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An Overview of Manet Power Management Approaches

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ABSTRACT

One of the primary issues with MANET is power optimization and utilization because it relies on the node's internal battery power to operate the wireless network. The performance of the MANET is also affected by one of the parameters of energy consumption and utilization. Each operation in the MANET requires some amount of energy to complete. This article elaborated on MANET power management from its inception to the present, as well as doing comparison research to recommend new methods for improving MANET power utilization. This study examines MANET power management options in terms of numerous parameter metrics, including Mobility Aware, Clustering, Topology, Transmission Range, QOS, and link-based. Finally, the methodologies used in MANET power management and performance factor improvement were summarised. To surpass all performance indicators in MANET utilization, new manipulative tactics are necessary. The innovative method is the most effective.

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1. INTRODUCTION

Due to the development of wireless networks in computer networking, the Mobile Adhoc Network has played a vital role in creating communication networks in wireless mediums without any access point. The major challenges of the creation of MANET with respect to the characteristics are transmission range limitation, overhead in the routing process, battery power constraint, asymmetric link, nature of the wireless network, packet loss, mobile notes route changes, frequent network partitioning, etc.

Among the challenges, battery power management is an important factor in MANET working operations. Enhancing the battery power is done by incorporating the transmission of packets, synchronization signal, beacon signal generation, etc. Several routing protocols have been established to improve battery power consumption in packet transfer. A new hybrid protocol is even being launched to improve battery power consumption. Concentrating only on the routing packet transfer alone is not sufficient to consume the battery power; apart from that, other layers also play a vital role in power optimization. Instant the physical layer beacon signal, MAC layer link establishment, network layer routing, transport layer connection establishment using TCP or UDP protocol, application layer usages, etc.

This article surveys how the different levels contribute to managing the power management in MANET. The article is structured in such a way that section II covers power management in MANET protocol layers, followed by a comparative analysis of power management techniques in MANET in section III, section IV summarises all the methodologies used in MANET for power management, and section V concludes with the new technique.

2. POWER MANAGEMENT IN MANET PROTOCOL LAYERS

2.1. Power Management at the Physical Layer

MANET physical layer power management depends on catering to the aspects of physical layer modulation, noise, power gained in antennae, coding techniques, and interference. The physical layer consists of PHY components and Antenna Components. The Models of signal transmission, reflection, and reception, MAC scheme, channel distortions, Physical parameters, and neighbor node interference are PHY components. The antenna functions and properties are the antenna components used for capturing signals when the antenna is in transmit mode. The total energy used for antenna signal functioning compromised the antenna power transmission, Antenna power receiving, and power required in idle and sleep mode, which is estimated by the equation of 1 to 4.

$$Antenna\,Transmission\,Power = Power\,Required\,to\,Transmit\,Signals * Vol * Time \quad (1)$$

$$Antenna\,Receiving\,Power = Power\,Required\,to\,Receive\,The\,Signals * Vole * Time \quad (2)$$

$$Antenna\,Idle\,Power = Power\,Required\,to\,Idle\,Mode * Vol * Time \quad (3)$$

$$Antenna\,Sleep\,Power = Current\,Required\,to\,Sleep * Vole * Time \quad (4)$$

2.2. MAC layer Power Management

MANET, MAC layer power management evaluates the routing indicators quantitatively, like energy consumption, packet delivery ratio (PDR), average delay, average jitter, and network delay. Energy consumption is estimated in the metric of joule, packet loss in the first node or middle node, and even the lost node is also the same energy consumed. The average packet delivery rate is the rate of data being received from the sender. Average Packet Delivery rate $P_{Avg,}$ using Equations 5 and 6.

$$PAvg = \frac{(NTrp * 100 + (n!/!(n-r)!)))\ \ (NTrp * 100 + (n!/!(n-r)!)))}{(\lim r \to \infty NSp)} \quad (5)$$

$$PAvg = \frac{(NTrp * 100 + (n!/!(n-r)!)))}{(\lim r \to \infty NSp)} \quad (6)$$

$Where\ \ NTrp - Number\ of\ Packets\ received\ totally$
$NSp - Total\ number\ of\ Packet\ sent$

The *Average End-to-end delay* is also an important parameter in MAC layer power management, which is computed from equation 7.

$$Delay\ Avg = \frac{\sum (Tr - Ts)}{Lim\ r \to \infty\ NRP} \quad (7)$$

$Where\ NRp\ total\ number\ of\ received\ Packet\ from\ all\ the\ nodes$
$Tr - Movement\ of\ Packet\ received$
$Ts - Packet\ Send$

The Average Jitter is the variation in delay in each Packet computed from Equation 8, which uses many data packets to play a role.

$$JA = \frac{[\sum (Tr - DAvg - Ts)\ 2]}{Lim\ r \to \infty\ NRP} \quad (8)$$

The throughput of the network is the ratio between the total amount of data passing in a local connection and the time spent transferring the data, as shown in Equation 9.

$$Ta = \frac{(\lim r \to \infty\ NRP)}{T\ tra} \quad (9)$$

2.3. Network Layer Power Management

Node Power

Every node's residual power is necessary to transmit the Packet; when the power gets drained, it leads to packet transmission failure disconnection in the route path. The minimum power for transmitting the Packet and minimum power for receiving the Packet of every node is to be estimated using the formula 10.

$$Mn = \sum_{fn=1}^{M} . Max * \frac{MMin}{Mg} \quad (10)$$

$Where\ f - total\ number\ of\ n\ nodes$
$MMax\ maximum\ receiving\ power$

$MMin\ Minimum\ receiving\ power$
$Mg\ Received\ power\ of\ nth\ node$

Link connectivity

Link connectivity is the bidirectional connection between the pair of nodes, which is estimated as follows in Equation 11.

$$Kn\ = \frac{1}{f}\sum_{fn=1}^{f}\frac{Kg}{\mathrm{t}} \tag{11}$$

$Where\ is\ t\ total\ connectivity$
$Kg\ represents\ the\ connectivity\ of\ the\ g\ th\ node.$

Lifetime of the link

The lifetime of every link is needed to connect two nodes and send packets. The link is used for transmitting packets. Due to dynamic topology changes, the link may get disconnected in MANET, so the lifetime of the link is estimated in advance before choosing the route. That could be estimated using the energy model Equation 12.

$$Nn\ =\ \frac{1}{f}\sum_{g=1}^{f}\mathrm{Eg} \tag{12}$$

Where, Eg Energy dissipation of g th node

Node Mobility

The mobility of the node, which is computed using Equation 13, is an important factor in MANET.

$$Nm\ =\ \frac{1}{|ph|}\sum_{g=Ph}\mathrm{Bg} \tag{13}$$

$|ph|\ -\ Set\ of\ neighbor\ nodes$
$Bg\ relative\ mobility$
$Node\ Distance$

Distance between the nodes is used to estimate the link stability, which is evaluated using the formula of Equation 14.

$$Rn\ =\ \sum_{fg=1}(\mathrm{Ug},\mathrm{Ph}) \tag{14}$$

$Ph-\ Set\ of\ neighbor\ nodes$
$Ug\ Energy\ of\ the\ current\ node$

2.4. Transport Layer Power Management

Reliable packet transmission is done in TCP protocol in the MANET transport layer. So, Transport layers support the responsibility of packet delivery by giving [92] ACK signal to the sender so that the retransmission of the Packet will not be initiated.

Old ACK and New ACK times were used in the TCP protocol to inform the source about the Packet received. The received packet rate of the destination is used in the formula in Equation 15.

$$RPR\ = \frac{Dnap - Doap}{Tnak - Toack} \tag{15}$$

$Where\ Doap\ -\ Number\ packets\ received\ at\ Toack,$
$Dnap\ -\ Number\ of\ packets\ received\ at\ Tnack.$
$Toack\ -\ Old\ ACK\ time,$
$Tnack\ -\ New\ ACK\ time$

3. POWER MANAGEMENT COMPARATIVE ANALYSIS

This chapter has done a thorough comparative analysis of the MANET power management protocol through the introduction of many classifications, which are illustrated in Tables 1 to 6, with the methodology employed and the benefits and drawbacks of each method. Table 3 discusses the different methodologies used for optimizing the node energy like LEA-AODV, RREQ modification, Route energy index, and Network lifetime, where some methods achieve the energy consumption, others load balancing, etc.

Table 1. Summary of Mobility Awareness

Authors Reference	Methodologies	Merits	Demerits
[1]	LEA-AODV	Distribute Load Balance s	-
[2]	RREQ modify	Energy Field	-
[3]	Route Energy Comprehensive Index	Energy Consumption	-
[4]	Network Lifetime By Enabling The RREQ	Energy consumed	-
[5]	LBMMRE-AOMDV	Maximum Residual Energy	-

Table 2. Summary of Topology Management

Authors Reference	Methodologies	Merits	Demerits
[6]	Optimized Power Control	Good Performance in Transmission Power, Delay, And Energy Consumption	Failed OPC -CC
[7]	M AODV	Reduced Delay And Overhead	Link Breakage
[8]	Automata-Based Topology	Self-Aware, Self-Adaptive, And Self-Adjust Topology	Routing Topologies
[9]	POR Algorithm	Changing The Network Capacity	Poor Network Performance
[10]	Secure Optimized Link State Routing Protocol	Link and Message Without Depending On The Third Party	Failed To Consider Attack Detection
[11]	TESAODV	Reduced The Network Lifetime	Unable To Maintain Energy Levels
[12]	KF-MAC	QOS Parameters	Maximum Delay

Table 3. Summary of Algorithmic Methods

Authors Reference	Methodologies	Merits	Demerits
[13]	SNDA	Reliable Communication	Severe Security
[14]	Game Theory-Based Model	Node’s Energy Level	Propagation Delay High Overhead
[15]	Credit-Based Method	Managing Less Energy Consumption	Generic Network Features
[16]	IDSM	reliable QoS	Not satisfied with the overall performance parameters.
[17]	NCV-AODV	Enhanced Neighbour Credit Cost	Delay Remains Also High.
[18]	Artificial Immune System	Increases The PDR	Package Loss
[19]	Energy-Efficient Method	Reliable Data Transmission	Overhead Is Increased.
[20]	MSD-SNDT	energy consumption is much less	vitality utilization
[21]	Fuzzy-Dependent SN Detection Method	More Active Nodes	Power Consumption Is High System To Costly.
[22]	Game Theory	Nodes Cooperate To Play Repeated Game	Overall Efficiency Is Not Satisfied
[23]	AODV Using A Wireless Network	-	Less Packet Delivery Ratio.

Table 4. Summary of Cluster Head

Authors Reference	Methodologies	Merits	Demerits
[24]	ORS	Better Throughput, Lower Latency, Lower Jitter, PDR	-
[25]	HAMBOCHLD	Energy Waste Reduced	-
[26]	HAODV	PDF, END, Routing overhead	-
[27]	EECAO	-	Lengthy Lifetime
[28]	ACO	Network Lifespan And Residual Energy	Two Cluster Heads
[29]	PDR and NLT metrics	Uniform Distribution Of Energy	-
[30]	C-SEWO	Innovative Design.	-

Table 5. Summary of Mobility Aware in Cluster

Authors Reference	Methodologies	Merits	Demerits
[31]	AGS-ROA.	Reduce Route Failure	-
[32]	EPO-FGA	Mobile Node's Lifetime	-
[33]	HPSO-GA	Node Energy	-
[34]	EEMST	-	Prolong The Lifespan
[35]	MKMPE	-	Packet Loss
[36]	E-CFSA	Effective	-
[37]	E-MAVMMF	Best Performance	-
[38]	EBDC	Reduced Consumption Of Energy.	-

Table 6. Summary of Transmission Range

Authors Reference	Methodologies	Merits	Demerits
[39]	Dynamic & Adjustable	Low-Cost	Each Node Having An Optimal Number Of Close To Three (3) Neighbour
[40]	ATP-AODV	Saved A Large Amount Of Energy	ATP-latency
[41]	Metric Norm During The Routing Process	Balanced The Network's Energy Consumption	Extended The Network's Lifespan
[42]	MTPR and MHR	Reducing Control	
[43]	Neighbour Nodes They Use Hello Messages	Maximization Of Network Throughput	Creates Some Delays
[44]	Energy Efficiency By Optimizing The Transmission Power	Throughput Maximization	-
[45]	Optimal Transmission Radius For Flooding In Large Scale Networks	Average Setting Time	-

4. PERFORMANCE COMPARISON OF MANET EXISTING METHODS

Table 7 summarises several approaches and algorithms in terms of supporting parameters. Some methods support some MANET parameters, while others do not. Figure 1 depicts the comparison of Parameters on different articles, from where power, delay congestion control, Packet overhead, security, antenna, and loadless research work was done. Next, the Packet Delivery Ratio and power of the moderate level of research work were carried out. Finally, many researchers concentrate on researching ways to overcome delay and energy consumption.

Table 7. Summary of Power management method with supporting performance

Authors Reference	METHODS/ ALGORITHM	Parameter								
		Power	Delay	Energy	Congestion Control	PDR	Overhead	Security	Antenna	LOAD
[1]	LEA-AODV	√	√	√	√		√			
[2]	RREQ modify		√	√			√			
[3]	Route Energy Comprehensive Index			√						
[4]	Network Lifetime By Enabling The RREQ	√	√	√						
[5]	LBMMRE-AOMDV							√		
[6]	Optimized Power Control			√						
[7]	M AODV		√							
[8]	Automata-Based Topology		√							
[9]	POR Algorithm		√						√	
[10]	Secure Optimized Link State Routing Protocol	√		√						
[11]	TESAODV	√	√	√						
[12]	KF-MAC		√							
[13]	SNDA				√					
[14]	Game Theory-Based Model								√	
[15]	Credit-Based Method			√						
[16]	IDSM			√						
[17]	NCV-AODV			√						
[18]	Artificial Immune System					√				
[19]	Energy-Efficient Method					√				
[20]	MSD-SNDT									√
[21]	Fuzzy-Dependent SN Detection Method	√	√	√						
[22]	Game Theory									
[23]	AODV Using A Wireless Network			√						
[24]	ORS			√						
[25]	HAMBOCHLD	√								
[26]	HAODV		√							
[27]	EECAO	√				√				
[28]	ACO	√				√				
[29]	PDR and NLT metrics	√				√				
[30]	C-SEWO					√				
[31]	AGS-ROA.			√						
[32]	EPO-FGA			√						
[33]	HPSO-GA			√						
[34]	EEMST		√	√						
[35]	MKMPE		√	√						
[36]	E-CFSA		√	√						
[37]	E-MAVMMF		√	√						
[38]	EBDC		√	√						
[39]	Dynamic & Adjustable		√	√						
[40]	ATP-AODV		√	√						
[41]	Metric Norm During The Routing Process		√	√						

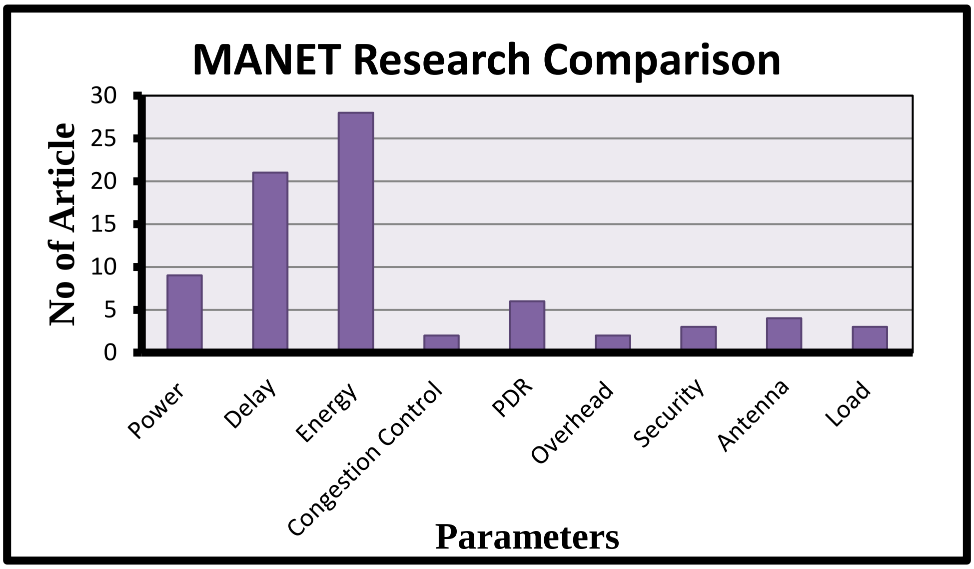

Figure 1. MANET Research Comparison

5. CONCLUSION

This research paper discusses MANET power management approaches with regard to several parameter metrics such as Mobility awareness, Clustering, Topology, Transmission Range, QOS, and link-based. Finally, the approaches employed for power management and performance factor improvement in MANET were summarised. Still, new strategies for manipulating are required to overcome all performance metrics in MANET utilization. Power management in a wireless network is a time-consuming task, especially in a Mobile Adhoc Network, because each node runs on its own power. When the internal battery fails, the entire communication system fails. Several strategies are proposed to increase the performance of the MANET battery management, and this might be used to evaluate the MANET's performance metrics. This paper finds new strategies enhanced in feature work, which could include adding internal node parameter adjustments such as introducing the mute ideal node, beacon signal utilization, and alteration in MANET working principles known as sleep and awake node management in MANET. The forwarding of packets by a single node amid the clustered to enhance battery life is accomplished by the collaborative route management technique.

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