ROUTING APROACH FOR MOBILE AD HOC SYSTEMS BASED ON FUZZY PETRI NETS

[1] SANTOSHI OMMI, Dr.M.SAMPATH KUMAR[2]
[1]M.TECH SCHOLAR ,PROFESSOR[2]

Department of computer science&Systems Engineering,

Andhra University College of Engineering(A),Visakhapatnam, India.

Abstract: computation in MANETs using Fuzzy Petri Nets-QTFPN", evaluates node trust value based on its quality of service (QoS) parameters In this paper, we explore the use of Fuzzy Petri Nets for QoS support in wireless ad hoc networks. We propose a fiizzy Petri nets technique for modeling and analyzing the QoS decision making for traffic regulation. Evaluation of node's trust value is certainly advantage in mobile Adhoc networks (MANETs) where the applications run efficiently by involving trustable nodes only. The proposed method "A Novel QoS Trust. Here the MANET is represented as Dynamic Adaptive Fuzzy Petri Nets **(DAFPN) model with concurrent reasoning algorithm (CRA). In which delivery of each packet from node to node requires** evaluation of certainty factor (μ) using fuzzy expert system. This fuzzy inference system uses QoS parameters as fuzzy input variables namely energy, bandwidth, node mobility and reliability. In the routing process the intermediate node's trust values are evaluated based on certainty factor. The concurrent reasoning algorithm can strengthen the proposed method in selection of quality path to destination and reestablishment of path in case of path breaks. The proposed method performance is analyzed theoretically in terms of time and space complexities. The simulation results are taken against node velocity and network size, where the proposed method outperforms the existing protocol

Keywords: Quality of service;Trustworthiness;Reasoning algorithm;Fuzzy petri nets.

I.INTRODUCTION

QoS provisioning is one of the advanced and challenging area in the MANETs. Due to node mobilites and lack of administration, it is not trivial task to establish the route to destination node with the potential intermediate nodes, in terms of quality resources. In multi constrained QoS provision it is hard to define the priority levels among the multiple quality parameters, which is influenced by network conditions. In this paper, the problem is overcome by using fuzzy rule base in aggregation of QoS parameters. Where the fuzzy rules are inferred based on network conditions.

QoS trust of a node in MANET represents how much it is dependable in quality wise. In the literature many people presented different definitions to trust [1,2,3]. Trust is having the context based meaning. In the MANET environment it can be defined as[4], "trust reflects the belief or confidence or expectations on the honesty, integrity, ability, availability and quality of servicetargetnode's future activity/behaviour". Here QoS trust is derived by aggregating quality parameters like bandwidth, energy, Link Expiry Time (LET) and Reliability using fuzzy inference mechanism.

The proposed method uses the Dynamic Adaptive Fuzzy Petri Net (DAFPN) with concurrent reasoning algorithm. DAFPN is a expert system to represent, capture and store fuzzy knowledge with the help of parameters such as threshold value, certainty factor and weight. The concurrent reasoning algorithm (CRA) is a matrix operations based algorithm, which can automate the working procedure of DAFPN.

In this paper, the MANET is represented as DAFPN. In the proposed routing protocol, source node initiates the routing process by sending Route Request (RREQ) packets towards destination node for path establishment. The destination node gathers the topological information through these RREQ packets and runs the CRA to find the quality and trustworthy route. It intimates the path information to source node through Route Reply (RREP) packet.

The existing protocols tried to achieve QoS through trust, but did not handle these parameters separately. We addressed this problem by considering node's competency (quality) and reliability (soft security) in its trust computation.

In case of path failure, the existing routing protocols are spending considerable amount of time in route recovery phase. But with the help of concurrent reasoning algorithm, the proposed method can select the alternate quality path immediately without initiating path finding process

Advantages of QTFPN: we used fuzzy inference mechanism to aggregate quality parameters to define node trust value. We modelled MANET topology as DAFPN to apply FPN rules. We introduced the route finding and recovery mechanisms using CRA in unicast and multicast methods.

Advantage of QTFPN: The proposed method is having the following merits

The method attains good throughput and packet delivery time, since it selects the intermediate nodes with sufficient energy and bandwidth. It deploys the stable nodes along the path, so could measure less number of path breaks. Since node's attitude is considered in trust evaluation, data can be transferred in secure environment. DAFPN properties and rules are discussed. Evaluation of QoS parameters is explained. In section 4, certainty factor (trust value) is evaluated using fuzzy inference system. CRA algorithm is applied for route finding of unicast and multicast. Performance of QTFPN is measured theoretically

Quality of Service; Trustworthiness; Reasoning algorithm; Fuzzy petri nets A large collection of systems connected in private or public networks which provides dynamic infrastructure for data, application and file storage is termed as a cloud computing. It is a practical approach to transform a data centre from a capital- intensive set up to a variable priced environment. The reality of large volumes of data storage and maintenance is offered with a massive infrastructure by the cloud providers. Since the cloud can scale dynamically, sudden workload spikes can also be managed effectively and efficiently. The deliver speed is critical due to enterprises having to adapt, even more rapidly, to changing business conditions. Using the most appropriate building blocks necessary for deployment, cloud computing stresses on getting applications to market very quickly. The crucial element that warrants security is data security. From vendors, enterprises are often reluctant to buy an assurance of business data security. Lose of data to competition and the data confidentiality of consumers is their major fears. Due to various security concerns, the actual storage location is not disclosed in many instances. The interface between service suppliers and multiple groups of service consumers, is the way in which the interface action moves with respect to cloud computing.

II. FUZZY PETRI NETS

Classical Petri Nets [15] do not have sufficient capacity to model the uncertainty in systems [14] [18]. This limitation of Petri nets has encouraged researchers to extend the exiting models by using the fuzzy reasoning theory [10] [11] [13]. The combination of Petri nets models and fuzzy theory has given rise to a new modeling tool called Fuzzy Petri Nets (FPN). FPN formalism has been widely applied in several applications such as, fuzzy reasoning systems [16], robotics systems [12], and real-time control system [14], etc. In what follows, we give a brief description about the FPN modeling tool [10] [12]. Let consider FPN = (PN, CND, MF, FSR, FM). The tuple PN = (P, T, A, FW, FH) is called Petri nets if: (P, T, A) is a finite net, where [14]:

P = {Pi, P2, ..., Pn} is a finite non-empty set of places,

T = {Ti, T2, ..., Tn} is a finite non-empty set of transitions,

^ c (P X D u (r X P) is a finite set of arcs between the places and

transitions or vice versa. FW: A-^ N^ represents a weighting function that associates with each arc of PN a non-negative integer of N^. FHcziPxT): represents an inhibition function that associates a place p. eP contained in FH (Tj) to a transition Tj itself

a) CND = {cdi, cd2,..., cdn} represents a set of conditions that will be mapped into the set P; each cd. e CND is considered as one input to the place P. eP. A condition cdi takes the form of "X is Z", which means a combination between the fuzzy set Z and the attribute X of the condition. For instance, in the condition "the delay measurement is small", the attribute "X = delay measurement" is associated to the fuzzy set "Z= small", but other fuzzy sets can also be considered (e.g. "Z = medium", "Z=large", etc.).

b) Consider MF: w^(x)-^[0,1], a membership function which maps the elements of X (as defined in b.) into the values of the range [0,1]. These values represent the membership degree in the fuzzy set Z. The element x belonging to X represents the input parameter of the condition "X is Z", and Uz(x) measures the degree of truth of this condition. Note that the composition of membership function degrees of the required conditions is performed by fuzzy operators such as

MIN/MAX.

c) Let consider the following rule R^: "R^, if Xi is Zi and /or X2 is Z2 then A is B". The firing strength function of rule Ri (FSRi) represents the strength of belief in Ri. The conclusion of Ri (modeled by CSRi) can take one of the following forms:

nets. A token is the primitive concept used in classical Petri nets for the definition of their executiof) The sequence 8 = {T^J^,...,T^)\s said to be reachable from a fuzzy marking FMi, if7; eTis a firable from FM^.i e FM and leads to FMi+i e FM, forall transitionsT.eS. The firing of transition T.eT (Figure 1) is performed in two steps: a) T. removes tokens and then, b) T. places tokens.

CSE, = MINiu^, (x,), w,2 (^2)) = "zi (^1) ^ W.2 (^2) CSR, = MAX(u^, {x, \u^, {x^)) = u^, {x,) v u^^ {x^)

d) SWR is the selected wining rule RL among the n-rules Ri, R2, ..., Rn- SWR is the rule which has the highest degree of truth. Let FSRLbe the corresponding firing strength of RL, then the selected rule SWR is given as follows:

SWR = MAX(FSR,,FSR,,...., FSR J

e) The marking task in FPN illustrates the satisfaction of events occurred during the performance of fuzzy rules. This marking function called "fuzzy marking" (FM) distributes the tokens over the places of the nets. A token is the primitive concept used in classical Petri nets for the definition of their execution.

In multicast routing protocols [22,23], the source data is transferred to group of receiver nodes. Where the intermediate nodes should have enough quality resources to forward the packets to group of node.

In Figure 9(a), the multicast tree is formed, where node S is the source, nodes (A, C, E, G) are receiver nodes and nodes (B, D, F) are forwarding nodes. Node K wants to join the group and broadcasts the join request packets. On receiving join request packets, the group members S,B,D,F and G send reply packets(RREP) to the node K. Through the RREP packets, the node K collects the topological information of the group members. It constructs the FPN model as shown in Figure 9(b), and runs the CRA algorithm to find the group member node with highest DoT value to join the multicast group.

Table 2. Performance of QTFPN

Table.1.multicast routing

Action	Time Complexity	Space Complexity
Neighbour monitoring	O(m × q)	It uses HELLO Packets
QoS metric estimation	O(m2)	No messages required
CF Estimation	O(n × fi)	No messages required
CRA	(× ×)	(× ×

The Aim of the project is to MANET is a special case of mobile networks, and new concepts have been emerged to improve the routing reliability to ensure the quality of information in a network containing mobile nodes. However, gain mobility is imperfect in other aspects such as speed of communication and quality of service. Compared to wired interfaces, only a few wireless interfaces offer fast throughput. As a result, routing consists of finding a path between the different elements of the network to send a message between two elements that do not communicate directly with each other. which aims to improve the routing between wireless mesh nodes in the emergency-response-network, based on the power utilized on a particular node. This algorithm exploits information about different paths, when this is available on a particular node, to calculate the necessary power. Message delivery power probability helps to discover most reliable paths available, which are selected based on the neighbour node's power level. There are three key challenges associated with opportunistic exploitation of paths with prolonged node power life and high quality of services (QoS With the proposed protocl, we seek to maximize the Packet Delivery Ratio (PDR) or equivalently minimize the Frame Loss Rate, maximize network capacity, and reduce end-to-end delays, taking into consideration bandwidth constraints, lifetime and reliability. The fuzzy synchronized Petri net (SynFPN) based on synchronized fuzzy transition approach, is substantially adopted in the modeling of the routing and detection/decision functions, where the ant system is used to find a solution to the problem of uncertainty events in ad hoc networks.

The main problem is to determine an optimal routing of packets across the network. The main objective of the proposed protocol is to find the least-cost investment in nominal capacities that ensures the routing of nominal traffic and guarantees its survivability in case of any arc or node failure. In this context, the fuzzy synchronized Petri net (SynFPN) is substantially adopted in the modeling of the routing and detection / decision functions that uses a synchronized fuzzy transition approach, where the ant system is used to find a solution for the problem of uncertainty events in ad hoc networks. The obtained results show the effectiveness of the proposed synchronized Fuzzy Ant System (SynFAnt) protocol compared to four protocols. The SynFAnt routing protocol improves the packet delivery ratio, the throughput, the end-to-end delay, and the acceptance rate of the QoS flows. Fuzzy logic (in the "ambiguous" sense of the term) has been developed to circumvent the impossibility or the extreme difficulty of modeling certain problems. In opposition to the Boolean logic that does not tolerate intermediate states, the idea is then to determine the veracity of a proposition as being a real number situated in the interval . It is inspired by classical human reasoning, which is often based on incomplete data. It is said that fuzzy logic makes it possible to make the link between symbolic modeling and numerical modeling. Used in artificial intelligence, fuzzy logic also finds applications in fields as varied as robotics, seismology, medicine, and even routing in ad hoc networks.

Related work: The work carried out in the framework of this paper consists in proposing an ad hoc network routing protocol with communication constraints and at the same time studying mechanisms of repair of connectivity. SynFAnt protocol is based on fuzzy logic and ant system. The main contribution of this paper is summarized in the following points :

Defining the types of nodes located at the network at the time 't' and the changes in each node over time using fuzzy petri net reasoning.

Defining several parameters or indicators (e.g. hopcount, packet, residual energy, delay, and distance).

Choosing the best close node based on the confidence value provided by neighboring nodes, which depends on the fuzzy logic in the calculation.

Proposing a new detection procedure based on the ant system, this procedure aims to reduce the extra cost of the signaling.

The integration of the detection procedure in the routing protocol helped to reduce mutual inference between the nodes and minimized broken routes. Finally, by using several network metrics, the Packet Delivery Ratio (PDR) and the network lifetime (LT) are increased, and the end-to-end delays is reduced.

Proposed work: B. B. Maqbool and M. Peer, Classification of current routing protocols for ad hoc networks-a review

In ad hoc wireless network is a collection of two or more devices or nodes or terminals with wireless communications and networking capability that communicate with each other withoutthe aid of any centralized administrator also the wireless nodes that can dynamically form a network to exchange information without using any existing fixed network infrastructure. And it‟s an autonomous system in which mobile hosts connected by wirelesslinks are free to be dynamically and some time act as routers at the same time. In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. The primary goal of such an ad hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Route construction should be done with a minimum of overhead and bandwidth consumption. This article examines routing protocols for ad hoc networks and classify these protocols based on a set of parameters. The article provides an overview of different protocols by presenting their characteristics and functionality, and then provides a classification of these different routing protocols available for the transmission in ad hoc networks.

S. K. Das, A. K. Yadav, and S. Tripathi, IE2M: Design of intellectual energy efficient multicast routing protocol for ad-hoc network

An intellectual energy efficient multicast routing protocol is proposed. It achieves enhanced performance over On-Demand Multicast Routing Protocol (ODMRP). The proposed protocol finds energy efficient multicast routes from source node to a group of receivers. Multicast mesh creation involves two phases: a Join Query (J-Q) phase and a Join Reply (J-R) phase. The J-Q phase initiates a route discovery process to find routes of the multicast group. In J-R phase, different routes of the multicast groups are set up. In the proposed protocol, we modify ODMRP and introduce fuzzy inference system to deal with imprecise and partial information during the route discovery phase. The decision maker uses two fuzzy variables such as energy and distance for evaluating reward as an output parameter of each multicast route. This output parameter helps to distinguish different multicast route and it also helps to reduce the effect of mutual interference between routes.

H.-C. Liu, J.-X. You, Z. Li, and G. Tian, Fuzzy Petri nets for knowledge representation and reasoning: A literature review

Fuzzy Petri nets (FPNs) are a potential modeling technique for knowledge representation and reasoning of rule-based expert systems. To date, many studies have focused on the improvement of FPNs and various new algorithms and models have been proposed in the literature to enhance the modeling power and applicability of FPNs. However, no systematic and comprehensive review has been provided for FPNs as knowledge representation formalisms. Giving this evolving research area, this work presents an overview of the improved FPN theories and models from the perspectives of reasoning algorithms, knowledge representations and FPN models. In addition, we provide a survey of the applications of FPNs for solving practical problems in variety of fields. Finally, research trends in the current literature and potential directions for future investigations are pointed out, providing insights and robust roadmap for further studies in this field

Y. Zhang, Y. Zhang, F. Wen, C. Y. Chung, C.-L. Tseng, X. Zhang, et al., A fuzzy Petri net based approach for fault diagnosis in power systems considering temporal constraints

The fuzzy Petri net is a promising and efficient approach that can tackle the complexities of power system fault diagnosis. In this work, the temporal constraint between event occurrences in power systems is investigated. Then, it is introduced to a fuzzy Petri net (FPN) for fault diagnosis. The temporal attributes are assigned to the propositions in the Petri net, so that temporal information can be taken into account, which makes the true hypothesis distinguishable from the false ones. The modified matrix execution algorithm can enhance computational efficiency, with a "weighted average" operation included to improve the fault-tolerance. The developed model possesses a modular structure, which is easy to adapt to topology changes, and to accommodate modern protection schemes. A preliminary evaluation of the operating performance of protective devices is also carried out after fault section identification. The testing results on the IEEE 14-bus power system and Zhejiang provincial power system in China demonstrate that the developed model is correct and efficient. Compared with three existing fault diagnosis methods, the proposed one has stronger fault-tolerance with lower computational cost, and is suitable for on-line fault diagnosis in large-scale power systems

BANDWIDTH MODEL

To ensure the flow of the stream QoS , we estimate the available bandwidth that can allocate them. The estimate must be distributed and consider the different phenomena specific to ad hoc networks (e.g., interference, collisions, etc.). The basic principle of most protocols is that nodes monitoring support the radio in determining the occupancy rate of a radio channel. Subsequently, an estimate of the timing of the transmitter and receiver mobile, as well as the collision rate, is performed to determine the residual bandwidth links. However, estimating these protocols does not consider the transmission type (or Best Effort QoS) in the network. Thus, we add it to the ADOV protocol , which is a mechanism to differentiate hopcont and the neighbor hosts as two criteria of the bandwidth model.

In the second control block, we used fuzzy logic to estimate the lifetime LT for each route. Consequently, we focus on two criteria: the number of packets sent by the route and the lowest energy consumed by the route nodes. One of the most important criteria in optimizing sending time is to control the number of packets sent by a node at time and the number of packets received. This factor is significant in evaluating the quality of the inkier. If one of the nodes is congested by a certain number of packets, then the shared bandwidth would be reduced in such a way that the unitary becomes unstable and loses packets

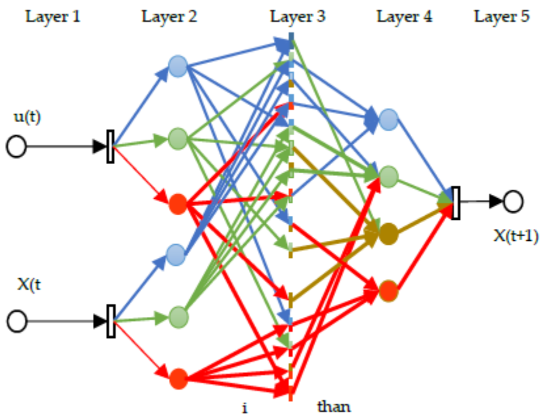
III. THE FUZZIFICATION

The first step consists in transforming the variables (input and output) into linguistic variables as depicted in the layer. The universe of speech (i.e. the range of values that the variable can take) is defined. Then, each variable is divided into categories called linguistic variables. These variables are expressed in words that give them meaning by using the human language (linguistic values).

IV. ANALYSIS OF SYNFANTPN

To optimally maximize the proposed tool, our study is essentially based on a probabilistic formula that is used to calculate the best probability to move from one node to another based on the previously cited parameters. Our study focuses on transitions, particularly on transitions with competing places.

Fig.1.



V. Conclusion

In this paper, a new routing protocol based on synchronized Fuzzy ant system, for ad hoc networks is proposed. The basic idea is to propose an adaptive solution to reduce congestion and end-to-end delay by checking the confidence values for each link in the network. The protocol uses parameters such as bandwidth, lifetime and reliability. Moreover, a new formula that considers energy, neighbor hosts number, efficient throughput and number of sent & received packets to estimate confidence values for each node, is proposed.

The process to find the best routes in the proposed protocol is based on fuzzy logic and ant system. The latter is a heuristic inspired by a biological field interested in the study of ant behavior. The proposed solution uses both systems due to their intelligence and ability to be adapted to the environment changes. This proposed solution to intelligently control the flow in MANETs has the following advantages: the control is preventive and quickly adapted to the changes that occur, and the proposed protocol can also detect faulty nodes and speedily propose new routing tables, to avoid large transmission delays that lead to packet losses.

The contribution of this work is: firstly, to integrate a new concept of routing by controlling the flow of the in information (Quantity and nature) to reduce the congestion and packet losses within an ad hoc network. Secondly, is to propose a new formula for real-time diagnosis for ad hoc communication networks.

VI. References

[1] H. Xia, and J. Yu, “Applying trust enhancements to reactive routing protocols in mobile ad hoc networks”, Journal of Wireless Networks, Vol.22, pp. 2239–2257, 2016.

[2] M.S. Khan, and M.I. Khan,“MATF: a multi attribute trust frame workfor MANETs”, EURASIP Journal on Wireless Communications and Networking, Vol.16, pp.1-17, 2016.

[3] V. Jayalakshmi, and T.A. Razak, “Trust Based Power Aware Secure Source Routing Protocol using Fuzzy Logic for MANETs”, IAENG International Journal of Computer Science, Vol.43, pp.98-107, 2016.

[4] K.Govindan, and P. Mohapatra, “Trust Computations and Trust Dynamics in Mobile Adhoc Networks: A Survey”, IEEE Communications Surveys & Tutorials, Vol.14, No.2, pp.279-298, 2012.

[5] L. Ju, E.H. Sha, H.Xia and Z. Jia, “Trust prediction and trust based source routing in mobile ad hoc networks”, Ad Hoc Networks Elsevier, Vol. 11, No. 7, pp. 2096-2114, 2013.

[6] S. Sridhar and B. Ramachandran, "Energy-and Trust-Based AODV for Quality of Service Affirmation in MANETs-ETQ", in Artificial Intelligence and Evolutionary Algorithms in Engineering Systems, Vol.324, pp. 601-607, 2014.

[7] B. Wang, X. Chen, and W. Chang, “A light-weight trust-based QoS routing algorithm for ad hoc networks”, Journal of Pervasive and Mobile Computing, Vol.13, pp.164–180, 2014.

[8] S. Zafar, and M. K. Soni, "Trust based QoS protocol (TBQP) using meta heuristic genetic algorithm for optimizing and securing MANET", International Conference on Optimization Reliabilty and Information Technology (lCROIT), pp. 173-177, 2014.

[9] I.R. Chen, J. Guo, F. Bao, and J.H. Cho, “Integrated Social and Quality of Service Trust Management of Mobile Groups in Ad Hoc Networks”, International Conference on Information Communications and Signal Processing (ICICS), pp.1-5, 2013.

[10] F. Hao, G. Min, M. Lin, and C. Luo, “MobiFuzzyTrust: An Efficient Fuzzy Trust Inference Mechanism in Mobile Social Networks”, IEEE Transactions on Parallel and Distributed Systems, Vol.25, No.11, pp.2944-2955. 2014.

[11] C.S. Bindu, and S. Nageswararao, “Weightage based trusted QoS protocol in Mobile Adhoc Networks”, IEEE Global Conference on Wireless Computing and Networking (GCWCN), pp.283-287, 2014.

[12] A.M. Shabut, K.P. Dahal, and S.K.. Bista, “Recommendation Based Trust Model with an Effective Defence Scheme for MANETs”, IEEE Transactions on Mobile Computing, Vol.14, pp.2101-2115, 2015.

[13] Z. Hu, H. Ma, G. Wang, and L. Liao, “A reliable routing algorithm based on fuzzy Petri net in mobile ad hoc networks”, Journal of Central South University, Vol.12, pp.714-719. 2005.

[14] H.C. Liu, and L. Liu, “Knowledge Acquisition and Representation Using Fuzzy Evidential Reasoning and Dynamic Adaptive Fuzzy Petri Nets”, IEEE Transactions On Cybernetics, Vol. 43, No. 3, pp.1059-1072, 2013.

[15] P. Sethuraman, and N. Kennan, “Refined trust energy-ad hoc on demand distance vector (ReTE-AODV) routing algorithm for secured routing in MANET”, journal of wireless networks. Vol.22, pp.1-11, 2016.

[16] C.C. Hu, H. Wu, and G.H. Chen, “Bandwidth-Satisfied Multicast Trees in MANETs”, IEEE Transactions On Mobile Computing, Vol. 7, No. 6, pp.712-723, 2008.

[17] K.P. Shih, W.H. Liao, and Y.C. Tseng, “A TDMA-based bandwidth reservation protocol for QoS routing in a wireless mobile ad hoc Network”, IEEE International Conference on Communications, pp. 3186-3190, 2002.

[18] N.C. Wang, and Y.F. Huang, “A Power-Aware Multicast Routing Protocol for Mobile AdHoc Networks With Mobility Prediction”, wireless personal communications, Vol.43, pp.1479–1497, 2007.

[19] Z. Wei, and H. Tang, “Security Enhancements for Mobile Ad Hoc Networks With Trust Management Using Uncertain Reasoning”, IEEE Transactions on Vehicular Technology, Vol.63, No.9, pp.4647-4658, 2014.

[20] T.C. Chiang, C.F.Tai, and T.W. Hou, “A knowledge-based inference multicast protocol using adaptive fuzzy Petri nets”, Elsevier Expert Systems with Applications, Vol. 36, pp. 8115–8123, 2009.