A Survey on Gateway Selection Techniques in Wireless Ad Hoc Network

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***Abstract*- Wireless Network enables people to communicate and access applications and information without wires. A Wireless Ad hoc Network (WANET) is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure and access points in managed wireless networks. MANET is a type of ad hoc network that can change locations and configure itself on the fly. A Mobile Ad hoc Network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected wirelessly. Vehicular Ad hoc Network (VANET) is a new technology based on MANET that provides communication among vehicles which is improve traffic safety and comfort of driving and travelling. A Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. The main role of gateway node like a border node is a mobile node which has at least one neighbour belonging to a different cluster. Although Clustering has been used to reduce data propagation traffic and facilitate network management in Wireless Ad hoc Network. A gateway is a vital role for communication among Wireless Networks. Selecting optimum network and gateway is the key point in integrated networking process. The selection of gateway is main aspects in clustering and non-clustering techniques. This papers focus on various gateway selection algorithms proposed for stability and communication in Wireless Ad hoc Network.**

Keywords - VANET, MANET, WSN, Clustering, Gateway selection.

1. INTRODUCTION

A wireless network is any type of computer network that uses wireless data connections for connecting network nodes. A wireless network enables people to communicate and access applications and information without wires. This provides freedom of movement and the ability to extend applications to different parts of a building, city, or nearly anywhere in the world. Examples of wireless networks include cell phone networks, Wireless Local Area Networks, wireless sensor networks, satellite communication networks, and terrestrial microwave networks. A Wireless Ad hoc Network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. There are three network is mainly used in Wireless Ad hoc Network. That is Mobile Ad hoc Network, Vehicle Ad hoc Network and Wireless Sensor Network.

Mobile Ad hoc Network is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. These networks work in a distributed manner with no fixed infrastructure. MANETs have different applications, such as battlefields, environmental monitoring, cars networks, etc. The Main characteristics of MANETs are: the nodes' movement is not restricted to a certain pattern and can move freely in the field. Also, MANETs have more concentration on selecting gateway node or gateway to enhance network communication (Saleha Mubarak AlMheiri,2015). On the other hand Vehicular Ad hoc Network consisting of a network of vehicles moving at a relatively high speed that communicates among themselves with different purposes. It includes V2V communication and V2R communication, that is important component of ITS. The primary goal of VANET is to provide road safety measures where information about vehicle's current speed, location coordinator are passed with or without the deployment of infrastructure.

VANET also provide value added services like email, audio and video sharing etc. Vehicular communication divided into three categories that are Inter-vehicle communication (IVC), Hybrid-vehicle communication (HVC) and Roadside-vehicle communication (RVC). IVC system is free-infrastructure that has on board units (OBUs)

sometimes also called in-vehicle equipment (IVE). Those systems divided into single hop and multihop. SIVC systems are useful for applications requiring short range communications. MIVC systems are more complex than SIVC but can also support applications that require long range communications.

A Wireless Sensor Network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or pre-determined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities (Ameer Ahmed Abbasi, M. Y. , 2007). Another unique feature of sensor networks is the cooperative effort of sensor nodes. One of the advantages of wireless sensors networks is their ability to operate unattended in harsh environments in which contemporary human-in-the-loop monitoring schemes are risky, inefficient and sometimes infeasible. Therefore, sensors are expected to be deployed randomly in the area of interest by a relatively uncontrolled and to collectively form a network in an ad-hoc manner (I.F. Akyildiz, W. S., 2002).

Clustering in Wireless Ad hoc Network can be defined as the virtual partitioning of the dynamic nodes into various groups. Groups of the nodes are made with respect to their nearness to other nodes. The connection of Wireless Ad hoc Network to internet is typically established via gateway. In WANET, gateway can be either stations units placed at fixed point along the roads or mobile units acting as mobile gateways for other nodes. Moving nodes to act as gateways will help reducing the infrastructure cost and improving the network performance by reducing route failure. However such network may operate highly dynamic. Communications are utilized between cluster and inside of clusters. First one is inter-cluster, which both source and destination nodes live in different cluster. Second is intra-cluster, which both source and destination nodes live in the same cluster. Need of clustering is used for to decrease the routing overhead, to enhance the message delivery and to proper network bandwidth. Clustering is divided into two categories according to cluster formation. First one is static, in which type of clusters done the works within range of RSU. Basically static clustering use same direction with same speed and no need of reconfiguration but scalability and other factors decrease the performance. Second one is dynamic, in which cluster done dynamically in minimum time. Cluster head and Gateway node changed because of high mobility. It is easily scalable one, reconfiguration and range of cluster depends on the density of the area (Samo Vodopivec, J. B. , 2012).

Different type of algorithm is used to select optimum gateway or gateway node or vehicle in efficient way. The rest of paper described as follows, section 2 describes basic concept clustering, section 3 presents gateway selection in wireless ad hoc network, section 4shows the classification of gateway selection algorithms, Section 5 describe cluster based gateway selection algorithm, section 6 describe non cluster based gateway selection algorithm, section 7 highlights the comparison of gateway selection algorithms and section 8 concludes the paper.

2. BASIC CONCEPT OF CLUSTERING

Cluster is a technique to group of node that have similarities according to some criteria together. In short, the roles of node in cluster are classified into three different types such that cluster head, gateway, and ordinary. After a cluster has been formed, cluster stability is an important goal that clustering algorithm by to achieve and is considered as a measure of performance of a clustering algorithm. By carefully selecting ordinary nodes, cluster head and gateway nodes that form a particular cluster their stability can be dramatically improved in Wireless. Clustering surveys categories of different algorithm used in terms of their principal application such that General purpose algorithm, Routing based algorithms, Channel access management, Security based algorithm, Qos assurance, Traffic safety and topology discovery algorithms and combination with cellular infrastructure (Samo Vodopivec, J. B. , 2012).

Clustering, in which a particular node called cluster head chosen within each cluster. In addition, a cluster head also keep a set of gateways belonging to another cluster or neighbouring clusters. Gateway selection is a resolvable step in optimizing the performance of clustering algorithm in MANET, VANET as well as WSN. Those algorithms identify the cluster which is best suited to act as gateway to clusters.

3. GATEWAY SELECTION

A network must discover and select a suitable gateway node form a number of gateways before staring communication with node in the infrastructure or less-infrastructure network based on MANET, VANET and WSN. Gateway selection is a process that selects a potential gateway node out of multiple discovered gateways based on network link and path or gateway node parameters. Some of author establishes gateway mechanism is static one which needs to be deployed at each particular smaller distance more cost and it doesn't support proper handoff. Some author establish in gateway mechanism between vehicle and RSU'S for efficient communication among them in VANET. Basically main gateway mechanism are proactive, reactive and hybrid gateway mechanism.

In proactive gateway discover mechanism all the vehicle will get updated information about neighbouring gateways. The merits of this mechanism give good connectivity's and it reduces delay but sometimes it increases the signalling overhead. In reactive discovery mechanism vehicle requires gateway connection for sending messages in a network. Merits of this mechanism are to reducing signal overhead but it has poor scalability. In hybrid gateway discovery is the merging of proactive and reactive approach. In this approach gateway broadcast the advertisement message in regular interval in which vehicle receive this message and set based upon the proactive approach, the vehicle outside this region discover the default routes to the gateway using the reactive approach. However gateway selection is process to select a node with in a cluster or between two clusters for communication. Those communication as been done in three ways first gateway node receive the data from cluster head, second it compress the data and finally transmit the data to the base station or other cluster head. The suitable node, vehicle or base station as gateway node can reduce control overhead and enhance network lifetime (Manu Sood, S. K. , 2014). However the gateway nodes are discovered from Wireless ad-hoc network cluster.

4. CLASSIFICATION OF GATEWAY SELECTION ALGORITHM

The classification of Gateway selection algorithm on Ad-hoc is derived into two types shown in the Figure 1. They are (1) Cluster Based Gateway selection (2) Non-cluster based gateway selection algorithm. In this type of algorithm, here elaborately explain various gateway selection algorithms in cluster and Non-cluster in the section 4 and 5.

5. CLUSTER BASED GATEWAY SELECTION ALGORITHM

Cluster based gateway selection in which, Cluster Gateway node is a border node which is used to convey the routing information from one cluster to another. The cluster heads and gateway nodes form the backbone network. Various algorithms are,

5.1. ELPC

Energy Level Based Passive Clustering (ELPC) Algorithm is proposed by Houda Zeghilet, NadjibBadache (Houda Zeghilet, M. M, 2012), which is based on Passive Clustering in WSN. ELPC algorithm is a none of on-demand clustering algorithm. It constructs and maintains the cluster architecture based on outgoing data packets piggybacking cluster related information. The gateway selection heuristic provides a procedure to select the minimum no of gateway. In this algorithm gateway node selection done by defining the Network Energy Level (nel) parameter and node's energy level. The minimum level energy is necessary for a node to be a gateway.

5.2. IPCA

Improved PC Algorithm (IPCA) proposed by Wu Di, Liang Hui (Wu Di, L. H. 2010) based on passive clustering in MANET. IPCA is used in large dense mobile network clustering. This is important, by this way it will eliminate unnecessary cluster break caused by the INITIAL node. The first CH_READY node that successfully sends the packets becomes the cluster and changes to the CLUSTER HEAD state. After receiving the cluster head's packets, the other nodes (not include cluster head) change to the right state according to the clustered number in the neighbour table. If it has two or more cluster head information's, the node changes to GATEWAY state. The node having only one cluster head information changes to ORDINARY state. It provides good performance in network.

5.3. VPC

Vehicle Passive Clustering (VPC) algorithm proposed by Sheng-Shih Wang, Yi-Shiun Lin (Sheng-Shih Wang, Y.-S. L. 2010), which is based on Passive Clustering in VANET. VPC algorithm borrows idea of the random back off in which gateway selection mechanism aim to determine minimum number of gateway node to maintain the connectivity of cluster structure. The state of node change based on priority. That priority calculated for all nodes. Priority is accomplished by a waiting period of time and high priority successfully become gateway node.

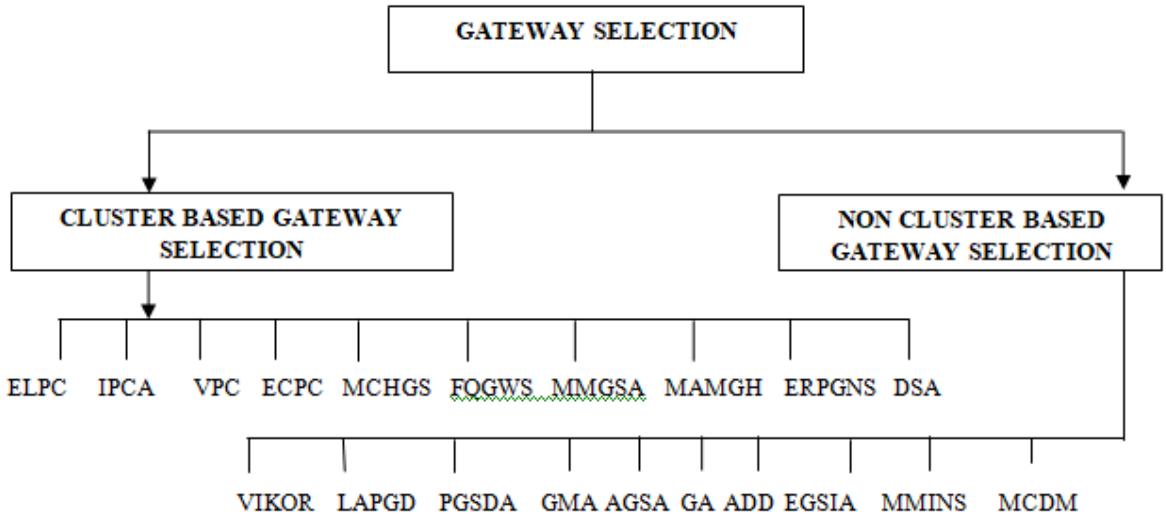

Figure 1. Classification of Gateway Selection algorithm

5.4. ECPC

Energy Conserving PC Algorithm (ECPC) proposed by M.D. Mamum-or-Rashid, Najib (Md. Mamun-or-Rashid, M. M.,2006) which is based on energy based passive cluster algorithm in WSN. ECPC will select better node as gateway in terms of residual energy and average distance of cluster head nodes within 1-hop. After the cluster set up will run with in certain time interval and each time new set of nodes will be selected as gateway. Enhanced PC based on Distance and Residual energy (EPCDRE) Algorithm also developed for to select optimum gateway based on cluster.

5.5. MCHGS

Mobility based Cluster Head and Gateway Selection Algorithm (MCHGS) is proposed by Sapna pal, S.P singh (Sapna Pal, S. S., 2013), which is based on identifier clustering in MANET. The selection of gateway node is useful to perform effective routing of data from source to destination. Gateway nodes are border node of a cluster that is significantly helpful for intra-cluster routing as well as inter cluster routing. MCHGS Algorithm used method for gateway selection done by comparing of Neighbour node ID, Cluster Adjacent Table (CAT), Neighbour Table (NT). Finally define the suitable gateway.

5.6. FQGWS

Fuzzy Qos balancing Gateway Selection Algorithm (FQGWS) proposed by Nithyavathi (Nithyavathi.K, V. S., 2016), which is based on hybrid clustering in VANET. FQGWS algorithm is a multi-criterion and QOS based scheme optimized by performing the fuzzy logic for making the decision over the appropriate gateway in Hybrid clustered VANET-LTE Advanced Hybrid network. In this algorithm input parameters are divided into two i.e. Attributes and criteria using fuzzy logic in cluster. New approach has been compared to the standard deterministic approach that uses the efficient cluster head as a default gateway.

5.7. MMGSA

Multiple-metric Mobile Gateway Selection Mechanism Algorithm (MMGSA) proposed by TarikTaleb et al (Abderrahim Benslimane, T. T., 2011), which is based on dynamic clustering in VANET as well as WSN.

MMGSA is efficient Gateway selection based on multiple metrics calculated by Simple Additive Weighting (SAW). In this algorithm multi criteria decision making Method is used to choose the optimum gateway node in cluster. The considered metrics for selecting optimum gateway include mobility speed, UMTS received signal strength and link stability in Dynamic cluster.

5.8. MAMGH

Multi-metric Adaptive Mobile Gateway Hand over Algorithm (MAMGH) is proposed by Tariktaleb (Abderrahim Benslimane, T. T. 2011), which is based on Qos dynamic clustering in VANET. MAMGH is used to select efficient gateway for hand over using predetermine threshold. The main concept behind UMTS RSS of gateway goes below the signal strength threshold and /or if the RET of the gateway it's predetermine threshold. This algorithm subsequently forms or joins a new cluster, while still maintaining its role as gateway.

5.9. ERPGNS

Efficient Routing Protocol for Gateway Node Selection (ERPGNS) proposed by Suruchi Pande and Raghav Yadav (Yadav, S. P., 2015), which is based on energy in WSN. ERPGNS scheme is a query based model which is designed to reduce energy consumption. In this algorithm maximum residual energy act as Cluster Head and Gateway selection for selection of Gateway node, If the node which has higher Residual energy, after the Residual energy of Cluster Head can act as a Gateway node else more energy consumption. ERPGNS considers nodes' packet reception rate, remaining energy and nodes buffer state with minimum hop while selecting gateway node.

5.10. DSA FOR UAV

Distributed Gateway Selection Algorithm for UAV (Unmanned Aerial Network) proposed by Feng Luo (Feng Luo, C. J., 2013). DSA for UAV algorithm is one of the clusters based algorithm in which whole network can be divided into sub-area via network partition method and distributed gateway selection algorithm to select stable node to be a gateway for their sub area. This algorithm based on mathematical model for gateway in which pre-set threshold (€) for stable gateway.

6. NON-CLUSTER BASED GATEWAY SELECTION ALGORITHM

Non- cluster based gateway selection in which, cluster less system contributes to effective broadcasting and relaying of message and increases the stability of inter node link within the Ad hoc Network. Various algorithms are,

6. 1. VIKOR

VIKOR **(**VlseKriterijumska Optimizacija I Kompromisno Resenje) that means: Multi-criteria Optimization and Compromise Solution, with pronunciation VIKOR) proposed by Majid Fouladian (Majid Fouladian, F. H., 2015), which is SAW based techniques in VANET. VIKOR method is used for decision making in heterogeneous networks. It is based on SAW techniques in which vehicle are equipped by 3G and 802.11p interfaces are considered as candidate for selecting optimum gateway. VIKOR method provides ranks the alternatives according to the criteria. Finally alternatives are ranked based on their values. In the method if there are some RSUs in the moving path, the RSUs will be evaluated like all candidate vehicles in neighbourhood of the source as candidate gateways, and according to priority of the packets, delay rate, geographical location of source vehicles and destination and all candidate gateways (both double-interface candidates and existing RSUs), finally the optimum gateway is chosen.

6. 2. LAPGD

Location-Aided and Prompt Gateway Discovery Mechanism (LAPGD) proposed by Kejian Ju (Kejian Ju, L. C., 2014), which is based on hybrid in VANET. LAPGD Algorithm undertakes a Hybrid gateway discovery approach and manages the gateway in dynamic way. Every vehicle is equipped with a 3G UTRAN (UMTS Terrestrial Radio Access Network) interface and an IEEE 802.11p interface. Each vehicle in the network has possibility to be a mobile gateway or a common node. It doesn't need clustering in the dynamic topology in VANETs. When the vehicle moves into the advertisement zone of another RSU, the car would have to update

the status of gateways recorded in its gateway list. This method selects a moving car as a gateway. Mobile gateway selection phase have Minimum number of gateways, Maximum number of vehicles in coverage and adaptively adjust the communication Radius of the gateway. The vehicle selects a gateway from its database and asks the gateway for another vehicle's information. LAPGD electing good gateway according to key metrics such as vehicle velocity, inter vehicular distance in efficient manner.

6. 3. PGSDA

Proposed Gateway Selection and Discovery Algorithm (PGSDA) proposed by Safdar Hussain Bouk (Safdar Hussain Bouk, I. S. 2012), which is based on Qos techniques in MANET. PGSDA is non-cluster based Quality of service based algorithm, in which QOS parameters of each path to the gateway node along with the path entries. It calculate the overall QOS value of each path index in the routing table and select the gateway that has a path with maximum path index value can be selected as efficient gateway.

6. 4. GMA

Gateway migration algorithm (GMA) proposed by Divya (Divya A.S, K. G., 2015). GMA is Quality of service based algorithm, in which to improve the overall network performance, it is necessary to select a gateway with stable path, a path with the maximum residual load capacity and the minimum latency in MANET. Gateway selection scheme considers multiple QoS path parameters such as path availability period, available capacity and latency to select a potential gateway node. TTL value is also used to select efficient gateway for network communication.

6. 5. AGSA

Any cast-based Gateway Selection Algorithm (AGSA) proposed by G E Zhihui (GE Zhihui, L. T., 2010). AGSA mechanism mainly used to avoid bottleneck problem. In that algorithm MST (minimum spanning tree) is used to find a path from source to efficient gateway and to provide internet access in wireless mesh network. The rule for optimize MST is delays of each edge have to satisfy with Qos constraints to select optimum gateway.

6. 6. GA based Gateway Selection

Genetic Algorithm (GA) proposed by Wenbo ma (Wenbo Ma, J. L., 2009).GA is used to select gateway based on hop count, gateway load, path Quality. This is Hybrid Approach which is based on orthogonal genetic algorithm and sensitivity analysis. Hop count is still an importance metric in gateway selection. Mobile nodes in MANET can passively acquire hop count value from gateway advertisements periodically, and also can initiatively acquire hop count value form gateway request/respond message. Fitness value evaluate for each node after that select efficient gateway. New configuration examples are generated by genetic operation of individuals in population, and the performance of the network with new configuration is simulated and compared with former configurations. The process is repeated until meet stopping criterion. The configuration provides best performance, in which gateway selection scheme of all nodes with Internet connective intention.

Table 1. Cluster Based Gateway Selection

ALGORITHM	METHODOLOGY	ADVANTAGE	DISADVANTAGE
ELPC	Energy based and Passive Clustering	Gateway selection increases the lifetime of the Network and has significant number of clusters.	Stability of cluster is relatively low maintenance.
IPCA	Mobility based and Passive Clustering	In this scheme relatively reduce the overhead, high cluster stability	Bottleneck problem and thus it has fewer chances to be elected gateway.
VPC	Priority based and Passive clustering	Provide high control over head and increase network capabilities	Candidate vehicle uses random competition to Become the cluster head or gateway, and then reliable vehicle is

ALGORITHM	METHODOLOGY	ADVANTAGE	DISADVANTAGE
			not guaranteed to be determined as cluster head or gateway.
ECPC	Energy based and Passive Cluster	Control overhead for cluster creation and maintenance and enhance lifetime of network.	Doesn't depend on global topological information only consideration time interval of cluster formation.
MCHGS	ID based and Mobility	Increase the life time of cluster. Reduce Number of cluster	Mobility of the node is not accounted for the stability.
FQGWS	Qos and Fuzzy logic	Standard deterministic approach that uses the cluster head as a default gateway	Linear complexity for the decision over gateway selection
MMGSA	Weight and Decision Making	It subsequently form or join a new cluster while still maintain role of gateway	No guarantees it will be the Cluster head of the new cluster
MAMGH	Weight based SAW techniques	It utilizes higher bandwidth rates	Some overhead involved due to migration
ERPGNS	Energy based and Routing techniques	Increase the network life time	Sometime performance low
DSA FOR UAV	Partition based	Good performance and efficiency	Gateway candidate are restricted in one sub area. problem in more asymmetric link

6. 7. ADD

Adaptive Distributed gateway Discovery (ADD) Proposed by Usman javaid,Francisco J. Ros (Usman Javaid, 2007). ADD algorithm is distributed adaptation of gateway discovery in Hybrid Wireless Network. This algorithm based on number of hops and TTL (Time to Live) value the active source in the network. Gateway advertisement message is used to select optimum gateway in HWN.

6. 8. EGSIA

Efficient Gateway Selection for Internet Access (EGSIA) proposed by Thamarai sevi (Thamarai selvi, G., 2015). EGSIA Algorithm choose efficient gateway scheme using factor such as signal strength, path availability, path latency and link expiration time to access internet. Then it calculates the distance between gateway and vehicle, check the range to select optimum gateway in VANET.

6. 9. MMINS

Multi Metric Intermediate Node Selection Algorithm (MMINS) proposed by P. Dharanya devi (P. Dharanyadevi and K. Venkatalakshmi, 2016). MMINS algorithm perform based on metric's that is based on direction of vehicles movement, LTE Received signal strength(RSS), Inter-Vehicular distance(IVD) and buffer size. Those metrics take as input, if node have maximum energy, buffer space then that newly node act as gateway node. Dynamically perform to selecting the gateway for efficient network.

Table 2. Non-Cluster Based Gateway Selection

ALGORITHM	METHODOLOGY	ADVANTAGE	DISADVANTAGE
VIKOR	Decision based	Good performance. No needs to use expert view to evaluate alternatives	High Overhead depend on Parameter with appropriate measurement
LAPGD	Hybrid Dynamic	Decrease computation	Performance low Gateway not

ALGORITHM	METHODOLOGY	ADVANTAGE	DISADVANTAGE
	based	overhead and communication	cover all nodes in whole network
PGSDA	Qos and routing based	Reduce packet loss and network congestion	Sometime path not available, time consume occur to select gateway
GMA	Qos and path based	Reduce bottle neck problem, control over head	It have less stable path
AGSA	Qos and tree based	Avoid bottle neck problem	high load balance among network
GA	Hop based	To balance gateway load and reduce general overheads	Poor performance in hand over
ADD	Hop based	Provide Active Region high mobility based on gateway	High load balance
EGSIA	Qos and distance, path based	Multi path communication to reach optimum gateway	Time delay occur
MMINS	Multi metric based	Dynamically performed by selecting the mobile gate way. bottleneck and congestion can be eliminated	Downgrade by some manner
MCDM	Weight based and Decision techniques	Relative low complicity and increases performance of node.	Energy metric obtain slightly higher when mobility is low.

6. 10. MCDM

Multiple Criteria Decision Making (MCDM) algorithm proposed by Fudhiyanto pranata Setiawan (Fudhiyanto Pranata Setiawan S. H., 2008). MCDM algorithm is general algorithm of gateway selection also called Simple Additive Weighting (SAW) to out rank the optimum gateway node. The gateway candidates can be any node in infrastructure network as long as they have IEEE 802.11b interface. This interface is used for ad-hoc mode connection in our scheme. This algorithm calculates the weight of gateway node. A node with the highest weight will be selected as a gateway in network.

7. COMPARISON OF GATEWAY SELECTION ALGORITHM

In order to easy understand the Clustering and non-Cluster based schemes, the various algorithms are considered for the comparison based on the method of Clustering and Non Clustering for efficient Gateway selection and it is give as Table 1 and Table 2.

The above comparison of cluster and non-cluster based gateway selection schemes gives different objectives and characteristics for select gateway node efficiently. The best algorithm gives low complicity, less control overhead, high packet delivery ratio, low delay and increases throughput for performance of node.

8. CONCLUSION

In this paper, the classification of Gateway selection techniques was presented based on their distinguishing features and their objectives. Clustering is responsible to determine member of vehicular application. This paper gives the extended survey of clustering and non-clustering based algorithm for efficient gateway selection which helps to organize MANET, VANET and WSN in a hierarchical manner and presented some of their main characteristics, objective, mechanism, and performance. We also identified the most of the clustering schemes focus on important issues such as cluster structure stability, the total control overhead of cluster formation and maintenance based on cluster head only. In addition, the different categories of clustering and non-clustering gateway schemes have different characteristics and objectives.

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