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Analysis of Reactive Routing Protocol Using Fuzzy Inference System

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Abstract

Earlier research in the field of routing protocols was extensively based on one constraint like shortest path between source to destination. There are several other parameters (such as dropping header packets in case of congestion in the network or alternate path in case of link failure) which should be considered for making efficient routing decision. In recent years, active research in the field of routing protocols has been done to make routing decision based on more than one constraint. Fuzzy inference system is one such system which offers a natural way of accepting multiple input constraints which are uncertain and imprecise in nature. This paper aims at analyzing the performance of AODV and DSR routing protocols using fuzzy inference system. Further the behavior of these protocols is analyzed in both cases (with and without fuzzy inference system).

Keywords: MANET, Fuzzy Inference System, AODV, DSR

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1. Introduction

Wireless Ad-hoc networks have fascinated researchers because of the flexibility, ease of deployment, dynamic topology, adaptivity, robustness etc. During last four decades, various kinds of routing protocols have been developed for different application areas like military, civil, search and reuse, communication in transportation, conferences etc.

Based upon routing information update mechanism (Murthy, 2004; Sharma & Alam, 2012); three categories of routing protocols are (1) Proactive (2) Reactive (3) Hybrid. Proactive protocols periodically exchange their routing information in the form of routing table. Whereas reactive routing protocol obtains necessary path information only when needed. Hybrid routing protocol combines the best of above two. However performance of same protocol varies in different scenarios. These routing algorithms take several aspects into account during route establishment which decide and influence the routing decision. But still there is a need to develop a system that can deal with uncertain and imprecise information. Fuzzy Inference engine is able to fulfill these needs and helps in achieving dependable solution to route finding.

2. Related Work

To optimize routing protocols in Mobile ad-hoc network, researchers have been exploring different mechanisms. The Fuzzy logic system proposed by Rea & Pesch (2004) uses caching decision to produce replies only for suitable routes in a route discovery process. Wang, Chen, Yang & Gao (2005) proposed fuzzy dynamic routing protocol that uses fuzzy logic to configure the routing parameters and categorize the network based on degree of membership. To find the most secure route in mobile ad-hoc networks Jin, Zhang, Lai & Zhou (2006) implemented fuzzy logic based security level routing protocol. For managing traffic problems, multimetric QoS routing has been proposed by Song & Fang (2006) that uses fuzzy theory. It achieves good results between QoS provision and network performance based on DSR. For multicast routing, to determine the appropriate route in mobile ad hoc network, AODV routing protocol modified by fuzzy logic has been proposed by Su, Wang & Huang (2008). On the basis of minimum bandwidth and hop count of each route, Torshiz, Amintoosi & Movaghar (2008) proposed energy based AODV technique that analyses the route to detect the optimal route. Fahad & Ali (2010) proposed fuzzy multi constraint AODV routing protocol. They improved AODV by considering mixed metrics in route selection decision using fuzzy logic. To choose the highest stable route in imprecise routing, fuzzy logic technique is used in DSR routing algorithm by Zuo, Ng & Hanzo (2010). In ZigBee mesh network, to reduce energy consumption, Ortiz, Royo, Olivares & Barbosa (2011) proposed Fuzzy logic based metric to be used in AODV routing protocol that select node in routing, on the basis of energy consumption and delay. Dehyadegari, Daneshtalab, Ebrahimi, Plosila & Mohammadi (2011) proposed an adaptive routing algorithm based on fuzzy logic that manages the traffic distribution and diverts the traffic to the less congested nodes.

3. AODV routing Protocol

The Ad Hoc On-demand Distance Vector Routing (AODV) protocol (Sharma & Bashir, 2012; Bai & Singhal, 2006) is a reactive routing protocol for mobile ad hoc networks. AODV is based on the DSDV and DSR algorithms. It uses the route discovery and route maintenance process of DSR and step routing, sequence number to ensure loop-free and up-to-date routes in an on-demand way and periodic beaconing mechanism of DSDV. Reactive routing protocols require routing information of current path at nodes, when needed. To know their current destination route, every mobile node preserves routing table of next-hop. The stale entries in routing table expire, to get current routing information.

AODV routing process, uses control messages: route request (RREQ), route reply (RRP), route error (RERR) and Hello messages (Murthy & Manoj, 2004). when a source node desires to establish a communication session, it initiates to send packets to the destination if it has a current route to the destination in its routing table, otherwise; it initiates a path discovery process by broadcast RREQs .Once the intermediate node receives the RREQ, it checks the request and forwarded RREQ packet to the neighboring nodes if it is not the destination. This process repeats until RREQ reaches to the destination address node. On reaching destination address node it will reply with RRP packet. This RRP is unicast along the reverse-routes of the intermediate nodes until it reaches the original requesting node. A bi-directional route is established among source and destination. Link status to the next hope can be preserved by the use of hello messages. If no link is detected by a node then it sends RERR packet to its neighboring nodes which in turn transmit RERR packet to the link-affected nodes. These link-affected nodes can acquire other routes through route discovery mechanism, if required.

4. DSR routing Protocol

The Dynamic Source Routing (DSR) (Sharma & Alam, 2012; Du & X, 2005) is a reactive routing protocol that follows source routing algorithm. Each node source route cache holds the known source route and it updated its cache, if new routes or shortest route are learned.

There are two major steps in DSR (Murthy & Manoj, 2004; Sharma & Alam, 2012), the route discovery step and the route maintenance step. The route cache is consulted when a source node wants to transmit a packet. If the required route is available, the source node includes the routing information inside the data packet before sending it. Otherwise it will initiate for new route discovery process which is similar to AODV. The difference is that each node used for broadcasting this route request message directs the route to originator, and keeps in its cache. There can be many route replies for a single request. DSR uses layer two built in acknowledgement to deduce a link failure between adjacent nodes If an intermediate node does not receive acknowledgement from its adjacent node during a message traversal, it deduce that a link failure has occurred and it will send an Route Error message to source and concerned nodes. Several additional optimizations improvements are Promiscuous listening, Packet Salvaging, Automatic Route Repair (Moghim, Hendessi & Movehhendinia ,2002). In Promiscuous listening a packet either addressed to the node or not, is examined by the node. It keeps on updating own resource route cache to find shortest and new path. During link failure, Packet Salvaging provides the capability to redirect the route in data packet by analyzing its own resource route cache. Automatic Route Repair omits redundancy errors between the node and its neighboring resource route cache.

5. Fuzzy Inference System

Dr. Lofti Zadeh of university of California proposed the concept of fuzzy logic (Ross, 1995; Wang, chen, yang & Gao, 2005) in the year 1965. It provides natural thinking mechanism based on human mind that include imprecision and ambiguity. The steps involved in working of Fuzzy inference system (Ross, 1998; Torshiz, Amintoosi, Movaghar, 2011) are as follows:

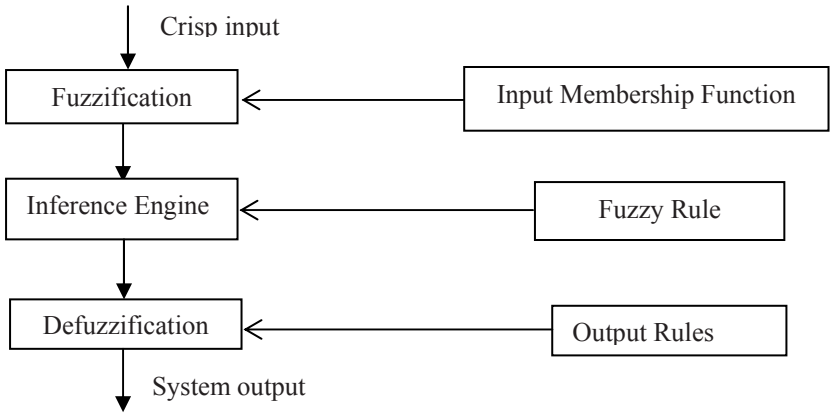

Figure1: Fuzzy Logic Infrence System

Step 1. Selection of input and output linguistic variable

Identify relevant input and output variable. Assign linguistic label to each variable. These variables are expressed using fuzzy set. The linguistic variables characterize the key features like minimum bandwidth, hop count, route selection, probability etc. and fuzzy sets labels these linguistic as low, high, small medium etc. Then select proper membership function for input and output variables.

Step 2. Applying Fuzzification processes

In this step, the crisp input is fuzzified with the help of membership function defined in the first step.

Step 3. Design of the fuzzy IF-Then rule base

The Set of IF THEN rules are constructed to obtain the desired behavior of the system on the basis of knowledge of human expert. IF x is A THEN y is B, Where A and B are linguistic values of the linguistic variables x and y, respectively. In order to achieve the full functionality of the system, the rules can be kept on changing.

Step 4. Aggregation of rule output

The output of inference engine is received by aggregating the measurement of fuzzified input with appropriate fuzzy design rules correctly.

Step 5. Applying Defuzzication processes

Defuzzification process converts the aggregated fuzzy set output of the inference engine in to a single real number. This real number shows the action taken by FIS.

6. Analysis

Numbers of routing protocols have been created in last four decades. Each has its own advantages and disadvantages, but no one is found better in all the conditions. To know their behavior by considering different metrics in different circumstances we have analyses AODV and DSR routing protocols based on Fuzzy inference system. We have also analysed their advantages and disadvantages.

Table 1 Comparative Analysis of Implementation of routing protocols Using Fuzzy Inference System

Routing Protocol	Metrics	No. of Nodes	Compared with	Simulation	Advantage	Disadvantage
FUZZY –DSR[3]	Route Request	30	DSR	C++ using	Route request control	FIFO policy used, path cost

	Overhead, Packet Latency, Packet Delivery ratio			CNCL	overhead is minimized. Packet Latency is minimized.	and time cost is not considered so better quality is removed.
FDRP[4]	Packet Delivery Ratio, Average End to End Delay,Average Energy Consumption	50,100	AODV	NS-2	In high mobility it can dynamically adjust the value of parameter	Energy consumption on an average increases when the maximum speed of the node is increased.
FLSL[5]	Security level of Final Route, Time consumption of route Discovery Process	18-83	AODV	NS-2	Route Security Level in FLSL protocol is higher as compared to AODV protocol.	Security level will be decreased when the amount of active neighbour is increased. It consumes more time than AODV routing protocol.
MQRFT[6]	Average End to End Delay, Overhead , Average Throughput	50	DSR	NS-2	MQRFT perform better including delay routing, overhead, average throughput.	Increased Density node affect change of link quality and performance decreases.
FMAR[7]	Average route Acquisition, Packet Delivery ratio	-	AODV Flooding	NS-2	FMAR perform better with respect to node mobility, packet delivery ratio, average route acquisition	Packet delivery ratio is same or less than AODV when speed is less than 4 m/s.
FE-AODV[8]	Minimum bandwidth, Hope Count, Route failure	500	AODV	NS-2	Select the optimal routes and consume less bandwidth.	Delay time is increased because of more calculation.
FAODV[9]	End to End Delay, Packet Delivery	20-30	AODV	OMNET++	FAODV Perform better in term of avg. delay and packet delivery.	It added delay period of each path.
FLDSR[10]	Normalized number of Route Break Events Packet Latency Network Throughput Inverse network control load	20	DSR	OMNET++	Lessens the number of route break event enhances the network throughput.	Frequent number of route break affects the performance. Suitable configuration of physical layer required.
AODV-FL[11]	Energy Consumed, number of collision end to end Delay number of hopes	25-200	AODV	Omnet++	it increase the life time. Decreases number of collision	In large networks the probability of obtaining a non –optimal route is higher

7. Conclusion

In this paper we focused on two reactive routing protocols namely AODV and DSR for MANETs using fuzzy inference system. We analyzed the performance of various routing protocols proposed in last decade

based on fuzzy inference system. These protocols are built upon conventional AODV and DSR routing protocol. It has been observed that by adding new metrics and made minor changes in the operation of AODV and DSR, routing protocols using Fuzzy inference system increase the performance in real time applications. For further research Fuzzy logic can be used with other reactive routing protocols also.

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