Power Management Strategies in MANETs – A Review

Lubna Naaz Fatima, Syeda Hajra Mahin, Fahmina Taranum, Khaleel Ur Rahman Khan

Abstract— A Node in MANETs bond with neighboring nodes that are existent inside the transmission range and contact them by means of wireless medium. Distinctive sorts of modes are Transmit, Receive, Idle and Sleep. Keeping up dynamic topology and states lead to outcomes, for example, utilization of more battery power, in this manner decreases the system lifetime. Accordingly, it is fundamental to advance power utilization for enhancing the continuance of the system. Many conventions have been proposed for effective routing of the data packets. Distinctive conventions can be teamed up with various energy models, for example, GENERIC, MICAZ, MICA-MOTES, and USER-DEFINED provided by QualNet, that also investigates the power utilization. These conventions are assessed to foregather the most dependable and productive convention. Examinations are finished with the fundamental emphasis to accomplish energy proficiency. Execution assessment is done dependent on measurements, such as, energy utilization, network lifetime, time to live, the measure of current used, cost of the battery, and so forth.

Keywords: Energy Models; Energy Consumption; MANET's; Network lifespan; QualNet

1. INTRODUCTION

Nodes in Manet's are deployed by utilizing radio implements and antennas at the physical layer. The adaptability of deploying a node is to guarantee the simple and straight-forward method for growing a system to a bigger scale. An spontaneous system comprises of self-governing nodes that collaborate with one another and send information either straightforwardly or through different intermediate nodes to the goal node. A Manet comprises devices that move easily toward any path while speaking with each other. Every node must go about as a router and ought to advance the information packets other than its own utilization. Thus, it is a shared and self-framing decentralized system. Not at all like a centralized system which comprises of a solitary base station, there is a possibility of single purpose of disappointment because of which the entire system fail. While in the decentralized system the possibility of the incorporated framework (centralized authority) is discarded. For example, information forwarding happens to make use of a multi-hop plan that takes various ways. Consequently, regardless of whether one node quits working alternate nodes keep on working bringing about a dependable system. This gives the lead to the decentralized system. A side from points of interest, there are likewise a few issues that should be taken care of viz. Topology, portability, and battery, the speed of the remote connection, dis-connectivity, caching, handovers, and hidden and exposed nodes identification.

Wireless situations are structured easily utilizing IEEE norms with essential learning of the innovation.

Regularly wireless system comprises of,

- Access Point: - It functions as a centre point offering bounty assistance to user, associated with different access points to cover a more wider topographical region.
- Wireless radios: - Radio waves or electromagnetic waves are utilized in transmission to allow signal transmission from uplink to downlink and the other way around, a radio transmitter supplies an electric current swaying at radio to the antenna' s apparatus terminals, and the receiving wire emanates the energy.

Distinctive simulation apparatuses can be considered to investigate MANET's, for example, NS2, NS3, OPNET, OMNeT++, NetSim, REAL, Glomosim, Manasim and QualNet. QualNet uncovers other certain aspects, for example, the location of nodes, the behaviour of nodes and connectivity so as to reflect sensible conditions for huge heterogeneous systems.

Power management's fundamental job is to prolong the life of the system. There are various strategies used to limit the power utilization by the nodes in the system that deals with various layers. Numerous methodologies are utilized to diminish the battery utilization, the generally utilized one is to move the condition of the device to power saving mode. The majority of the phones are driven by batteries, thus, they stand out with limited energy. Power utilization becomes prime focus while considering wireless system, particularly when the mobile systems are evolving in their technology. High Power usage in the portable system can be because of various reasons, for example, CPU, memory, gadget display, dynamic nature, etc, making it the most urgent issue that should be addressed to.

The lifetime of the node is also depended on the duty cycle (d) and the transmission energy (Etx). The duty cycle is inversely proportional to the lifetime of the battery. A lifetime in seconds may be calculated using the available battery at an instant of time divided by transmitting energy multiplied by distance.

Modelling of the physical Layer is required in simulation to consolidate qualities of the transmitter and the recipient in active and passive modes by catering parts of a wireless framework, for example, modulation, coding, and noise, interference and antenna gains.

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In QualNet, a Physical Layer comprises of two sections: a PHY segment and an antenna segment. The PHY segment models signal transmission, reception and reflection utilizing the impacts of the MAC scheme, node status, physical parameters, corruption from the channel, and interference from neighbour hubs caused amidst transmission. To capture more signals during transmit mode, the antenna component models the functions and properties of the antenna.

Energy consumed in transmission mode

$P_{Transmission}$ = Current required to transmit signals * Voltage*Time (1)

Energy consumed in receiving mode

$P_{perceiving}$ = Current required to receive signals * Voltage *Time (2)

Energy consumed in idle mode

P_{idle} = Current required in Idle mode * Voltage * Time (3)

Energy consumed in Sleep mode

P_{sleep} = Current required in Sleep mode *Voltage * Time (4)

The units of power are mW, voltage is volts, time, current, battery life is mAh, and the charge is mA's.The total energy utilized is equal to the aggregation of energies in all modes.

1.1 Protocols

Routing protocols can be ordered [2] [14] as shown in Figure 1 and Figure 2.

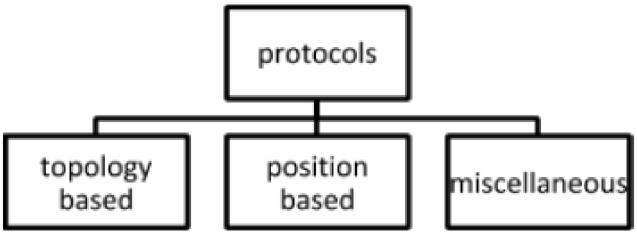

Fig. 1: Classification of routing protocols

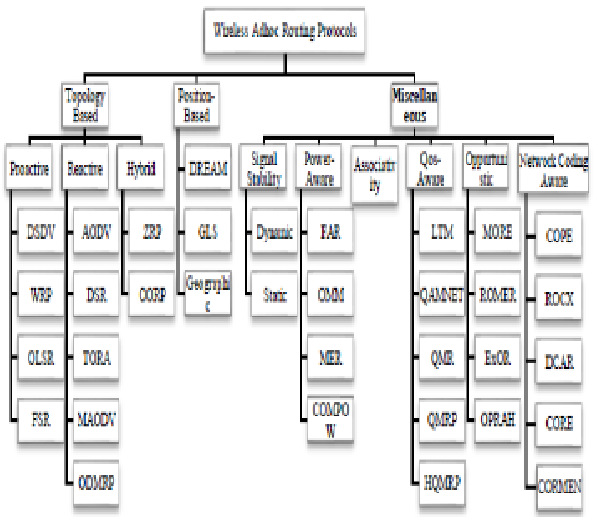

Fig. 2: Detailed classification of routing protocols

1.1.1 Topology-based routing protocol:

The topology-based routing protocol can be can be additionally sorted as

a) Table-driven protocols: Every single node solely in the mesh has at least one table providing data about other nodes that chip in to perform an operation, which routes to the goal

b) Reactive/On Demand/Lazy protocols: focussing on the requirement for the data by the goal, the path is made by the originator node that route towards the predetermined node.

c) Hybrid protocols: Hybrid routing protocol embraces the characteristics of both table driven and on-demand protocols.

1.1.2 Position based routing protocol:

It basically centres around information gathered on geographical location. The area of the node is distinguished either by utilizing GPS or by utilizing different positioning methodologies. Area services are utilized by the sender to find the goal nodes. Three principle packets sending plans are [14],

- Greedy forwarding
- Restricted directional flooding
- Hierarchical approaches

Geographic based routing protocol: It relies upon data of geographic position. It is otherwise called Geo Routing [14], where every one of the nodes determines their area utilizing the geographic location and forwards the data to the goal node [18].

1.1.3 Miscellaneous routing protocols:

Some of them are,

a) Signal Stability Routing Protocol: Its vital accentuation is on choosing the route, depending on signal excellence between nodes, likewise also considering the node's stability [14].

b) Power-Aware Routing Protocol: Its prime focus is on making smart power control choices that direct the genuine transmission of information.

c) Associatively Based Routing Protocol: The route is chosen to rely upon the strength of affiliated stability [14].

d*) Opportunistic routing:* In Opportunistic routing, when a node gets into the transmission stage, the neighbours surrounding it are equipped for hearing it. Neighbour node on getting a packet from the originator node, it further advances the data packet to its nearby neighbour nodes that routes towards the goal node, so that, some predetermined conditions are fulfilled [17].

e) QOS based routing protocol: Path is created by taking into consideration conditions, for example, distance, constrained, limited minimal search, bandwidth, and traffic conditions [14].

f) NC-mindful directing: The nodes are known as coding points that consider the NC-mindful convention in the system, that guide in choosing a way for forwarding the packets in the network[1]

2. POWER MANAGEMENT TECHNIQUES

There are plentiful ways to preserve power and increase effectiveness as well as the continuance of the live network

2.1 Energy model

Utilizing the energy models given by the QualNet simulator, the examination could be possibly done on different routing protocols bringing about effective power

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management mechanisms. With the assistance of energy model parameters for example electrical current load expended [14] and relying upon modes/states, for example, transmit, receive, idle and sleep, energy consumption can be determined. Distinctive kinds of energy models given by QualNet are,

- *Generic:* Power use of radio is estimated by this generic energy model in various power modes and for variable transmission control.
- *MICAZ:* Power utilization of MicaZ nodes is provided by the radio specific energy model and this model is preconfigured.
- *MICA-MOTES:* Power consumption of Mica nodes is given by the radio specific energy model and this model is additionally preconfigured.
- *USER DEFINED:* User can indicate the quantity of energy that is available for the nodes to employ in the system.

These energy models should be implemented, configuring certain parameters preceding their usage [14], which becomes more familiar with the measure of power utilized and the need to control the power utilization. Subsequently, giving a gainful strategy to use power.

2.2 MAC Layer

Utilizing the Mac layer, energy utilization at the station hub is decreased with the assistance of power saving mode which is for the most part bolstered by three strategies [14].

- Wake-up Procedure
- Sleep Procedure
- Power-save Poll (PS-Poll) Procedure

On consolidating them power management can be accomplished for different purposes.

Wake-up Procedure: A STA fundamentally awakens because of two boss reasons 1) to advance pending information or 2) to retrieve buffered information from an access point (AP). At the point when an STA modify its status from sleep mode to an active mode, by transferring an uplink frame to it with the power-save (PS) bit set to one, it informs an AP.

Sleep Procedure: Identical to the wake-up method, the transformation to the sleep mode is finished by setting PS bit one

PS-Poll Procedure: An AP can perform two activities, either sending of buffered downlink frame with an outcome appearing as a prompt data response or sending an affirmation message with a response comprising of the supported information/buffered data frame. With an accentuation on instant data response case, sending a supported downlink frame can be just a response to the PS-poll from the STA..

A Mac protocol every now and again makes utilization of omnidirectional antenna model which helps in dispatching and accommodating radio signals. While thinking about the directional antenna, MAC protocols need all different nodes in the encompassing territory to keep being quiet. This makes it liable to achieve the most extreme increase in gain value and limits the transmission to an accurate route towards destination.

The beneath are a few of the rules recorded for limiting the power usage.

- The principal reason for regular retransmissions that should be turned away is Collision.
- Since more power is consmed by transceivers in dynamic mode, the change to the stand-by mode turns into a need, at whatever point conceivable.
- The transmitter additionally has the capability to move to power saving mode that gives sufficient battery capacity to the goal to acknowledge the data packets.

2.3 Battery model

The battery is mainly a depository of electrical charge which gets loaded on recharging and discharges itself when in use. Therefore, the performance of the peripherals such as CPU, DC-DC converter, sensors, memory blocks, etc attached to the battery is often limited. DC-DC converter acts as a voltage regulator for various components [14]. With the help of battery models provided by Qualnet, the network efficiency can be achieved, perhaps increasing the lifetime and predicting the behaviour of the nodes under various circumstances.

Battery models catch the qualities of genuine batteries and can be utilized to anticipate their conduct under various scenarios such as system architecture, power management policy, Lifetime of the battery, transmission power control and components based on time. Three Battery models supported by Qualnet 7.4 includes Service lifetime, Linear and Residue which are useful tools for a battery-driven system.

The total energy utilized by the system per cycle is equivalent to the sum of energies absorbed by the peripherals i.e. nodes/transceivers (ETransceivers), processors (EProcessors), the DC-DC converter (EDC-DC) and the discharged amount of current in the battery (EBatttery).

The equation used to calculate E (consumed) for battery model and interfaces are depicted in (5). The architecture to show the energy dispersed in peripheral devices is shown in fig 3.

$$E(consumed) = E(DC\ to\ DC\ converter) + EProcessors + ETransceivers + EBatttery \quad (5)$$

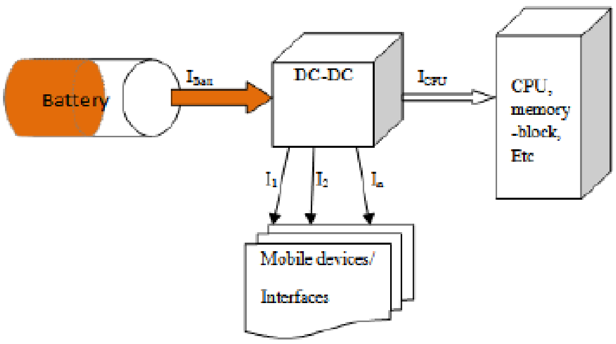

Fig. 3: Block diagram of power consumption in a system

There are various battery models. Some of them are Electro-chemical models, Electrical-circuit models, Analytical models, Kinetic Battery Model, Stochastic models.

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Each of them possesses certain advantages and disadvantages.

In Analytical models, battery lifetime is predicted using Peukert's law. Extension to Peukert's law, to improve the accuracy of calculation of battery lifetime, made use of Fick's law and Faraday's law that focused on one-dimensional diffusion The use of these models can be diverse.

Therefore, the main emphasis is laid on the energy consumption of wireless communication devices; hence, they can be combined with the models provided by the Qualnet simulator such as

- Precise Service Life Estimator
- Precise Residual Life Estimator
- Linear Model

Precise Service Life Estimator model:

With help of Rakhmatov's analytical model yield precise estimation of the service life of a wireless device that makes use of battery under predefined time-varying load. Battery specification of batteries such as DURACELL AA, DURACELL AAA and ITSY is considered for this model.

Precise Residual Life Estimation:

While circuit consumes power from the battery, this model estimates battery efficiency. One of the main features of the battery is to distribute the energy to the peripherals; a bit of energy is misspent. Batteries such as DURACELL AA, DURACELL AAA and PANASONIC are considered or this model.

When the battery output voltage is predefined and if the current consumed by the circuit is I, then actual current dissipated by the battery is given by (2)

$$I_{battery} = I_{actual} * \mu \qquad (6)$$

Where $I_{actual} \geq I_{battery}$.

μ gives the utilization factor or battery efficiency

Linear Model:

It makes use of coulomb counting technique which assembles the consumed coulombs and gives the residual service life of the battery by comparing the accumulated dissipated coulombs with a pre-recorded capacity of the battery at the beginning of the cycle.

2.4 Models for 802.11 MAC layer coordination functions

Basically, the issue evolved in WLAN's is sharing of the communication medium and the protocols that help in allotment of the medium i.e. concluding when a station can forward the data are recognized as co-ordination functions. Two main coordination functions are that play a prominent role

- DCF (Distributed Coordination Function)
- PCF(Point Coordination Function)

The communication model of BSS is shown in fig 3, which consists of groups of the station that Interact with one another internally and communicates with those outside the group with the help of an AP and performs functions in infrastructure mode.

IBSS assembles the stations into groups that interact with each other directly without considering an AP and works in an ad-hoc mode.

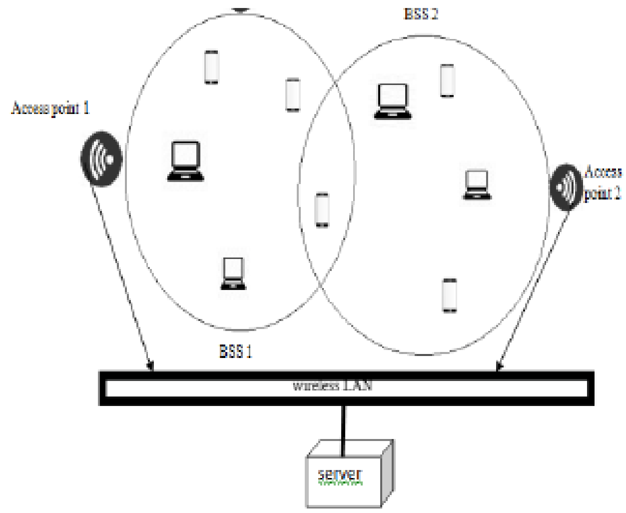

Fig. 4: Overview of communication in the Basic service set

2.5 Other strategies

Different methodologies accessible at the lower level protocols are recorded as mentioned below

Power-Aware Medium Access Control with Signaling (PAMAS): When left with no transmission, a node stops its power utilization, while it knows about transmissions going on in its region.

Dynamic Power-Saving Mechanism (DPSM): DPSM utilizes the plan which includes 2 states i.e., sleep and wake to decrease the power utilization. Being an alternative of the IEEE 802.11, it utilizes variable dimensioned ATIM windows to accomplish extended nap time for nodes.

Power Control Medium Access Control (PCM): In PCM, data packets and ACK packets are sent with a minimal dose of energy, while the RTS and CTS parcels are dispatched with most extreme power usage, so as to encourage the continuous correspondence between two endpoints.

3. RELATED WORK & RESULTS

A few procedures have been proposed to understand the issue of energy utilization.

[3] The writer of this paper thought of a Probabilistic Energy Efficient Routing convention (PEER). Amidst route handling operation the node computes its own remaining battery, keeping it in view of which, it dispatches the packets with some probability appended to it. This probability depends on the level of the rest of the battery of the node. In this way, a route is found by nodes with high energy and attempts to preserve the power and shields the system from early collapse.

[4] This paper focuses on the employment of star topology in the mobility model. Mobility models portray the action of the mobile user and provides the acceleration, speed, and area that change after some time of the dynamic user, with the end goal that when another communication is built up they can be utilized for simulation purpose. Mobility model can be of numerous sorts, some of them are File based mobility model, Group based mobility model, Pedestrian mobility model,

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Random Waypoint mobility model. The assessment is done and the adjustments in the measurements like jitter, throughput is scrutinized. Expressing that, among the previously mentioned mobility models, the Group based mobility model is seen to be practical for transmission.

[5] Gives comprehensive review on Effective Energy-Efficient Node Placement Algorithm, which concentrates on the situation of sensor nodes in the simulated area at a uniform separation with various patterns, for example in random, circular and grid pattern and furthermore looking at the energy used by the nodes that are arbitrarily placed with that of nodes organized in an enhanced way.

[6] This paper assessed the energy utilization in AODV, DSR and DYMO routing protocol exercising MICAZ Energy Model. Eventually, the outcomes were correlated and the report demonstrated that the energy consumed in idle mode is most elevated pursued by Receive and after that in Transmit mode along these lines. Additionally, it has been noticed that DYMO gives the most extreme throughput joined by DSR and AODV.

[7] This paper concentrates on localization. This localization plan can be implemented with the assistance of the beacon node (node that realizes its position utilizing a GPS). The head offering of this paper is to plan the an optimal path for the beacon node and localize all sensor nodes, with the emphasis that their localization error is least

[8] This paper's refinement is on the energy model (MICA, MICA Z) and modulation schemes. It is settled that mica mote associated with ASK modulation is very viable than O-QPSK and BPSK modulation. Though, on the examination, it is deduced that MICAZ utilizes restricted energy out of active mode when functioning with BPSK modulation

[9] There is a use of the altered form of AODV that rehearses the proposal of drain count. It estimates the amount of energy remaining at the nodes and juxtaposes it with a specific threshold value. Henceforth, it sends data along the way with least depleted nodes that co-work in securing the enhanced system lifetime. On the off chance that the remaining energy of a node is underneath the threshold point, at that point the drain count value of the path is incremented by a factor of one. The route with least hop count is selected if more than one path showcases same drain count measure else route with least transmission power is favoured.

[10] This paper presents another Energy-Efficient Survivable Routing Protocol that uses hop penalty approach and flooding delaying approach in order to improve the regular technique. On watching it was discovered that the use of energy in ESRP is profitable than ordinary convention. Therefore, it tends to be inferred that ESRP makes conspicuous enhancement in the system survivability.

[11] An energy efficient routing protocol viz. EERP is expressed. Amid the route reply process, the space isolating two successive nodes is figured dependent on RSS (received signal strength). It pursues the standard "if the nodes are neighbouring one another, RSS is high". Thus, low transmission power is used to forward the data which thus lessens battery utilization.

[12] This paper concentrates on Multi-hop relay strategy. Considering portable conditions, the battery usages are measured against the existing system utilizing QualNet 5.1. Aside from that, the heterogeneous system topology is given its points of interest over existing systems. The batteries, for example, AA and AAA that are demonstrated in the battery model and have been viewed as source which gives data on the residual battery in a node and service life of the node after a particular simulation time. Energy models are considered for the various nodes which gives the pattern of the energy utilized by the nodes configuring the energy model parameters prior to the execution.

4. CONCLUSION

The spotlight is on energy proficiency in MANET's. As nodes in MANET's changes with one mode then onto the next mode, for example, transmitting, receiving, and idle and sleep mode, this prompts more utilization of battery power resulting in decreased system lifetime. In this manner, greater importance is given to reduce the power utilization in the framework, accordingly also focusing on increase in the lifespan of the battery of the mobile nodes with help of energy models, battery models, and power saving mode, co-ordinate functions and so on. This examination of efficiency can be tested by making use of QualNet simulator

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REFERENCES

1. Muhammad Azhar Iqbal, BinDai, Ben xiong Huang, A. Hassan, Shui Yu, " Survey of network coding-aware routing protocols in wireless networks", journal of network and computer applications, Vol. 34, (2011), available online: https://www.sciencedirect.com/science/article/pii/S1084804511001500, last visit:28.10.2018
2. Behra Rajesh Umashankar, Rakhi Kumari Purnima," A Comparative Study of Topology and Position-Based Routing Protocols in Mobile Ad Hoc Networks", International Journal of Advanced Research in Computer Science & Technology, Vol.2, No.1, (2014), available online: http://www.ijarcst.com/doc/vol2-issue2/rajesh.pdf, last visit:28.10.2018
3. Mansi Rajgor, Prasanna Shete, R. N. Awale," Probabilistic Energy Efficient Routing Protocol for Wireless Sensor Network", International conference on communication information & computing technology(ICCIC),(2018), https://ieeexplore.ieee.org/document/8325889
4. Parma Nand, Rani Astya, Abdul Wahid Ali," Performance Analysis and Impact of Different Mobility model on the specific configured network with IEEE 802.15.4 for WSNs", International Conference on Computing Communication and Automation (ICCCA), (2016), https://ieeexplore.ieee.org/document/7813772
5. Kirankumar, Y. Bendigeri I, Jayashree D. Mallapur2," Node Placement in Wireless Sensor Network: An Energy Approach", National Conference on Recent Advances in Electronics & Computer Engineering, RAECE lIT Roorkee, India, (2015), https://ieeexplore.ieee.org/document/7510223
6. Sonika Kandari, M.K.Pandey," Evaluation of Energy Consumption by nodes of MANET", National Conference on Recent Advances in Electronics & Computer Engineering, (2015), https://ieeexplore.ieee.org/document/7510221

7. M.S. Aruna1, R. Ganesan2, and A. Pravin Renold," Optimized Path Planning Mechanism for Localization in Wireless Sensor Networks", International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy, and Materials (ICSTM), (2015), https://ieeexplore.ieee.org/document/7225409
8. Sarvesh Kumar Singh, Rajeev Paulus, Shiv Veer," Analysis of energy model and QoS in wireless sensor network under different modulation schemes", International Conference for Convergence of Technology, (2014), https://ieeexplore.ieee.org/document/7092114
9. Dr. Annapurna P Patil, Varsha Chandan, B., Aparna, S., Greeshma, R., Akshatha," An Improved Energy Efficient AODV Routing Protocol for MANET 's", international Conference on wireless and optical communication networks, (2014), https://ieeexplore.ieee.org/document/6923063
10. Uma Rathore Bhatt, Priyanka Jain, Raksha Upadhyay," An Enhanced AODV- An Energy Efficient Routing Protocol for MANET", Nirma University International Conference on Engineering (NUiCONE), (2013), https://ieeexplore.ieee.org/document/6780114
11. Akshay Jain," Reduction of Power Consumption at Mobile Station in Multi-hop Networks In Mobile Environments", International Conference on Emerging Technology Trends in Electronics, Communication and Networking, (2012), https://ieeexplore.ieee.org/document/6470043
12. Moustafa A. Youssef , Arunchandar Vasan , Raymond E. Miller "Specification and Analysis of the DCF and PCF Protocols in the 802.11 Standard Using Systems of Communicating Machines", IEEE international conference on network protocols,(2002), https://sci-hub.tw/10.1109/icnp.2002.1181394
13. Dharma Prakash Agrawal, carlos de morais cordeiro, a Book on Adhoc and Sensor Networks Theory and Applications, World Scientific Publishing Company ,(2006) [14] M.R. Jongerden and B.R. Haverkort "Battery Modeling" , CTIT Technical Report Series (2008),
14. https://research.utwente.nl/en/publications/battery-modeling
15. QualNet- 4.5.1-Wireless Model Library. Book
16. Wikipedia: https://en.wikipedia.org/wiki/Mobile_ad_hoc_network
17. ResearchGate:https://www.researchgate.net/publication/310790633_Opportunistic_Routing_in_Wireless_Networks
18. Wikipedia: https://en.wikipedia.org/wiki/Geographic_routing