ORIGINAL ARTICLE

Intelligent Model for Improving the Capacity of Wireless Ad-Hoc Network

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Abstract: In Ad-Hoc network, devices make connection in the network through wireless medium. In these networks, each device have a unique IP address and it helps in identification of nodes for routing. Routing becomes difficult when the location of node changes. The IP address of every node should be updated, and there is a requirement of complex protocols to handle such changes. The challenges of IP addresses are many. In such wireless networks, connection is to be re-established with different IP address when a node moves from one access point to another .This will increase the latency of the network and provides interruption in service. This problem can be solved using mobile IP. It will maintain the same IP address even if the host node changes location .Hence it provides continuous connectivity in the network. In our proposed network, packets have been distributed using probabilistic approach i.e.pareto for grid and random topology & performance of the network is improved for DSR Routing protocol.

Keywords: Routing Protocol, Ad-hoc Network, Pareto, Residual Energy

Introduction

Wireless internet is the extension of the service offered by the internet to the mobile user. It will be useful to access information and data irrespective even though mobile users are at different location. There are many inherent problems associated with wireless domain such as mobility of nodes, design of protocol and it needs solution to have wireless internet as a reality. Major issues for wireless internet are address mobility, inefficient of transport layer protocols, inefficient application layer protocol.

A node structure consist three main sections of microcontrollers for data processing, battery for power requirements and storage for containing information in.

Address Mobility

The network layer protocol adopted in the Internet is internet Protocol which is designed for wired network with fixed number of nodes. This IP has a hierarchical addressing with a global 32 bit address. It has two parts that is network identifier and host identifier. Network identifier will be for subnet address to which host system is connected .This addressing scheme is used for reducing the routing table size in the core routers of internet. Routing decisions will be taken with the help of network part of IP address.

Inefficiency of Transport layer protocols

These protocols are important in the internet to ensure setting up and maintaining end to end connections, reliable delivery of packets, congestion control and flow control.TCP is the predominant protocol for wired networks and UDP being connection less protocol used by some of applications. Wireless Internet requires efficient operation of the transport layer protocols.

Wireless medium is not realiable due to its time varying and environmental dependent characteristics.TCP is also efficient in handling congestion in the network. If a data packet or acknowledgement is lost ,TCP might assume that it is due to congestion and this reduces the congestion window.TCP does not provide good performance in wireless link .Real cause of packet loss needs to be investigated and solution needs to be provided for transport layer .Some of solutions are snoop TCP,Indirect TCP and mobile TCP.

Inefficiency of Application layer Protocols

Application layer protocols such as TELNET, HTTP, and SMTP are designed and optimized for wired domain. These protocols do not work efficiently with wireless domain. Wireless bandwidth is limited and much more expensive .Wireless application protocols is one of solutions for the application layer issue.

Mobile IP

Computer in the network have unique IP address which is used to identify its location and it will be used for routing the data in the network. This IP address assigned cannot be restricted to a region .Solution to the above problem is that to change IP address when the host node moves from one subnet to another. The problem with changing IP is that as host node moves, TCP identifies its connection with another terminal node based on IP address. If the IP address changes itself, TCP connection is to be reestablished then if we continue with the same IP address and special routing entries is to be added to track the current location of user.

Compatibility, scalability and transparency of the network should be taken care of while providing these solutions.

Tradional TCP

TCP is a connection oriented, byte stream service and is more realiable.TCP needs to establish a TCP connection before they go for exchanging the data. It is a full duplex transmission. Each TCP connection will support a pair of byte stream one flowing in each direction. It includes flow control mechanism and congestion control mechanism .TCP will divide the data stream to be send over smaller segments and assign the sequence number to them. This sequence number would help the receiver to provide the higher level with in order packet delivery and will be useful in detecting packet loss. The reliable delivery of data is guaranteed by sliding window mechanism and ensured that the data is delivered in order and will enforce the flow control between sender and receiver. In sliding window process, the sender sends several packets before awaiting acknowledgement and receiver acknowledges several packets at a time and send it to transmitter the relative byte position of the last byte of message that it has received successfully. Fast retransmit and recovery is also the important characteristics of TCP.

TCP over Wireless

High packet loss and variable latency is observed in case of wireless domain so TCP will respond with slow start. Due to retransmission of lost packets, bandwidth utilization will further be reduced. Forward correction method is used to correct small error. In this scheme, redundancy is encoded into the send message to allow self-correction at the receiver. The motto behind this is to hide small errors from TCP.

Related Work

Network lifetime is enhancement is possible if the load is distributed between all nodes in a wireless network. This needs that we should calculate the residual energy of each and every node in the entire network between the source node and destination node and always select the optimal path in terms of energy efficiency [1]

Routing protocols DSR and AODV are tested using NS2.Various performance parameters i.e. Throughput, Residual energy and Delay.[2]

There have been a tremendous growth in big data .Distributed wireless sensor networks are beneficial and generate large amount of data. There are many challenges for gathering real time data. These challenges are overcome by energy efficient routing algorithm. Clustering communication is done on the basis of received signal strength indicator and residual energy [3]

Machine-to-machine networks are created in a hierarchical order to initiate the data transmission from the source nodes to a destination node .It will improvise energy through a cluster head formation process which has been seen in many wireless sensor network (WSN).Network congestion occurred in such network is tackled using the load balancing approach.[4]

Routing technique is an open issue where efficient distributed algorithm need to design. Simulations are needed to for testing different scenarios which are close to the real cases. Algorithm can be studied & improved for enhancing the capacity of wireless networks.[5].

In wireless networks, sensors are deployed but these sensors are having limited battery. Two cluster heads are selected based on residual battery power, centrality of node as well as speed. Fuzzy logic has been applied to these factors for selecting super cluster head. Networks
are simulated and the performance parameters such as end-end delay, average energy consumption and residual energy is tested [6].

Broadcasting is a mechanism where node disseminates a message to other nodes in the wireless Ad-Hoc network. Resource management is done to improvise the network performance and clustering plays a very important role in it.[7]

For reducing energy dissipation and extending the lifetime of a node, clustering plays a very important role. Clustering problems can be solved using Game theory (GT). Cost dependent exponential function is used to compute the probability of cluster head. Game theory based clustering protocol is efficient protocol as compared with LEACH, LGCA and HGTD [8]

Networks can be divided into clusters and data will be collected and send it to the base station. Few of them considers residual energy as a selection criteria for cluster head and others might elect cluster head rotation wise in a period of time. They do not study the density and local distance. Energy efficient algorithm is introduced where best node is selected to become the head of cluster .This selection will depend on density, residual energy and distance. This e EEDCA algorithm will improve the lifetime of network [9]

Major issue in wireless ad-Hoc network is lifetime of node which ultimately brings many IoT solutions in real world application. In case of sensors, infinite lifetime will be achieved only with the help of battery replacement and recharge. EAMP-AIDC protocol which is an energy aware MAC protocol proposed for such EH-WSN will be affected by duty cycle optimization. It will take residual energy of node and application to have individual dynamic duty cycles to create a balanced load in terms of coordinating various tasks for continuous operation [10].

Techniques such as Multiple Input Multiple Output is useful technique for increasing the throughput of link, extending its transmission range, as well as it reduces energy consumption. Because of its limited range, it is not possible to install more than one antenna. Sensor nodes can will be cooperating in transmission and reception for deploying a virtual MIMO transmission. Power management with good energy efficiency scheme is proposed for Multiple Input and Multiple output in a multi-hops systems [11]

In remote control and sensor applications, Zigbee protocol is used. Zigbee tree routing protocol is used as it neither uses route discovery and routing tables nor can be used for devices which are in their range. Packets are routed through fundamental tree topology [12].

Energy consumption among sensor nodes can be balanced using cooperative transmission (CT). Based on the residual energy consumption and its relay node, cooperative transmission is enabled. Receiver initiated CT MAC protocol, is effective in decision making process [13].

Wireless sensor networks will have two routing protocols: clustered routing protocols and flat routing protocols. Low Energy Adaptive Clustering Hierarchy seems to have major improvements in clustering routing protocols in WSN [14].

In developing low power limited range wireless Ad-hoc networks ,probability of information loss due to congestion will become high If congestion in the network is detected well in time ,significant improvement can be done .At present residual buffer space is monitored continuously as well as link utilization is monitored. These solutions will consumes high energy and it degrades the network performance. To address this issue, a novel approach is adopted which detects the congestion level with minimal overhead. [15]

Promising area now a day is Energy Harvesting Wireless Sensor Network (EH-WSN), where in case of temporal death of nodes will not meet quality-of-service requirements in the network. Markov model is suggested to trace the energy harvesting process [16]

In time critical road safety applications, Vehicular Ad-Hoc Networks provides effective communication services for the purpose of traffic safety. This includes the challenge of delivery message up to 100% with good reliability. Enhanced Time division multiple access cluster-based MAC (ETCM) protocol which is based on TDMA slot reservation is proposed for multichannel vehicular networks.[17]

For safety and efficiency of traffic, many vehicular Ad hoc Network (VANET) are proposed. Since Geographic routing will be applied to VANETs .These routing will not need route establishment as well as route maintenance. Selecting of the nearest next-hop to destination is important. Nodes are selected near the edge of communication range in Geographic routing. Link becomes less stable due to interference and node's mobility. Poor selection of nodes for next hop is possible in such cases so enhanced directional greedy forwarding is proposed in [18].

Mobile Ad-Hoc Network (MANET) are extremely affected by attacks due to its characteristics of mobility and dynamic change in topology changes. Routing process are designed to prevent from such attacks and effective transmission of data. Combined technique is proposed for attack monitoring and risk assessment in MANET routing.[19]

Survey paper to identify many challenges and issues in wireless Ad-Hoc network is proposed .It specifies various methods to increase the lifespan of wireless Ad-Hoc network [20].

Mathematical Analysis

There is a impact of shape factor in energy consumption in a wireless Ad-Hoc network .In order to study the impact & role of shape parameter of this distribution in affecting energy, we have derived the relation between shape parameter and energy consumption.

$$Energy = \int_{-\infty}^{+\infty} pdf^2 dx$$

$$= \int_{-\infty}^{xm} pdf^2\, dx + \int_{0}^{\infty} pdf^2 \text{dx}$$

$$= 0 + \int_{xm}^{\infty} dx \left[\frac{\alpha xm^{\alpha}}{x^{\alpha+1}}\right]^2$$

$$= \int_{xm}^{\infty} dx \left[\frac{\alpha.xm^{\alpha}}{x^{\alpha+1}}\right]^2$$

$$= \frac{\alpha^2 xm^{2\alpha}}{x^{2[\alpha+1]}}$$

$$= \int_{xm}^{\infty} \alpha^2 . \frac{xm^{2\alpha}}{x^{2\alpha+1}}\, dx$$

$$= \propto^2\, xm^{2\alpha} \int_{xm}^{\infty} x^{-(2\alpha+2)} dx$$

$$= \propto^2\, xm^{2\alpha} \left[\frac{x^{-(2\alpha+2)+1}}{-(2\alpha+2)+1}\right]_{xm}^{\infty}$$

$$= \frac{\propto^2 xm^{2\alpha}}{1-2\alpha} \left[x^{1-2\alpha}\right]_{xm}^{\infty}$$

$$= -\frac{\alpha^2 xm^{2\alpha}}{1-2\alpha} \left[x^{1-2\alpha}\right]_{xm}^{\infty}$$

$$= -\frac{\alpha^2 xm^{2\propto}}{(1-2\alpha)} \left[xm^{1-2\alpha}\right]$$

$$= -\frac{\alpha^2 xm^{2\alpha} xm}{(1-2\alpha) xm^{2\alpha}}$$

$$= -\frac{\alpha^2}{1-2\alpha} xm$$

Cumulative distribution function of pareto is derived as

$$\text{CDF} = \int_{-\infty}^{x} PDF$$

$$= \int_{-\infty}^{x} \frac{xm^{\alpha}\alpha}{x^{\alpha+1}}\, dx$$

$$= \int_{xm}^{x} \frac{\alpha\, xm^{\alpha}}{x^{\alpha+1}} dx$$

$$= \alpha.xm^{\alpha} \int_{xm}^{x} x^{-(\alpha+1)} dx$$

$$= \alpha.xm^{\alpha} \left[\frac{x^{-(\alpha+1)+1}}{-(\alpha+1)+1}\right]_{xm}^{x}$$

$$= \alpha.xm^{\alpha} \left[\frac{x^{-\alpha}}{-\alpha}\right]_{xm}^{x}$$

$$= \frac{\alpha.xm^{\alpha}}{-\alpha} \left[x^{-\alpha}\right]_{xm}^{x}$$

$$= \frac{\alpha.xm^{\alpha}}{-\alpha} \left[x^{-\alpha} - xm^{-\alpha}\right]$$

$$= 1 - x^{-\alpha} xm^{\alpha}$$

$$= 1 - x^{\alpha} xm^{-\alpha}$$

$$= 1 - \frac{xm^2}{x^2}$$

Results & Discussion

Simulations are done up to 40 mobile nodes in NS2.These networks are built using DSR routing protocols with probabilistic distributions. Networks are tested for grid and random topologies. By varying different parameters of Pareto distribution, performance parameters are tested.

Figure 1, 2 and 3 shows the NAM file of 05, 10 and 30 mobile nodes simulated in NS2. Network of 05, 10 and 30 nodes are created in grid fashion and network of 20 and 40 nodes are created in random fashion. These networks are tested for packet delivery ratio, throughput and average residual energy.

Figure 1. Nam file for 05 mobile nodes.

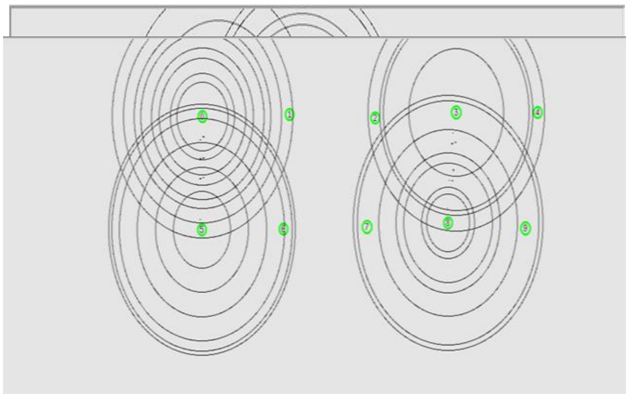


Figure 2. Nam file for 10 mobile nodes.

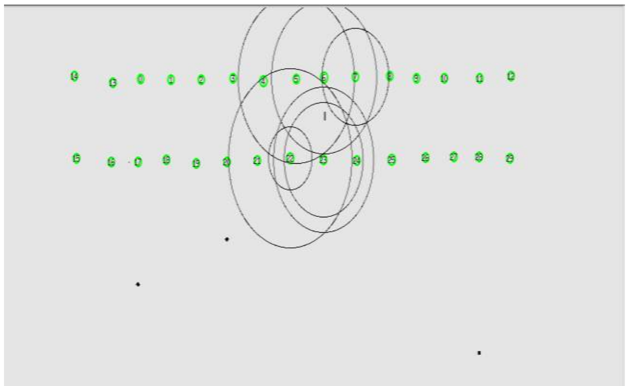


Figure 3. Nam file for 30 mobile nodes.

Table 3 shows the packet delivery, Average throughput and residual energy of a network in case of network configured as per Table 1. Table 4 shows the packet delivery, Average throughput and residual energy of a network in case of network configured as per Table 1 and added distribution to nodes as per Table 2.

Table 1. Simulation Parameters.

Number of nodes	5/10/20/30/40
Routing Protocol	DSR
Initial Energy(J)	5
Tx Power(W)	0.9
Rx Power(W)	0.8
Idle Power(W)	0.0
Sense Power(W)	0.0175

Table 2. Pareto Parameters.

Packet Size	210
Burst Time (ms)	500
Idle Time(ms)	500
Rate	200K
Shape	3.0

Table 3. Packet Delivery Ratio, Average Throughput, Residual Energy of Wireless nodes 5-40 mobile nodes without any distribution.

Number of nodes	***Packet delivery ratio***	***Through put (kbps)***	***Average Residual Energy***	***Average Energy Consum ption***
5	94.59	128.04	4.26	3.65
10	98.46	486.36	4.07	0.926
20	77.85	218.49	4.35	12.189
30	90.49	448.28	3.95	1.0473
40	82.63	476.30	3.6132	1.38

Table 4. Packet Delivery Ration ,Average Throughput ,Residual Energy of Wireless nodes 5-40 mobile nodes with Pareto distribution.

Number of nodes	***Packet delivery ratio***	***Through put (kbps)***	***Average Residual Energy***	***Average Energy Consum ption***
5	93.48	15.53	4.79	4.79
10	98.25	51.07	4.107	4.05
20	78.56	229.94	4.38	0.61
30	92.81	92.19	3.89	1.10
40	91.24	381.86	3.93	1.061

Various parameters such as shape parameter (α), Burst time, idle time & packet rate is set in this Pareto distribution with different values and assigned these distribution to nodes while sending packets. Shape parameter and burst time is tested to improvise the performance parameters i.e. Packet delivery and at the same time it seems to improvise the residual energy of network.

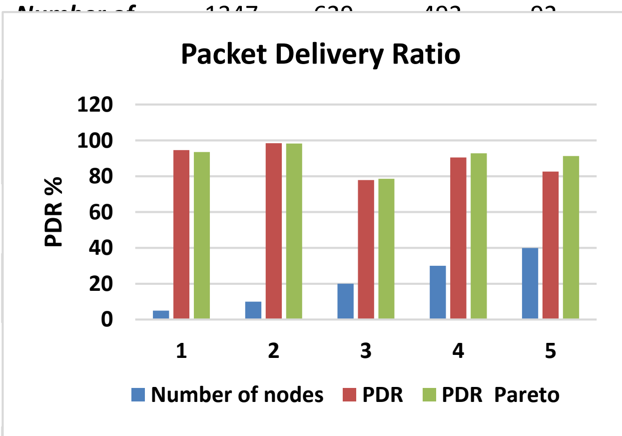
Table 05 and Table 06 shows how the performance parameters are affected if shape parameter and burst time affects are varied in Pareto distribution.

Table 5. Result for configuration of Table 1 for varying value of α for 05 mobile nodes.

Shape parameter	α=1.2	α=2.0	α=3.0
Number of packets Send	1885	1779	1894
Number of Packets received	1840	1764	1849
PDR (%)	97.61	99.16	97.62
Throughput(Kbps)	405.51	313.88	380.37
Total Energy consumption (Joule)	20.93	20.06	20.68
Average energy consumption (Joule)	4.18	4.012	4.13
Overall residual energy (Joule)	4.064	4.934	4.316
Average residual energy(Joule)	0.812	0.98	0.86

Table 6:-Result for configuration of Table 1 for varying value of burst time for 05 mobile nodes

α=2.0	***Burst Time =250ms***	***Burst Time =100ms***	***Burst Time =50ms***	***Burst Time =10ms***
Number of	1347	[illegible]	[illegible]	[illegible]

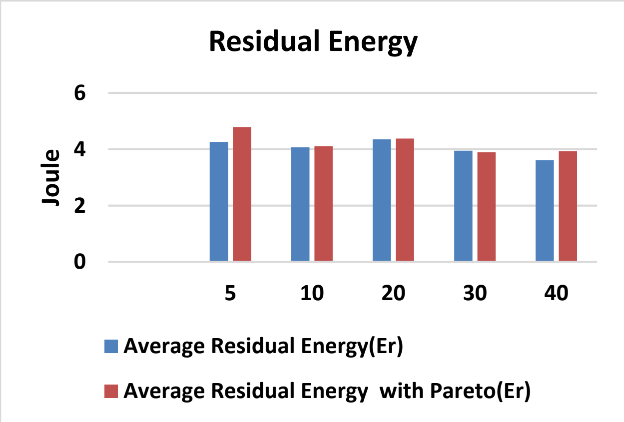


Average energy consumption (Joule)	2.99	1.406	1.11	0.2334
Overall residual energy (Joule)	10.04	17.96	19.42	23.97
Average residual energy (Joule)	2	3.59	3.88	4.79

Graph 1 & 2 shows the comparative analysis of packet delivery and residual energy of a node in case of

Pareto distributed network and network without Pareto distributions.

Graph 1. Comparative analysis of Packet delivery ratio



Graph 2. Comparative analysis of Residual energy

Conclusion

In this, method is proposed to improvise the performance of DSR routing protocol. Packets are send using Pareto distribution with different shape factor, burst time & packet rate. Packet rate and burst time plays an important role while distributing packets in wireless adhoc network & packets are distributed uniformly which works according to cumulative distribution function of pareto and help in saving energy of a wireless network with good packet delivery ratio.

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