

# **A Survey on Adaptive Gateway Discovery Strategy in MANET**

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**ABSTRACT:** In MANET various mobile node communicate with each other in short range network. MANET is a collection of mobile node and is dynamic in nature because of this wireless link between mobile node are often changing. The range of mobile node for communication is limited in the MANET so two nodes of different network which are placed in long distance are unable to communicate between them. Utility of MANET can be upgrade if mobile node has internet connectivity. MANET is infrastructure less and internet is infrastructure type network so they require an interface to connect with each other. So in this condition, internet gateway act as an interface between mobile node and internet, so if a mobile node wants to internet service, mobile node initiate a communication with an internet gateway. Use the internet gateway by mobile node, it needs to be discovered and selected based on different parameter for improve the overall performance of network. For gateway discovery and selection heterogeneous approaches have been proposed in the past. Reactive, proactive and hybrid internet gateway discovery mechanisms are popular approaches. But in contemporary a new approach adaptive gateway discovery and adaptive distributed gateway discovery has become well liked which is dynamic in nature. In this paper, we present some of the proposed adaptive gateway discovery concepts with future direction.

**KEYWORDS:** Adaptive Gateway Discovery, MANET, ACO, GWADV, GW\_SOL.

## **I. INTRODUCTION**

Mobile ad hoc network is a collection of independent mobile nodes that communicate each other through wireless link. MANET is created with wireless links without use of any existing infrastructure. Due to their free mobility, mobile nodes should repeatedly self configure to preserve the route between mobile nodes. Between two mobile nodes an intermediate node exists that is cooperate for retransmit and route the packet to the final destination. Therefore, each mobile node act as a router and node in MANET at the same time and nodes are move in any direction with different speed in independently of other mobile nodes movements. The behaviour of wireless links is continuously change maintained by protocols which are executed by the nodes in the MANET. Due to their capability to work independently, because of this behaviour originally MANET is used in military communications and for rescue operation. Wireless communication was success and for other scenarios, provoked the extension of this technology for conferences, visiting parks or recreation areas. PDA, laptop, cellular phones are different types of element can coexist for these situation. External networks, mainly to the internet are needed for civil application. Among all the nodes for successful communication MANET range is not always sufficient. If mobile nodes in MANET are want to communicate with other networks it needs to connect to the internet. Gateway device is used for provide internet connectivity to infrastructure less networks such as MANET, gateway have two interfaces for MANET as well as fixed network. MANET nodes discover the gateway and then MANET nodes are register with gateway for internet connectivity. The infrastructure networks (internet) provide an Access Router to allow for MANET nodes to be connected. Gateway is played the role of Access Router. Ad hoc routing capability is provided by internet gateway those are missing by Access Router, commonly when Access Router belongs to telecommunication operators. Hybrid mobile ad hoc network is referred by MANET when internet gateway present. Two main task is executed by gateway, first routing the

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

packet from internet to mobile nodes and second generating Modified Router Advertisement (MRA) messages for inform about the configuration parameter. Upon getting the MRA message by nodes, node creates, update or optimize the route to the gateway which is sending the packet to the internet hosts. The internet gateway provides bridge between MANET nodes and infrastructure network. Ad hoc nodes first discover the gateway then from multiple gateway available select a gateway based on path parameter before starting the communication with infrastructure network. Hence, for integration of MANET and infrastructure network gateway discovery and gateway selection is very important task done by mobile nodes. By gateway discovery mechanism multiple gateways are finding and then based on gateway node parameter, link and path one of the potential gateways is selected for communication. To select potential gateway from multiple gateway consider different QoS or non-QoS parameter and methods in [1] [2]. Maximum gateway selection methods consider mobility traces, hope count, delay, and residual load capacity of gateway and link connectivity or combination of this parameter.

In [1] [2] based on hope count a prospective gateway is selected. Gateway broadcast a gateway discovery message each nodes calculates distance between mobile nodes and gateway based on that message. In terms of hope count node select a shortest path to the gateway for transfer traffic from MANET to the infrastructure network.

But choose of minimum hope count is not always good for communication with other nodes because many number of nodes uses same least hope count path for communicating. So along this route more traffic because of this congestion problem is occurs. So consider some other metrics for selecting a route to a node either in internet or in local MANET. The other metrics can be remaining energy, traffic load, stability etc.

Discovery processes are classified in to three main categories: proactive, reactive and hybrid.

In proactive gateway discovery approach [3], gateway periodically generated MRA message and broadcast these message to MANET nodes for announcements of gateway. Periodically messages (MRA) are generated for a certain interval of time. GW\_ADV (MRA) message are needed to mobile nodes for register with gateway and message are contain relevant information about gateway. These gateway message MRA are not always used for configuration procedure also used for update/ or minimize the route to the gateway. In this case, extra control overhead generated if use invalid or non optimal routes because generation of Modified Router Solicitation(MRS) this message is generated by nodes without an active route to the gateway and this message is received by gateway and force to the gateway for sending MRA message to that mobile node who send MRS message. GW\_ADV message is generated by gateway and this message is received by mobile nodes and this mobile node are broadcast these message to next hop mobile node and it continue for covering all MANET nodes. But proactive approach limited the region of proactive by set the TTL (time to live) is equal to the minimum no hop count to cover the all active node. TTL logic is implemented in the hybrid approach which is the combination of proactive benefits and reactive benefits. The positive side of proactive approach is that less end to end delay because mobile node and gateway node route are pre available. But at the negative side more overhead is generated because advertisement message is continuous periodically generated by gateway. Periodic generated message is control by T parameter is the critical parameter for this kind of algorithm. If proactive approach will take low value of T, then generate more MRA message in the network. This extra MRA messages may not be used for update the route still they are valid. On the other hand if proactive approach will take high value of T then forces nodes routes to the gateway is discover by reactively by means of MRA message. Therefore, it is important for update the routes in the network set the T parameter for control the unnecessary MRA message. For set the T parameter control system is used and this is adjusting the T parameter dynamically in order to avoid the sending of unnecessary MRA message. Since small route updated later, the adjustment is based on number of short route is estimated that nodes to the internet gateway. Then the estimation of T parameter requires mathematical analysis of the spatial distribution of the MANET nodes.

In reactive approach MANET nodes send GW\_SOL message to the gateway and communication is always start by MANET node. Gateway reply GW\_SOL message to mobile node and reactive approach is on demand gateway discovery approach. Mobile nodes in MANET are waiting for uni cast MRA message from the gateway. The request message GW\_SOL is go through the intermediate node to the gateway. Less overhead of this approach in the positive side and number of control message is less in compare to proactive approach. More end to end delay in the negative side because route discovery is start by mobile nodes only when internet connection is required. Most widely protocol AODV is used in MANET routing protocol and this is based on reactive technique.

In hybrid approach, previous strategies proactive and reactive approaches are used to discover the gateways. Some part of the MANET work as proactive and remaining part of MANET work as reactive. Mobile nodes which are not in the range of proactive zone discover the gateway based on the reactive approach. This approach solves the disadvantage of

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Vol. 5, Issue 2, February 2016

previous approaches in positive side but increases the complexity of discovery and selection of gateway. To achieve a low control overhead and good scalability hybrid approach is used in which gateway send out periodic MRA message at a certain distance of MANET nodes and remaining part of MANET discover and select the gateway based on reactive approach. Depending up on the network condition range of advertisement is dynamically set. In addition, intermediate node act as a gateway if they know sufficient information for further reduce the overhead. In fact, Extensible MANET Auto configuration Protocol (EMAP) internet draft [4] is used to Achieve the network performance. In normal hybrid approach, the area of proactive approach is set as statically and not changed. This is very inflexible approach and current network condition not fit in this and consideration of proactiveZone dynamically is not adjusted in this rigid approach. In the proactive zone periodicity of gateway advertisements is another issue. Figure 1 represents architecture for interconnection of MANET network and internet using gateway. In this figure, proactive scheme uses the range of one hops count so broadcast and received the GW\_ADV message within this range. Where as in reactive, remaining region are send GW\_SOL message to the gateway for connection

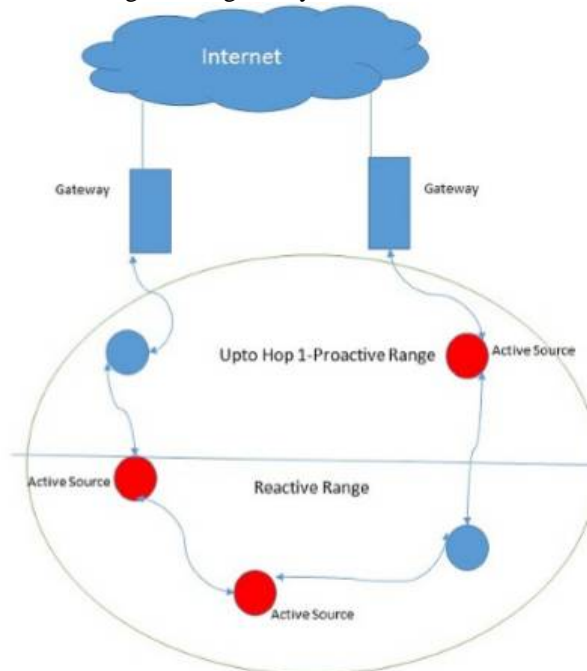


Figure1. MANET architecture

In this paper, we discuss adaptive gateway discovery strategies given by various authors. Advantage and disadvantage of each approach we are present. And discuss about the future work for adaptive gateway discovery can be done. The remaining part of the paper is organized as follows: Section II, show the related work in the area of adaptive gateway discovery strategies done by the various author. While section III show the discussion of the gateway discovery approaches proposed in various papers. Finally section IV concludes the study with some notice for the work in future based on that approaches.

## II. RELATED WORK

For connecting the MANET with the internet most of the paper proposed the protocol, some paper discussed for interconnection of MANET and internet with some methods and not dependent of any protocol. Gateway discovery approaches is discussed by only few paper. Number of survey papers in various network conditions has discussed the behaviour of gateway discovery approaches.

In [5] the authors proposed an approach, if detected the change in the topology of network then advertisements are sent out.

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In [6] adaptive gateway discovery approach is discussed based on the dynamic adjustment of TTL. They proposed an algorithm for find the TTL value dynamically for next gateway advertisement. They are used short period for sending the GW\_ADV messages (e.g. 4 second).

Various authors proposed a various approaches in some of the survey paper are summarized below:  
The work by Rafi U Zaman [7] has discussed on adaptive gateway discovery approached with their behaviour in various network condition. This paper gives full study of various mechanisms on adaptive gateway discovery even small changes in various strategies with their benefits. Some strategies such as maximal benefits coverage and maximal source coverage is increase the network performance of MANET.

### III. ADAPTIVEGATEWAY DISCOVERY STRATEGIES

The drawback of proactive and reactive approaches overcomes by combining the feature of both approaches called hybrid approached but one issue left in hybrid approach is the need to be addressed. More overhead in larger proactive area because maintenance of route in large area. Low overhead in smaller proactive area but delay in the gateway discovery is more. So, proactive region is needed in a balanced way in order to minimize both. We need to adjust the area of proactive region and gateway advertisement interval dynamically based on the changes in the network condition which make the MANET network adaptive. Now a day adaptive gateway discovery scheme is highly implemented in MANETs because of the adaptive properties. Adaptive gateway discovery scheme is overcome all the issues contain in proactive, reactive and hybrid gateway discovery approach. But this scheme exhibits high complexity in comparison to other three discussed schemes. In recent years to provide adaptability to MANET bio-informatics are being used.

#### Strategy 1:

In paper [8] covers only adjusting the range of GW\_ADV message dynamically. The scheme Maximal Source Coverage it cover the active source which are the longest distance from the gateway. For send the data packet mobile node uses the gateway either proactive or reactive scheme called the active sources. Gateway finds out the distance of active sources at which active sources located from the IP header of the packet. After locating the active sources TTL value is change with the number of are needed for reached the active sources. In the next advertisement message, GW\_ADV is broadcasted with new TTL value. Further this node drifts from reactive zone to proactive zone. It is a very simple with very less implementation complexity.

The main advantage of this heuristic is that low overhead and high packet delivery ratio as close as possible. But the disadvantage is that when a single active source is located at far distance then proactive zone is increased for a single node because of this increase the packet overhead. Since the MANET is dynamic, because TTL value is dynamically adjust. It is the first adaptive gateway discovery approaches.

#### Strategy 2:

This paper [9] also dynamically adjusts the range of GW\_ADV message. Distributed scheme use for decide the TTL value and not by the gateway. The GW\_ADV message is send to the active sources which are the part of some route. Which node desires the gateway connectivity then these node initiate the communication and initially all node in MANET are covered in reactive zone. Which node need the gateway send the GW\_SOL messages to the gateway and reply gateway broadcast GW\_ADV messages with TTL = 1. In the route of requesting node intermediate node part of this route set the TTL = 1 and broadcast the message. And the nodes which are not the part of this requesting route set the TTL = 0 and discard this message. In this way, receives the GW\_ADV messages only those node which nodes desire internet connectivity. Figure 2 show the working of this approach. Overhead is less in this approach comparison to other approaches this is main advantage.

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(A High Impact Factor, Monthly Peer Reviewed Journal)

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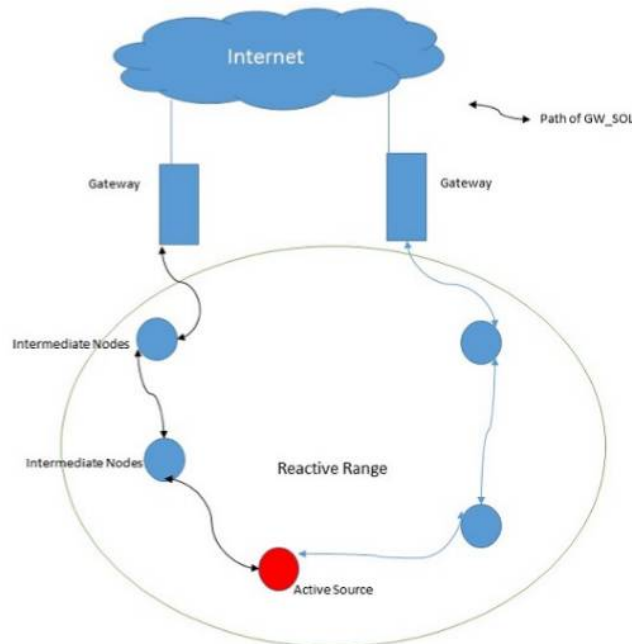


Figure 2: Working of Adaptive distributed Discovery

### Strategy 3:

This strategy is discussed in [10] that introduce maximal benefit coverage strategy. This approach is also adjust the dynamically TTL value of GW\_ADV messages. Gateway set the TTL value dynamically for GW\_ADV messages those gives the maximal benefit in Maximal Benefit Coverage. Maximal benefits can be calculated if incomplete information is available.

Maximal benefit is found as: A ratio between the costs of flooding the whole ad hoc network to the cost of providing internet connectivity in which not any GW\_ADV messages sent. This ratio is used to find the most appropriate TTL value for GW\_ADV message.

$$B(S) = \frac{N \cdot S(a)}{S(S + 3)}$$

Here, N is the message of flooding cost in the network and S(s) is the function and this is represent the number of active sources for the gateway and distance is less than are equal to s. The advantage of these strategies is that higher packet delivery.

### Strategy 4:

Complete adaptive gateway discovery approach is discusses in paper [11]. At large interval periodically sent out GW\_ADV messages and based on the detection of mobility in MANET periodicity is adapted for T. Maximal Benefit Coverage algorithm is used for maintain the TTL value of the GW\_ADV message in dynamic way. A heuristic function is used to determine whether to adapt the TTL periodicity. At regular interval, regulated mobility factor (RMF) is calculated by the each gateway, which evaluate the amount of source node mobility and source node has already registered with gateway. Periodicity of the GW\_ADV message whether to bring adapted is determine by RMF parameter which is used as threshold value. Maximal Benefit coverage algorithm is used for the demand of adaption. Number of nodes and number of intermediate nodes (AF) communicating with the internet is required to know for decide the benefit of adaptive advertisement. In figure 3 we are using TTL entries for counting the number intermediate nodes.



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| IP address | TTL |
|------------|-----|
| .....      |     |
|            |     |

Figure 3: Table to store TTL entries for sources

Following equation, calculate the total AF nodes:

$$Total\ AF\ Nodes = \sum_1^{nextTTL>1} Ns(TTL - 1)$$

Ns = number of sources communicating with the internet

Maximal Benefit Coverage algorithm decides the value of next TTL. Following Expression, is used when next TTL value is greater than 1. Adaptive advertisement is always beneficial if value of next TTL is one because the distance between source nodes and internet gateway is one hop. Regulated Mobility Factor is calculated by equation 3 for compute the performing an adaptive advertisement benefit.

$$RMF = \frac{NS}{Total\_AF\_nodes}$$

RMF is calculated by gateway for every X second where X is minimum advertisement period.

### Strategy 5:

Calculate the average number of hops of active sources based on adjusting of the TTL value and this approached is discussed in paper [12]. Value of TTL is fixed as a predefined value at the network initialisation time. Calculate the average number of hops for all active sources after stabilisation of the network. Next TTL value is decided based on that calculation. Reactive approach is used for gateway discovery when TTL value is less than or equal to 3. TTL value is set to the average number of hops if TTL value exit between 2 and 8. To provide better connectivity frequency of GW\_ADV is increased for large number of active sources if TTL value is greater or equal to 8. Frequency of GW\_ADV message is decreased if average number of hops is less than 8.

The main advantage of this approach is Time of computation is less which are computed by gateway.

### Strategy 6:

To decide the next TTL value used in GW\_ADV messages also uses the metric, average number of hops of the active sources discussed in the paper [13]. But it is a bit different previous discussed approach. New TTL is deciding by the following equation:

$$TTL_{new} = TTL_{old} + (AvgHop_{old} - AvgHop_{old-1})$$

Periodicity of the GW\_ADV messages also change by this approach.

### Strategy 7:

Optimal TTL value is used by author in paper [14] based on the network condition and a particular scenario of the network. So, if set the optimal TTL value then increase the packet delivery ratio with less increase in overhead. The author propose a architecture for future in which WLAN network and cellular networks are combines and, according to the density of active source nodes and quality of the link present in the network TTL value is decided by each base station or gateway. In this approach, for adjusting the TTL value a different and novel approached is proposed. This approach is an alternative of Maximal Source Coverage method.

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Here proactive zone is changes if adjust the TTL value. TTL value is adjust based on the Signal strength of the gateway and changes in the average distance of active sources from the gateway.

### Strategy 8:

In paper [15] adaptive distributed gateway discovery algorithm is discusses and it is totally distributed approach for gateway discovery. The ADD is targeted only those node which need the gateway and other nodes hampered with periodic gateway advertisement. In ADD algorithm initially discover the gateway by active source node in reactive manner. Once the route to the gateway is known, source node sending the data by using this route. By looking the IP header of the data packet which is received by gateway then gateway know the number of hops count is needed for reach the active source node. Based on this information gateway constructed a source table and based on this information all intermediate nodes between active source node and gateway are also capturing this information.

During the gateway advertisement periodically, initially sent the GW\_ADV message with TTL = 1 by gateway. Then which node receives this message then it verifies whether it is intermediate node. If node find that it is already send the message to the gateway then this node is intermediate node. If find the intermediate node then it forwards further the GW\_ADV message with TTL = 1 and other than intermediate node does nothing. All intermediate nodes forward this GW\_ADV message. Then path is maintained towards the gateway hop by hop for communicating with gateway. Between gateway and active sources an active region is formed and each active region has at least one active source for communication. From this distributed approach other than intermediate node not involve for gateway discovery, therefore significantly decrease the overhead. Figure 3 show the adaptive gateway discovery approach. However, if high mobility condition exit intermediate node help the active sources. Intermediate node also change if active sources is moves, from this situation active region is also moves. To this end, active region is always intact with active source node, and active region adapts itself based on the active source movement. If an active sources down the route to the gateway then this active node send the query to the any node of active region and then update the route to the gateway.

Finally advantage of this approach without generating more overhead in dynamic network this is because update the route to the gateway by active source node in very less time.

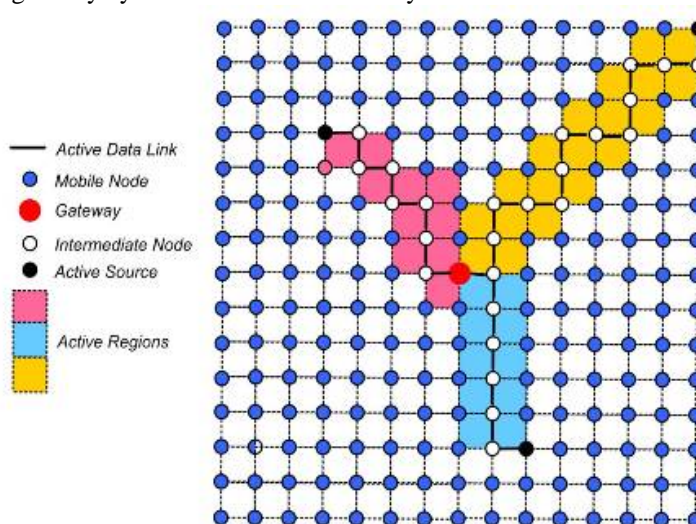


Figure3. Adaptive Distributed gateway discovery (ADD) scheme

### Strategy 9:

This strategy discussed in paper [16] for manipulate the GW\_ADV time interval T from the novel genetic algorithm. To find the density of the network, detect the number of nodes neighbourhood of the gateway. Gateway GW\_ADV message is sent at large interval if detected network density is high. This technique controls the unnecessary messages in the network which are the reason of the congestion in the network. Based on the Fitness function Genetic algorithm is used in this strategy. Based on the end-to-end delay and packet loss rate Fitness function is used to compute the

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interval T of MRA message. Based on changing in network topology interval T of MRA message is adjust on the basis of Fitness function.

### IV. CONCLUSION AND FUTURE DIRECTION

A lot of work has been done in the field of adaptive gateway discovery strategies conclude from this survey paper. Different types of strategy is available in this paper has some advantage over other. That adaptive algorithm maintained both periodicity and TTL value of the gateway then this algorithm is a good strategy compare to other strategy. Some strategies have more implementation complexity, and other have less implementation complexity. Particular strategy is best for particular scenario basis of particular requirement.

Bio- informatics algorithm such as genetic algorithm is used in recent year for manages the adaptive nature of MANET. To provide dynamism in MANET for gateway discovery use of fuzzy logic has been started and its use will become more ubiquitous.

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