the protocols of MANET is AODV (Ad-hoc On demand Distance Vector) Routing Protocol.

The main problem in this network is that the nodes in this network are frequently moving thereby the topology is changing frequently in MANET. Thus it is very much necessary for every node in the network to keep track of change so that an efficient packet transmission can be done. This is done by modelling the AODV routing protocol. In this paper, the network is modelled by using the Colored Petri Nets (CPN). CPN is the high level petri net that has the capacity of formally modelling and verifying complex system. Implementation in CPN tools requires time values to be incorporated amongst the states (i.e. places and transitions) which indicate the delay taken by a router or delay associated over a link or it may be delay due to queuing of packet. This value can be extracted for a particular route and delay value associated with it can be obtained. We have assumed that all the nodes have sufficient energy while participating in the routing process.

Keywords: AODV, Colored petri net tool, Mobile Ad-hoc Network, routing protocol, TPN.

I. INTRODUCTION

Mobile ad hoc networking is a technology which works without requiring an already established infrastructure and centralized administration and provides for the cooperative engagement of a group of mobile nodes. In a mobile ad hoc network, each node can function as router and thus mobile nodes directly send messages to each other via wireless to a destination node beyond its transmission range by using other nodes as relay points. Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks (MANETs) and other wireless ad hoc networks. It is jointly developed in Nokia Research Center, University of California, Santa Barbara and University of Cincinnati by C. Perkins, E. Belding-Royer and S. Das. In AODV routing protocol, the network is silent until a connection is needed. At that point the node that needs a connection broadcasts a request for connection. Other nodes in AODV forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the particular node. When a node in AODV receives this request message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes in AODV. The routing table checked and unused entries in the routing tables are recycled after a time. When link fails, a routing error is passed back to a transmitting node, and the process repeats.

With the explosive growth of the internet and mobile communication networks, challenging requirements have been added into MANETs and designing routing protocols have been added into MANET and the designing routing protocols has become more and more complex. One approach to ensuring correctness of an existing routing protocol is to create a formal model for the routing protocol and analyze the model to determine if needed the protocol provides the defined service correctly. One way to create and analyze the formal model of a protocol is by using the tool called Colored Petri nets. Coloured Petri Nets (CPNs) is a graphical language for constructing models of concurrent systems and analyzing their properties. CPN is a discrete-event modeling language combining the capabilities of Petri nets with the capabilities of a high-level programming language. Colored Petri Nets provide the foundation of the graphical notation and the basic primitives for modeling concurrency, communication, and synchronization. CPN allows tokens to have a data value attached to them and this attached data value is called token color. Although the color can be of arbitrarily complex type places in CPNs usually contain tokens of one type. This type is called color set of the place[15].

II. WORK DONE

MANET is jointly developed in Nokia Research Center, University of California, Santa Barbara and University of Cincinnati by C. Perkins, E. Belding-Royer and S. Das. CPN Tools is originally developed by the CPN Groups at Aarhus University from 2000 to 2010. The main architects behind the tool are Kurt Jensen, Soren Christensen, Lars M.

Kristensen, and Michael Wastergaard. From the autumn of 2010, CPN Tools is transferred to AIS group, Eindhoven University of Technology, The Netrherlands. Ye Wint Maung Maung, Aung Aung Hein[1], presents a composite web service model base on colored petri nets approach. This paper can assist web service composition designers and developers to deliver lasting solution, in concordance with technology's critical needs. Chinara et al. [10] have proposed the validation of neighbor detection protocol for ad-hoc network by using the CPN tools. Erbas et al. [5] proposed a two designed position based routing approach based model on Colored Petri Nets for mobile ad-hoc network. Here the author shows that the multicast routing protocol delivers better result than the basic ODMRP (On Demand Multicast Routing Protocol). This model (CPN model) developed reliable unicast and multicast routing method based on geographical position of a node. In [1], colored petri nets along with their various properties and applications are discussed. A brief introduction to Protocol Engineering and at what stage Colored Petri Nets are used in Protocol Engineering is also presented. In [3], Alessandro Bianchi, Sebastiano Pizzutilo proposes a tool, which allows both formally modeling and simulating a Mobile Ad-hoc NETwork – MANET. They developed the prototype of moDEling MObile NEtworks (DEMONE) is able to simulate MANET behavior as well as other simulators: DEMONE has been applied to 3000 simulations. . In [4], this paper has reviewed the working of DYMO Routing Protocol in comparison with the existing AODV Protocol. To improve quality of route selection for MANET routing protocol, Nakhaee et al. [11] presented new route selection criteria instead of hop count. This scheme adds two parameter to route request packet: number qmean and number maxq, shows the average queue length and maximum queue length of the nodes in the path respectively.

III. SIMULATION OF AODV ROUTING PROTOCOL USING CPN

When simulating a model of a discrete-event system, it is often useful to be able to examine and extract information from the states and events that occur in the model during the simulation. Such information could be numerical data that is used to calculate performance measures, string values to be saved in a file, or arbitrary data values that are used for other purposes. In CPN Tools it is possible to exchange data with external processes via TCP/IP, to update domain-specific graphics, or update files using standard I/O function. In a simulation tool there should be a clear distinction and separation between modeling the behavior of the system and monitoring the behavior of the model. It is possible in CPN Tools to inspect and control a simulation without having to modify the structure of the model. 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. All these inscription are written in CPN ML programming language. The Figure 1 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).

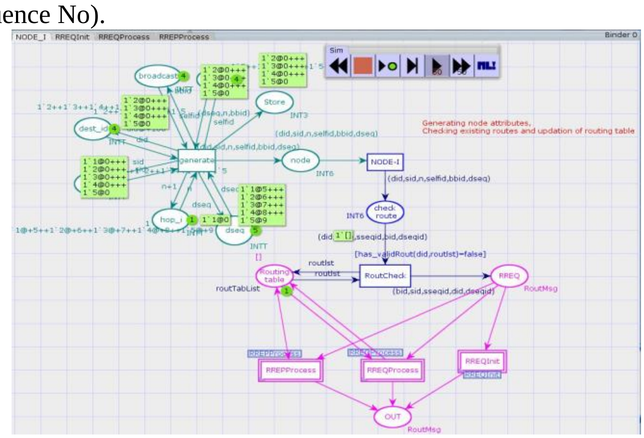

Figure 1 Main module of simulation

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 _figure 1. When the transition Generate res, a token is placed on the place node as shown in the figure 2.

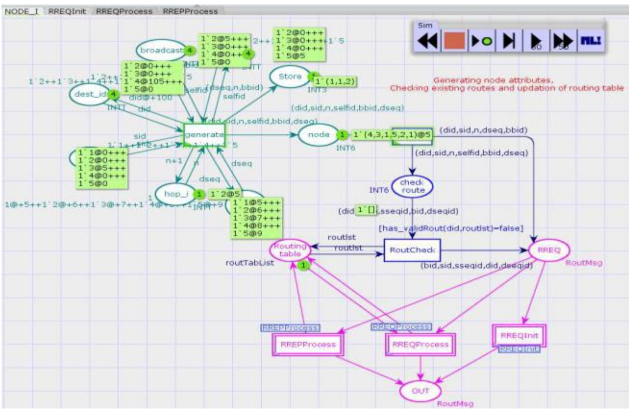

Figure 2 Simulation after the occurrence of transition Generate

As soon as the token reaches the place "node" the transition NODE I gets enabled as shown in figure 3. Whenever transition "RoutCheck" is enabled, the guard function has−valid route() is evaluated. A guard is a CPN ML Boolean expression that evaluates to either TRUE or FALSE. Each expression used in a guard must be a Boolean expression. Here if the expression evaluates to false then transition is enabled and the packet moves to the next subpage i.e. RREQInit subpage.

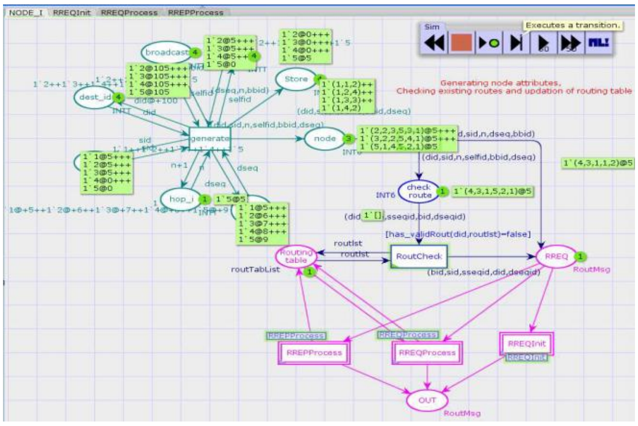

Figure 3 Simulation after the occurrence of transition "NODE-1"

In this subpage the transition "Broadcast" is enabled and the tokens are fired with a time delay of 10units as shown in figure 4.

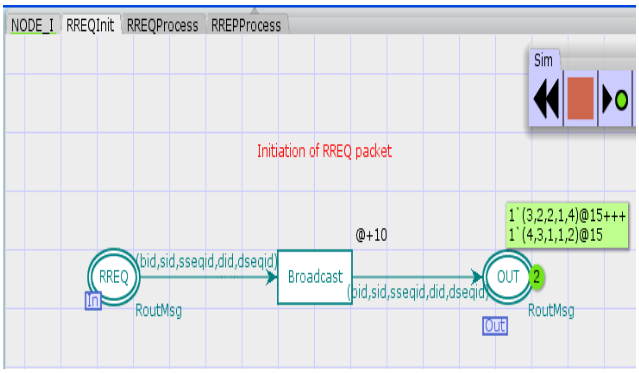

Figure 4 Simulation after the occurrence of transition "RouteCheck"

A transition "delay" must be a positive integer expression. The expression is preceded by @+, and this means that the time inscription has the form @+ delay-expr. Time delay is always added relative to the current time. The token after moving from this subpage goes to the main page after which it is fired to RREQProcess subpage.

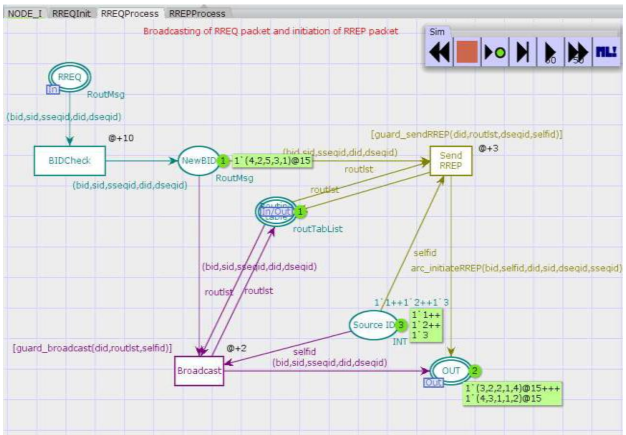

Figure 5 Simulation after the occurance of transition "BIDCheck"

The tokens from the place "RREQ" moves to the place "BIDCheck". As shown in figure 5, two paths exist from this transition. If the destination node mentioned is same as that of self id then the packet moves towards the transition "RREP" otherwise same RREQ packet is broadcasted using the transition "Broadcast". The transition "SendRREP" has a guard function guard−sendRREP(). This transition is enabled when did and self id are same like in this case its 3. Hence the transition is fired with addition of time delay of 3units. Similarly the transition "Broadcast" has a guard guard−broadcast() which is enabled when the destination id and self id are not same.

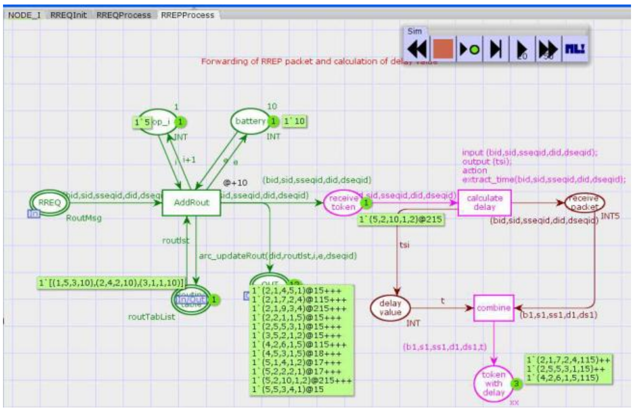

Figure 6 Tokens available at transition “calculate delay”

The packet then moves to RREPProcess subpage, as shown in figure 6, where forwarding of RREP packet and calculation of delay takes place. The packet first moves to the transition named “AddRout”. As shown in figure 6, the tokens from transition “AddRout” is transferred to two places “OUT” and “receive token”. When the token is transferred to the place “OUT”, the Routing table is updated using the arc inscription arc−updateRout. When tokens are available at place “receive token”, the transition “calculate delay” is enabled and this transition is associated with a coding part where the input part accepts the token and output part obtains the delay value associated with that token. The delay value is obtained using the function named extract−time().

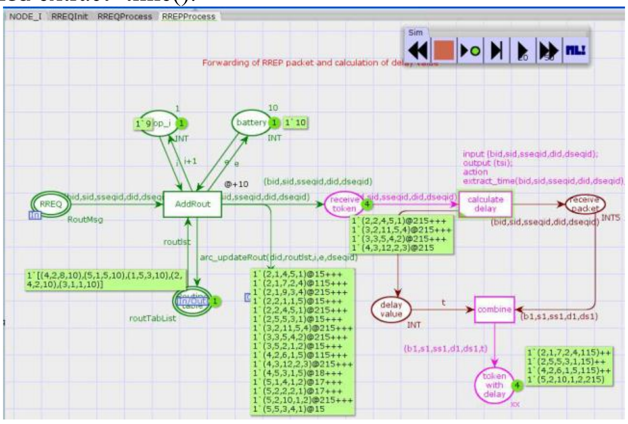

Figure 7: Simulation after the occurrence of transition “Combine”

Similarly rest of the tokens are also fired and all tokens moves to the place “token with delay”. This place contains all the tokens along with their delay values as shown in figure 7.

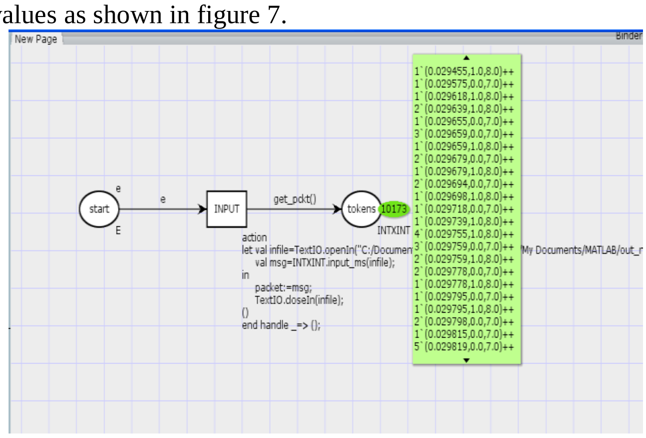

Figure 8: Inputting values into CPN tool

The figure 8 consists of a transition named “INPUT” where the code is written for inputting the values from a text file named “out−new.txt”. All the values inputted are accumulated in the place “tokens”. The values inputted contain the source node, the destination node and the end−to−end delay.

IV. CONCLUSION AND FUTURE WORK

In this paper, AODV routing protocol is modeled using Coloured petri net and the performance is analyzed. While modeling, various concepts like hierarchy, colour, timing were considered. In this paper, 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 requires timing values to be incorporated amongst the states which represent 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. In future work, AODV routing protocol is modeled using more efficient simulator that increases the performance of the routing protocol.

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