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SURVEY OF FUZZY INFERENCE MODEL AND IMPACT ON QOS PARAMETERS USING ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM IN MANET

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ABSTRACT

Adhoc Networks are new paradigm of wireless communication which lack specific infrastructure. Scalability and Routing are the two major challenging issues that need to be addressed for providing better performance of the network. Due to mobility nature and dynamic topology, the conventional routing protocol should be manipulated to meet QoS requirements required for multimedia traffic. To overcome the scalability issue, QOS parameters are kept in rigorus bound for group communication. Fuzzy Inference based System (Adaptive Neuro Fuzzy Inference) is used to optimize the QoS parameters such as delay and node speed for attaining the better performance of the network. This proposed scheme provides improvement in QoS metric such as delay, packet delivery ratio and minimizes the possibility of link failures and the overhead needed to construct the paths.

Keywords: MANET, quality of service, fuzzy inference system, optimization.

1. INTRODUCTION

Adhoc networks form without a need of centralized controller. It do not require any wired infrastructure for inter communication. Adhoc networks can change location rapidly and configure it because they use wireless connections to various networks. Mobile adhoc networks require no base stations and no fixed routers. All nodes in the network are capable of movement from one node to another node. Nodes in this network are autonomous, they carry out network control and routing protocols. MANET is a Multihop communication. It needs the support of dynamic routing protocols. Quality of service guarantees a certain level of performance to a data flow for different applications.

The properties of MANET include Neighbor Discovery, Data routing abilities, and limited wireless connectivity range and resource constraints. The important characteristic of MANET Distributed operation, multihop routing, and Dynamic topology, light weight terminals and shared physical medium. Various Multimedia applications such as Video on Demand, video conferencing require stringent QOS requirements which are sensitive to delay and bandwidth. The Quality of Service (QOS) is the guarantee to satisfy the user requirements provided by the networks. . This paper provides the study of fuzzy models such as mamdani model, takagi-sugeno model, and tsukamoto model and ANFIS based IF-THEN rules for optimizing the QoS parameters.

The work is organized as follows: Section 2 describes the related works. Section 3 presents various fuzzy systems used with their related merits and demerits. Fuzzy based QOS improvement scheme is proposed in section 4 and results and the performance of the system is evaluated in section 5 and 6.

2. RELATED WORK

Shafigh, A. S. Abdollahi , K. Kassler Andeas J [1] proposed Fuzzy logic control method to improve the performance and reliability of the multicast routing protocols in MANET. Strong and small forwarding group is established to decrease the resource consumption and higher stability of the delivery structure. A forwarding group is made out of set of strong /weak nodes. Fuzzy logic is proposed to distinguish the strong and weak nodes in the network. Join query packet is periodically broadcasted to update the routes in the network. An intermediate node receives a non-duplicate join query; it stores the upstream node ID into the routing table and rebroadcasts the packet. A node receives a join query message; it needs to fuzzyfys the parameters such as bandwidth, node speed and power level of previous node. The value of previous node's parameter is used to classify them as low, medium or high. After fuzzification, inference process is used to derive the probability of caching and forwarding the join query to other nodes. Using fuzzy based approach only links and nodes which are more robust or have more available power will participate in the forwarding mesh.

S. S. Manvi, M. S. Kakkasageri [2] proposed Agent based multicast routing scheme. Five types of agents are used i.e. Route manager static agent, Network initiation mobile agent, Network management static agent, Mobile agent, Multicast management static agent. Route manager static agent and Network initiation mobile agent cooperate to identify reliable nodes. Network initiation mobile agents connect reliable nodes through intermediate nodes. Intermediate nodes just forward packets from one reliable node to another reliable node. Route manager static agent (RMA) triggers the network initiation agent and multicast initiation agent to form the backbone and set

up multicast route. Agent cloning is performed to avoid the restriction of the agent movement. Clone of NIA moves from host reliable node to adjacent reliable node. If NIA finds the path, sends the traced path to parent NIA at host reliable node and destroys itself MIA (Multicast Initiation Agent) forms a multicast tree comprising of reliable nodes, intermediate nodes and group members and provide the group ID to all the members of the packet-forwarding nodes. RMA applies Dijikstra's algorithm to compute the shortest routes between the reliable nodes. Network management agent (NMA) monitors the intermediate node connecting it to the reliable node in the network. If an intermediate node or reliable node moves out of range then the NMA requests RMA to initiate the NIA to find the new paths between the reliable nodes. The agent based method provides flexible, adaptable and asynchronous mechanisms for distributed network management.

Martinez-Alfaro, H., & Hernandez-Vazquez, M. A. [3] Adaptive fuzzy inference system is proposed to improve the scalability of adhoc networks. Fuzzy network consist of three layers. First layer represents input variables, Intermediate layer represents fuzzy rules and third layer denotes the output variables. A set If-Then rule is used by the fuzzy logic to map complex non-linear relations. To solve the scalability problem adaptive fuzzy inference is designed with the combination of Fuzzy Logic Inference and Recursive Least Square Algorithm. Error driven protocol called witness aided routing is used to find the broken link in the route. Hop to live concept is used to discover the broken links in the path.

3. STUDY OF FUZZY SYSTEMS

A Mathematical calculus is proposed by fuzzy systems to translate the subjective human knowledge of the real processes. The neuro fuzzy term was developed based on the techniques called as neural networks and fuzzy logic. Neuro fuzzy system is a learning machine that finds the parameters of a fuzzy system (i.e., fuzzy sets, fuzzy rules) by exploiting approximation techniques from neural networks. The three stage of inference systems are: Fuzzification, Rule processing and Defuzzification.

Fuzzification: The numerical values and membership functions are mapped according to the respective fuzzy sets.

Rule processing: Computes the firing strength of the associated rules.

Defuzzification: The resultant fuzzy values are transformed into numerical values.

Fuzzy system advantages

Interaction between domain expert and system designer is easy. Because of natural rule representation, result interpretation is easy. Knowledge extension is easy through the addition of new rule

Fuzzy system disadvantages

It depends on expert to find the interference logic rules.

Figure-1. System design.

a) Fuzzy logic rule base

Fuzzy IF-THEN rules

The fuzzy logic operations are: and, or, not, implication, and equivalence $a \wedge b$, $a \vee b$, a, $a \Rightarrow b$, $a \Leftrightarrow b$

A general fuzzy Fuzzy IF-THEN Rule has the form

"IF a1 is A1 AND ... AND an is An THEN b is B"

Using the fuzzy logic AND operation, this rule is implemented by the following evaluation formula

$\mu A1\ (a1) \wedge ... \wedge \mu An\ (an) \Rightarrow \mu B(b)$ where

$\mu Ai\ (ai) \wedge \mu Aj\ (aj) = \min\{ \mu Ai\ (ai), \mu Aj\ (aj) \}$, $1 \leq i, j \leq n$, and, therefore, $\mu A1\ (a1) \wedge ... \wedge \mu An\ (an) = \min\{ \mu A1\ (a1), ..., \mu An\ (an) \}$

Drawbacks

In general fuzzy IF-THEN rule, there is no OR and NOT operation.

To overcome the drawbacks occur in the general IF-THEN rule,, the rule containing the OR operation can be split according to the clear understanding format

For Example: IF a1 is A1 AND a2 is A2 ORa3 is A3 AND a4
is A4 THEN b is B."

This rule can be split into the understanding format as two fuzzy IF-THEN rules,

"IF a1 is A1 AND a2 is A2 THEN b is B."
"IF a3 is A3 AND a4 is A4 THEN b is B."

Interpretation of fuzzy IF-THEN rules

Fuzzy IF-THEN rule can be easily interpreted, namely "IF a is A THEN b is B" is itself clear: the condition "a is A" infers the conclusion "b is B."

For example, the statement "IF a is positive THEN b is negative" is crisp, nonvague, and absolute

b) Fuzzy inference methods

The most important types of fuzzy inference methods are mamdani, sugeno fuzzy inference methods.

Mamdani Fuzzy model: Steps

- A set of fuzzy rules would be determined
- The input membership functions is used to fuzzify the inputs
- Rule strength is established by combining the fuzzified inputs.

- Consequence of the rule would be determined by combining the rule strength and the output membership function
- For getting an output distribution, consequences are combined
- Finally Defuzzification takes place

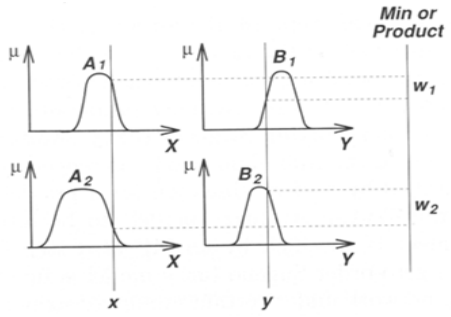

Figure-2. Takagi-Sugeno-Kang fuzzy model-- membership functions.

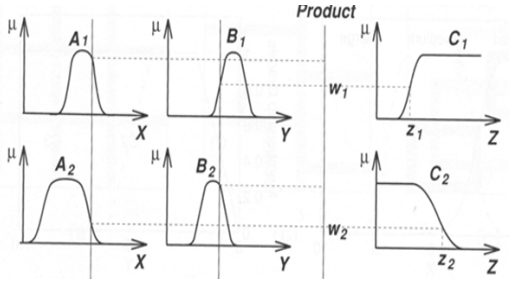

Figure-3. Tsukamoto fuzzy model- membership functions.

Takagi-Sugeno-Kang fuzzy model: Steps

The main aim aim of sugeno model is to reduce the number of rules required in mamdani model. From a given input output data set fuzzy rules are to be generated.

Fuzzy rule:

If x is A and y is B then z = f(x,y) where A and B are

fuzzy sets in the antecedent, and Z = f(x,y) is a crisp function in the consequence

$Z_1 = P_1x + q_1 + r1$

$Z_2 = P_2x + q_2 + r2$

The weighted sum should be calculated to reduce the computation time required in mamdani model.

$$z = \frac{w_1 z_1 + w_2 z_2}{w_1 + w_2}$$

Tsukamoto fuzzy model

The consequent of each fuzzy if-then-rule is represented by a fuzzy set with a monotonical MF.

Fuzzy rule

R1: If *X* is small then *Y* is C_1

R2: If *X* is medium then *Y* is C_2

R3: if *X* is large then *Y* is C_3

The average weight value is

$$z = \frac{w_1 z_1 + w_2 z_2}{w_1 + w_2}$$

4. PROPOSED METHODOLOGY

The neighboring nodes are discovered using Regular neighbor discovery scheme. It is used that guarantees discovering secure neighbors and also to provide secure data transmission. To overcome scalability issue, QoS parameters are optimized using ANFIS scheme.

a) Regular neighbor discovery

The regular -neighbor of a requesting user receives the neighbor discovery message from the requesting user directly and can authenticate directly.

Step-1: User S (source) generates and broadcast the neighbor discovery message to the participating nodes with nonce number and compute g^{rs} modp

Step-2: The participating nodes (A,B) verify the message using source 'S' public key and records in its neighbor candidate list.

Step-3: Source verifies the reply message from A by computing $K_{AS} = (g^{rA})$ mod p and record user A as regular neighbor in neighbor list.

Step-4: Source generates the corresponding reply message and sends to user A. The user A verifies the message and remove S from the neighbor candidate list and add S to the neighbor list.

Step-5: In a given time period, if the user A does not receive the reply message from 'S', then A retransmits the same message 't' times.

b) ANFIS based QoS routing

A fuzzy neural system is a learning system which uses set of fuzzy rules. Adaptive Neuro Fuzzy Inference System is the adaptive network which constructs input output mapping in the form of fuzzy rules (if-then rules) and produces stipulated input output data pairs.

When the number of nodes increases in the network, the performance degrades which leads to scalability problem. In order to provide better scalability in the network, QoS parameters are optimized using Adaptive fuzzy inference system according to user requirements. The QoS parameters such as Node speed, Residual power, link delay are used for optimization using fuzzy neural scheme

ANFIS system is the multi-layered which consists of 5 layers namely

Layer 1: Fuzzification

The degree of membership function is determined.

Layer 2: Rule

Computes the firing strength of the associated rule

Layer 3: Normalization

The normalized firing strength of a given rule is calculated

Layer 4: Defuzzification

The weighted consequent value of a given rule is calculated.

Layer 5: Output

Output layer consisting of single fixed node represented as Σ

ANFIS is based on inputs, rules and outputs. The inputs considered are node speed and delay. The If-Then rules considered are

If node speed (NS) is represented as T1, Link Delay (LD) as T2 and Battery Power(BP) as T3 , then

(Rule) f1 = $_{n11}$ *NS* +$_{o11}$ *LD* +$_{m11}$ *BP*.

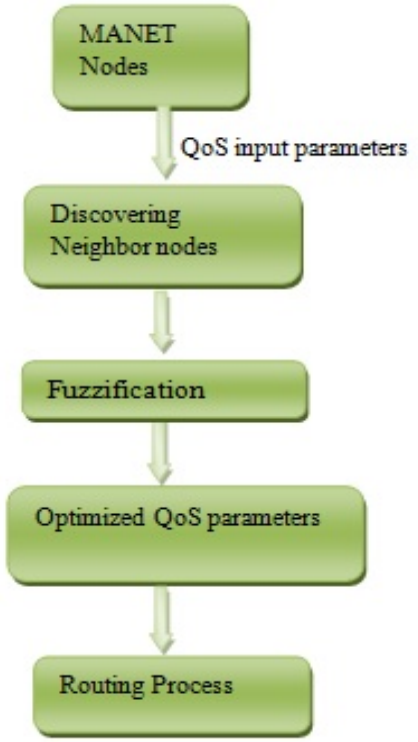

Figure-4. System architecture.

5. RESULTS

The simulations are carried out in network simulator NS-2. The random way point network model is used in the simulation.

a) Regular neighbor discovery

The MANET nodes are placed in random manner and they are discovered using regular discovery scheme. The discovered neighbors are shown in Figure-5.

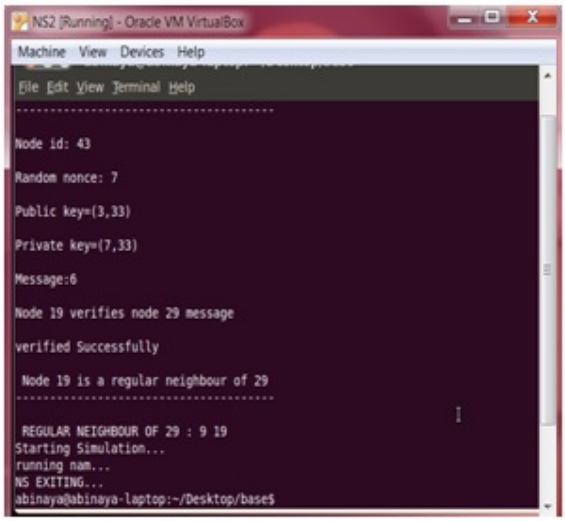

Figure-5. Regular neighbor discovery.

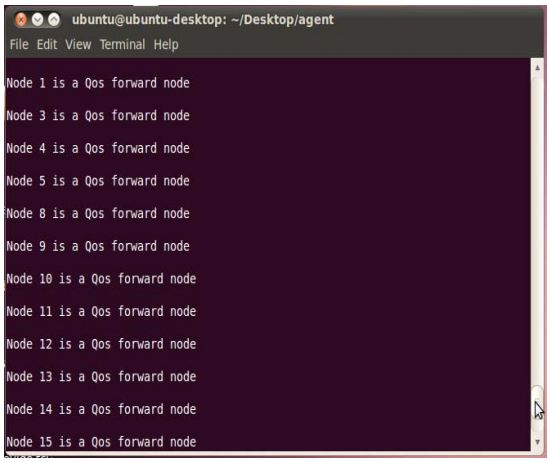

Figure-6. QoS forward node discovery.

b) Fuzzification

By using fuzzy rules, the QoS satisfied nodes are extracted and the results are shown in Figure 6.

6. PERFORMANCE EVALUATION

This section provides the performance improvement in adhoc networks. Throughput and success ratio is evaluated and the results are compared with QoS Optimization (applying fuzzy rules) and without QoS optimization.

Figure-7 shows the throughput which is the ratio of the total number of packets received to the total number of packets sent. By optimizing the QoS parameters, satisfied nodes are selected and opted for routing communication. This would avoid unnecessary dropping of packets and increases the performance of the adhoc networks.

Figure-8 shows the success ratio obtained by varying number of nodes. From the graph, we infer that increase in number of nodes do not disturb the

performance of the networks. The obtained success ratio is remarkably significant and improves the overall efficiency of the system

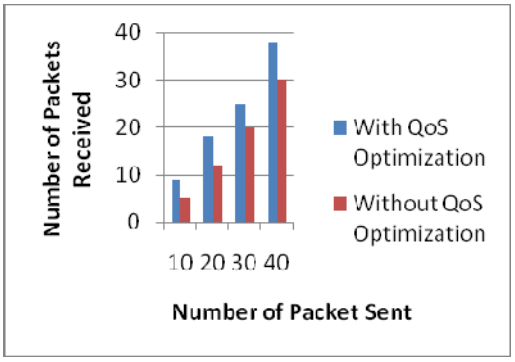

Figure-7. Throughput.

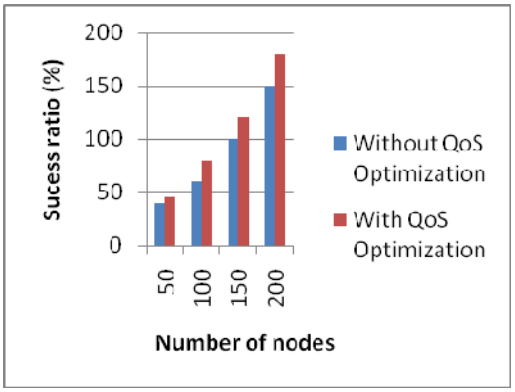

Figure-8. Success ratio (%).

7. CONCLUSIONS

MANET is a mobile adhoc network where every node joins and leaves a network. The proposed method ensures scalability of the adhoc network and provides Optimized QoS parameters. By using fuzzy Inference system, the network attains better performance. The proposed scheme showed significant improvements in terms of packet delivery ratio, packet delay and various overheads. This work can be extended by including more number of QoS input parameters and fuzzy rule sets for better routing process.

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