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ENERGY EFFICIENT ROUTING PROTOCOLS IN IOT-MANET SMART ENVIRONMENT: A REVIEW

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ABSTRACT

MANET is a self-organizing wireless network with transceiver and receiver radio nodes and a multi-hop system. Two nodes cannot communicate independently due to restricted radio range constraints and need support from other nodes to relay the data packets. MANET does not have any structured network like others and have many characteristics such as dynamic topology, self-organizing network, unidirectional wireless links. MANET is specially used for military scenarios, mobile communication cooperation, and communication in emergency scenarios, sensor network and wireless access. The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. MANET nodes can move around the IoT network and collect data from the sensors, RFID attached nodes, or any fixed Wireless nodes. Also MANET nodes are used between the sensor and the Internet Gateway, instead of connecting the low-power sensor nodes directly to the Internet. Fundamentally, WSN comprises of various sensors that can detect the information, incidentally store it and move detected information to another organization hub, which is additionally a sensor. Both Wireless sensor organization (WSN) and Mobile impromptu organization (MANET) are self coordinated and multi-bounced networks. This study provides overview on IOT aided MANET and various Energy Efficient Routing protocols are

highlighted with Route selection, Route Maintenance, Energy Consumption, Packet Delivery ratio and latency. It also presents comparative Analysis of their performance.

Index Terms- IOT Aided MANET, Energy Efficient and safe-weighted clustering Routing Algorithm, Trust based Data Routing, Intelligent water Drop Routing protocol.

1 INTRODUCTION

People's internet has changed the world, but a new internet is developing that links things, so its name is the Internet of Things (IoT), here things share their experiences and interact with one another.[1] We just want to live a better life and software like IoT has the potential to sound, connect and provide us with new levels of comfort. Collecting raw data and converting it into information and then wisdom and pushing the human race forward is a great technology. Technology speeds up intensity. The smart things can send information in MANET across all active things without any centralized scheme.[2]MANET is a set of nodes, which are basically distributed spatially and communicating each other wirelessly and here smart things can communicate with each other remotely The IoT MANET is a combination of compact, autonomous smart things that can transmit data through a wireless network to each other. It is widely recognized that WSNs and MANETs are key technologies for several IoT application domains in smart cities[3]: their suitability is also boosted by their localized and self-configuring capabilities. Very recently, mobile phones, already equipped with multiple wireless interfaces (IEEE 802.11, Bluetooth, and 3G), have started hosting onboard also low-power connectivity solutions, such as IEEE 802.15.4; moreover, low-power connectivity is expected to become available on most consumer devices in the near future.[4]

The WSN-IoT in which sensor nodes can communicate without human intervention and this form of communication is called automation communication between machine and machine. Generally, WSN IoT is a network that is classified into heterogeneous WSN IoT and homogenous WSN-IoT. In homogenous WSN-IoT, all sensor nodes possessed similar configuration like communication range and computation resource. However, in heterogeneous WSN-IoT, all sensor nodes possessed different type’s capability, computational resources, and type of sensor.[5] The most numerous of WSN applications are industrial sensor networking, volcano sensor networking, obstacle detection, health monitoring and home networking, etc.

MANET is a self-organizing wireless network with transceiver and receiver radio nodes and a multi-hop system. Two nodes cannot communicate independently due to restricted radio range constraints and need support from other nodes to relay the data packets. MANET does not have any structured network like others and have many characteristics such as dynamic topology, self-organizing network, unidirectional wireless links.[6] Basically MANET[7] specially used for military scenarios, mobile communication cooperation, and communication in emergency scenarios, sensor network and wireless access.

MANET has a crucial role in our work, and is used as the backbone of the IoT network. The MANET nodes can create spontaneous connections with other nodes without the need for any infrastructure due to their inherent properties. MANET nodes can move around the IoT network and collect data from the sensors, RFID attached nodes, or any fixed Wireless nodes. Thereafter it can process the data and send it to the Internet gateway through some intermediate MANET nodes. The MANET nodes use an effective route to enter one of the Internet gateways open. We used MANET nodes between the sensor and the Internet Gateway, instead of connecting the low-power sensor nodes directly to the Internet. Sensor nodes or RFID enabled objects send data either to the WLAN's MANET node or 'Access Point' or, in both cases, transmit data through sensor gateway nodes. In smart cities, there are many applications where these devices play an important role and provide people with various services, including environmental monitoring, traffic management, etc.[8]

The applications of IoT cover broad areas including manufacturing or the industrial sector, health sector, agriculture, smart cities, security and emergencies among many others.

A. Smart Cities

As indicated by[6], the IoT assumes a vital part in improving the keenness of urban communities and upgrading general framework. Some of IoT application regions in making savvy urban areas incorporate; canny transportation frameworks[7], shrewd structure, gridlock[7, 8] waste administration[9], brilliant lighting, keen stopping, and metropolitan guides. This may incorporate various functionalities, for example, observing accessible parking spots inside the city, checking vibrations just as material states of extensions and structures, setting up sound checking gadgets in touchy pieces of urban communities, just as observing the degrees of walkers and vehicles.

B. Healthcare

A great deal of advantages that IoT application offers in the medical services area is generally ordered into following of patients, staff, and items, distinguishing, just as validating, people, and the programmed assembling of information and detecting. Application areas in this area incorporate; having the option to screen a patient's consistence with remedies, telemedicine arrangements, and cautions for patients' prosperity. In this way, sensors can be applied to outpatient and inpatient patients, dental Bluetooth gadgets and toothbrushes that can give data after they are utilized and patient's observation. Different components of IoT in this limit in corporate; RFID, Bluetooth, and Wi-Fi among others.

C. Smart Agriculture and Water Management

IOT fortify and improve the agribusiness area through looking at soil dampness and on account of grape plantations, observing the storage compartment distance across. IoT would permit to control and save the amount of nutrients found in agrarian items, and manage microclimate conditions to capitalize on the creation of vegetables and foods grown from the ground quality.

D. Retail and Logistics Executing

The IoT in Supply Chain or retail Management has many benefits. Some include; observing storage conditions throughout the supply chain, product tracking to enable trace ability purposes, payment processing depending on the location or activity period in public transport, theme parks, gyms, and others. In the industry domain, IoT helps in detecting levels of gas and leakages within the industry and its environs, keeping track of toxic gases as well as the oxygen levels within the confines of chemical plants to ensure the safety of goods and workers.

E. Smart Living

In this space, IoT can be applied in controller gadgets whereby one can distantly turn machines on and off consequently forestalling mishaps just as saving energy.[9, 10] Other keen home machines incorporate fridges fitted with LCD (Liquid Crystal Display) screens, empowering one to realize what is accessible inside, what has over remained and is nearly terminating just as what should be restocked. Furthermore, a wide scope of kitchen gadgets can be interfaced through an advanced cell, henceforth making it conceivable to change temperature, as on account of an oven.[10]

F. Smart Environment

The IoT technology allows observing and managing of air quality through data collection from remote sensors across cities and providing round the clock geographic coverage to accomplish better ways of managing traffic jams in major cities. IOT can be applied in measuring pollution levels in water and consequently enlighten decisions on water usage. In weather forecasting, IoT can be used to deliver a significant accuracy and high resolution for monitoring the weather by information sharing and data exchange.

II IOT Aided MANET

Potential outcomes of wide utilization of Internet of Things frameworks in various zones are straightforwardly reliant on the chances of interoperability between various correspondence advancements and organizations in brilliant conditions. Fundamentally, WSN is an organization, which comprises of various sensors that are competent self-governing to peruse data from the item, which is been estimated, to deal with detected information, incidentally store it and move detected information to another organization hub, which is additionally a sensor.

As WSN is a typically brought together organization[12], so the information, detected and moved from different sensors, are communicated to the focal hub, which is normally called the sink. As such, the remote sensors can speak with one another and hence open wide convenience chances of remote sensor networks in IoT frameworks. Remote sensor networks fundamentally are the essential component in the worldwide Internet of Things framework, as sensors can assemble data from various things and send it over the organization.

However, the reliability of IoT systems is highly dependent on the power consumption and scalability of WSN.[13] The sensors should transmit measured data so efficiently to the sink, that the energy of their battery would be used at the minimum level. Due to this, the wireless sensor network should be constrained that it can easily accommodate changes in the network. This is related to the lifetime of WSN as well, as low or empty battery leads to the death of sensors.

The routing principles and methods are very important and challenging issue of WSN as data should be transmitted by another sensor, eliminating dead sensor from the routing path. And it should be done with respect to Quality of Service (QoS) over wireless sensor networks.[14]

Both Wireless sensor organization and Mobile impromptu organization (MANET) are self coordinated and multi-bounced networks. In any case, the geography of MANET is more inconsistent than WSN. MANET conventions can let it to go about as a WSN spine.[15] Due to the assignment to utilize sensors' energy proficiency during the information transmission and to lessen information preparing time by choosing legitimate steering conventions and standards, it is an interest for the intermingling of MANET and WSN organizations. Additionally, these two organizations can empower more viable and dependable cross-network directing in the Internet of Things setting. The principle part of association between Internet of Things, remote sensor organizations and versatile adhoc networks is addressed in Figure 2.1.

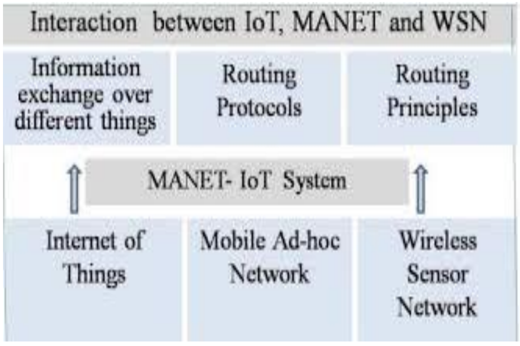

Figure 2.1.

Systems administration in the MANET-IoT framework depends on the directing conventions of MANET, steering standards of remote sensor organization and information detecting from things, dealing with and handling utilizing Internet of Things. When all is said in done, systems administration of such the framework is an exceptionally testing in regards to steering angles. MANET conventions (the greater part of them) are planned with the attention on QoS[16,17] and directing in remote sensor networks is centred around the proficient energy utilization of organization hubs.[18] The association of various things with restricted highlights to the Internet and collaboration with various remote and portable impromptu organizations should ensure network, availability and dependability of the MANET-IoT framework in brilliant conditions.

The solutions for the routing protocols of ad-hoc network modification in order to fulfil the requirements of the Internet of Things were presented by Tian and Hou.[19] Routing principles were changed by integrating IPv6.[20] However, the interaction of Internet of Things with MANET and WSN requires new, optimized solution for data routing in such the MANET-IoT system. The authors proposed an algorithm for data routing, which is mainly focused on energy efficiency and safe weighted clustering in the MANET-IoT system.

III (I) ENERGY EFFICIENT AND SAFE-WEIGHTED CLUSTERING ROUTING ALGORITHM

The algorithm presented in Figure 1 has three phases: setup, steady and threshold. First step is a cluster head selection. All the chosen cluster heads send a message of advertisement to all the non-cluster head nodes after the selection of the cluster head.

The non-group head hubs pick their bunch sets out toward the current round dependent on the got signal strength of the message publicized and send back a solicitation message to the chose group heads illuminating their participation that prompts the development of group. The message shipped off the group heads incorporates the hub's ID and the area of the sender hub.

At the point when all hubs are conveyed, the organization begins to choose the bunch heads and complete grouping and layering. At that point, the hubs start to occasionally begin information assortment and send them to the sink hub. With the difference as expected, the organization geography structure is additionally evolving. On the off chance that group head energy is lower than the predefined limit esteem; the third circle is applied to supplant bunch head by another hub, which represents the biggest energy inside the group. The new bunch head keeps on helping out group individuals. This way secures bunch heads with lower energy.

This system can shield group heads from speedy passing and drag out the organization lifetime. At the point when we have all the data about organization and hubs, at that point we are picking the directing technique for transmission data. For the assessment of organization lifetime three course way determination strategies are utilized: NP (hub place), BST (hub battery state) and ER (energy asset).

The NP intends to discover the course with least bounce tally .The group head assesses all neighbor hubs in the bunch. On the off chance that the data doesn't fulfil needed standards, group heads send message to the neighbor bunch head to help discover a course to the sink. BST chooses hub with higher battery state. Utilizing the ER technique we ascertain all organization energy assets.

The sensor life time has been increased in the overall IoT system, because dynamical cluster head selection was used, the weighting factors are added for routing from the sensor to the sink. Weight function was used to calculate each sensor's node value and thus the cost of all routes.

(II) Trust Based Data Routing Protocol

An expectation based trust the executives structure empowers hubs to set up a dependable course and solid information conveyance in IoT-MANET. We have received the Distributed confided in grouping structure as depicted in[21] for bunching and Cluster head (CH) political race. The Clustering Algorithm is typified by the accompanying Task.

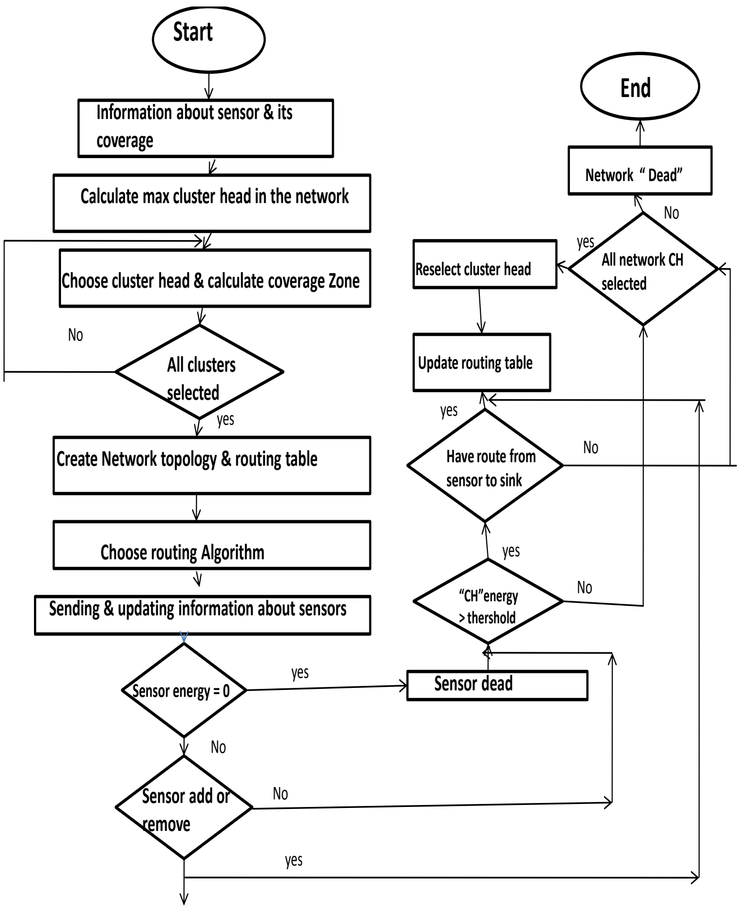

Fig 3.1: Data Routing Algorithm.

1. Cluster set up : This phase is a combination of the following.

(i) Initial clustering initially nodes join to the network one by one and forms the Clusters.

(ii)Trusted clustering after the formation of initial clusters nodes start to take part in intra cluster communication. A secret voting mechanism is invoked for CH election and forms the stable trusted clusters.

2. Cluster maintenance: A node can join or depart from the cluster due to mobility or Switch-off itself. Therefore, cluster may split at any time and merge again. Cluster Maintenance addresses these situations.

3. Secure routing: Secure intra cluster routing can start after the initial clustering, whereas inter cluster routing can only possible after the trusted cluster setup.

To gather network boundaries for trust computation, hub A screens traffic of each neighbor of hub B and figures the immediate trust proof for specific time span ttrust Nodes are ordered from their Good and Bad practices. To ensure reliable data delivery, the following network parameters have been considered.
1. Number of packets properly forwarded (Good).
2. Number of packets dropped (Bad).
3. Number of packets falsely injected (Bad).

Trust calculations have been performed periodically, and after the expiration of each time period of t_{trust}, the trust parameters are collected and direct trust observation is calculated by node A using a β distribution.

The Trust Model
Fig 3.2 shows the system architecture of the proposed model. As depicted in Figure 1, the Cluster head initiates the trust calculation and takes responsibility of trust propagation and establishing routes from source to destination in order to achieve reliable end-to-end delivery of packets and node availability.

(i) Trust Revocation: To gather network boundaries for trust computation, hub A screens traffic of each neighbor of hub B and figures the immediate trust proof for specific time-frame ttrust Nodes are sorted from their Good and Bad practices.

(ii) Trust Generation: In this phase, the trust value of each member of a cluster is evaluated. This phase is performed in two separate phases; direct trust (ζdir) calculation and resultant trust (ζres) generation. The detail procedure is described below. After calculating the trust value nodes are categorized.

(iii) Node Categorization: In MANET, a parcel can be dropped by a hub because of organization clog, connect disappointments (hub versatility) between hubs, network impedance and disputes, narrow-mindedness (the hubs having restricted energy saves their energy by not sending the bundles), and vindictiveness (the noxious hubs purposefully don't advance the parcels). In an ideal situation, the parcels are dropped simply because of noxiousness of a hub. Anyway in a genuine situation, there are some intrinsic properties of the mechanism for which parcels might be dropped; however the real explanation can't be recognized without any problem. Along these lines, we characterize a "awful hub" as a hub that arbitrarily drops parcels intentionally. In our situations parcels might be dropped consequently, and not for other inherent organization reasons (clog, interface disappointments, and so on)

In this node categorization phase, CH categorizes the member nodes into groups for their good behaviour and bad behaviour using a threshold limit between Max_{th} and Min_{th}. These threshold values can be set according to the network deployment scenarios.

Good: if $\zeta res \geq Max_{th}$
Bad: if $\zeta res \leq Min_{th}$;
Uncertain: if $Min_{th} < \zeta res <$

(iv)Trust Propagation: Once the resultant trust of each member node is finalized, in this phase CH propagates these values to the other cluster members.

(v)Routing: For creating routes between source and destination, maintaining the routes and the network, the proposed routing needs to perform the following three phases.

Neighbor Discovery: This phase is responsible for maintaining the list of trusted neighbours, along with their trust status.

Route Discovery: In this phase the end-to-end path is established by including only good and uncertain nodes.

Route Maintenance: This phase maintains the established route. Each node on an active path monitors the link periodically. It also revokes the route discovery phase if link failure occurs due to node mobility.

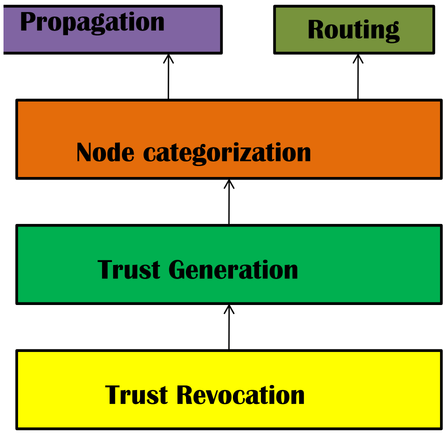

Fig. 3.2: Trust Model.

(III) INTELLIGENT WATER DROP ROUTING PROTOCOL

To achieve packet routing, we propose a new bio-inspired approach called IWDRP. This protocol is inspired from action and reaction that happens between water drops and the riverbed. IWD met heuristic could be a good alternative to solve routing issue in MANETs because of the followings.

• It can provide multipath routing,

• It is totally distributed,

• It is highly adaptive to network changes,

• It is robust to agent failures.

Because of every one of these reasons and the exhibited proficiency of IWD calculation, we feel that this strategy can fit well with the unique part of MANET when planning a steering convention.

In IWDRP, every hub of the organization comprises of the accompanying information structures.

• Routing table it stores a rundown of courses to every reachable objective. Every section of this table comprises of the accompanying fields: objective id, Next jump, Soil sum, delay, next course disappointment time.

• Neighbour list rundown of all neighbours of a hub. Every passage of this cluster comprises of the accompanying fields: Neighbour ID, last got signal force, last got signal time, next connection disappointment time.

Six types of control packets are used to support IWDRP concepts.

• Reactive Forward IWD (RFIWD),

• Reactive Backward IWD (RBIWD),

• Proactive Forward IWD (PFIWD),

• Proactive Backward IWD (PBIWD),

• Route Error (RTERR),

• HELLO.

Algorithm

When a node s needs to send a data packet to a destination d and no route is available, it selects the link with less soil amount. Algorithm 1 shows the pseudo code of selecting next hop.

Algorithm 1: Select next Hop

If (No route is available to *d*)

Begin

Reactive_route_discovery(*d*);

End

Min = MaxValue

Next_hop = -1

For each neighbor *n* of node *S* with a route to *d* do

Begin

If(n.soil_amount < Min and n.next_route_failure_time > current_time)

Begin

Min = n.Soil_amount

Next_hop = n

endIf

end

return Next_hop

Reactive Route Discovery Phase

Be that as it may, if no course is accessible to objective d, a responsive course revelation measure is launched. Figure 3 shows the calculation executed by hubs during the receptive stage.

In this way, a RFIWD parcel is communicated from the source hub until it arrives at the objective hub. While voyaging, RFIWD retains data pretty much totally visited hubs: ID and arrived at time. When shown up at the objective hub, a RBIWD parcel is made and the RFIWD bundle is annihilated. The RBIWD navigates similar hubs however in the converse manner. It will probably build up a course or numerous courses for each visited hub I, and to instate soil sum for all navigated joins (I, j). The estimation of soil sum Soil (i, j), is given by Eq. 1.

$$\text{Soil}(i, j) = QC \cdot \text{delay}_d(i, j) \quad \text{Eq.1}$$

where QC is a parameter of the protocol and $\text{delay}_d(i, j)$ is the end-to-end delay between current node i and destination node d when choosing j as the next hop.

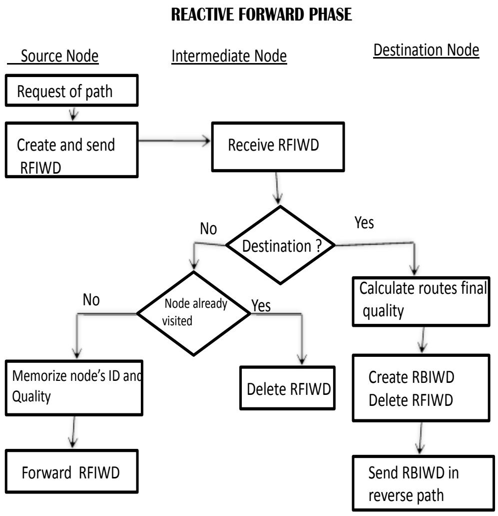

Fig 3.3

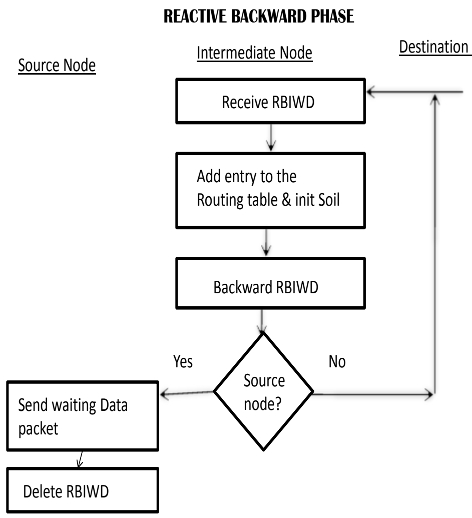

Fig 3.4

IV PERFORMANCE METRICS

Generally there are three execution measurements, as recorded underneath, have been utilized to assess how the conventions perform.

• End-to-end delay the absolute passed time spent while conveying a parcel from a source to an objective hub.

• Packet conveyance proportion (PDR) the proportion of information parcel effectively conveyance to the all out of information parcel produced by the traffic sources. The bundle conveyance proportion metric encourages us in assessing the power and viability of a steering convention.

• Total number of course disappointments happened we considered here is estimating the effectiveness of the proposed procedure for the course disappointment.

Parameters	Weight based clustering data routing protocol	Trust Based Routing Protocol	Intelligent Water drop Algorithm for Routing
Routing Approach	Weight based clustering Approach	Based on Global trust value of a node	Based interactions observed between the water drops and the riverbed.
Routing Structure	Hierarchical structure	Hierarchical structure	Routing table and Neighbour list used
Route selection	Yes	Yes	Yes
Multiple Routes	Yes	Yes	No
Route optimization	Optimized based on Energy level of the Node	Optimized based on Global trust value of a node	No
Energy Consumption	Less Energy consumed	More	More
Latency	Normal	More	Latency depends on mobility
Network life time	Good	Better	Better
Route maintenance	Yes	Yes	Yes
Advantages	(i)Sensor life time can be Improved. (ii)Weight function used to calculate Node value. (iii)Applied in Heterogeneous Network.	(i)Provides security in software-defined mobile ad hoc networks (SD-MANET) (ii)Applied in smart cities to provide security	(i)IWDRP anticipates route failures. (ii)Minimum Route Failures. (iii)Minimum End – End Delay
Disadvantages	Dynamic topology.	High Node mobility	Few constraints

V CONCLUSION

This study provides an overview of IOI-MANET Environment and its few routing protocols used there. Here we discussed IOT aided MANET environment, applications of IOT, Similarities between wireless sensor Network (WSN) and MANET. The working of various kind of data routing protocol in IOT aided MANET environment. Comparative analysis of different routing protocols has been done. Due dynamic Topology and infrastructure less features, it is difficult to built Energy efficient routing protocols in MANET. Even though the Weight based clustering data routing protocol consumes less energy if compared with others. Since route maintenance also to be incorporated it takes more latency.

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