International Journal of Grid and Distributed Computing
Vol. 13, No. 2, (2020), pp. 305 – 322

Improved Energy Efficient Cluster-heads Re-usability Mechanism for Wireless Sensor Network

Monali K. Fulbandhe, Prof. Nutan Dhande,
Department of Computer Science and Engineering Agnihotri College of Engineering, Nagthana India

Abstract

Wireless sensor networks (WSNs) offers a vast range of advantages to many applications by lowering their cost and reducing their overall power consumption. A WSN is an arrangement of randomly distributed devices, i.e. sensor nodes (SNs), which are interconnected having sensing capabilities to communicate and share data with some special features. Each SN is equipped with limited resources and thrown in terrain with an unconditional climate having a pre-configured set of tasks that it needs to perform. Each of deployed SN in WSN cluster faces a considerable energy issue and needs to manipulate the power consumption to increase their lifetime and make sure that they perform all the allocated tasks. Due to the unavailability of an external power source, the energy efficiency considered as one of the critical issues in WSNs. Selection of a sensor node (SN) from a wireless sensor network (WSN) cluster to serve as an aggregator or cluster head (CH), considered as an efficient method to increase the lifetime of wireless sensor network (WSN).In this paper, we are presenting the cluster head reusability scheme to enhance the lifetime of network and to reduce the average residual energy of a single WSN. The proposed algorithm is helpful in solving the problem of unbalanced energy consumption inWSNs.

Keywords: *Wireless Sensor Network; Sensor Node, Cluster Head.*

I.INTRODUCTION

Wireless sensor networks (WSNs) offers a vast range of advantages to many applications by lowering their cost and reducing their overall power consumption [1]. These additive advantages of wireless sensor network (WSN) have increased their use in many fields including advanced agriculture [2], [3] and many other, related to the automatic irrigation system for farmland [4], to improve the yield of crops. The integration of WSN in the internet of things (IoT) can be used to generate an early warning of earthquake [5]. In this context, the WSN provides a wide range of applications and considered as one of key enabling technology for IoT.

A WSN is an arrangement of randomly distributed devices, i.e. sensor nodes (SNs), which are interconnected having sensing capabilities to communicate and share data with some special features [6]. These SNs are used for multimedia applications by installing a CMOS device, e.g. camera, on sensor node (SN) [7]. Each SN is equipped with limited resources and thrown in terrain with an unconditional climate having a pre-configured set of tasks, that it needs to perform. Each of deployed SN in WSN cluster faces a considerable energy issue and needs to manipulate the power consumption to increase their lifetime and make sure that they perform all the allocated tasks.

Diverse solutions are presented in the literature to allow each SN in WSN to utilize their limited resources efficiently. Many energy efficient scheduling techniques are available in the literature [8], to accommodate each SN to perform well under confined power resources. Authors in [9] proposed an idea of multicore energy efficient scheduling with energy harvesting for wireless multimedia sensor network (WMSNs), by utilizing lightweight processors (LWP) to manifold multiple tasks practically, without compromising on deadline. In [10] a routing protocol based on spanning tree technique using the hybrid multi-hop partition clustering, is presented to enhance the lifetime of the WSN.

The term MANET (Mobile Ad hoc Network) refers to a multihop packet based wireless network composed of a set of mobile nodes that can communicate and move at the same time, without using any kind of fixed wired infrastructure. MANET is actually self organizing and adaptive networks that can be formed and deformed on-the-fly without the need of any centralized administration. Otherwise, a stand for "Mobile Ad Hoc Network" A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Ficonnection, or another medium, such as a cellular or satellite transmission.

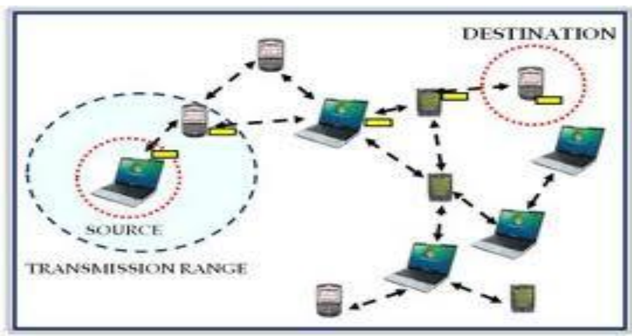

Fig: Structure of MANET

The purpose of the MANET working group is to standardize IP routing protocol functionality suitable for wireless routing application within both static and dynamic topologies with increased dynamics due to node motion and other factors.

Approaches are intended to be relatively lightweight in nature, suitable for multiple hardware and wireless environments, and address scenarios where MANETs are deployed at the edges of an IP infrastructure. Hybrid mesh infrastructures (e.g., a mixture of fixed and mobile routers) should also be supported by MANET specifications and management features.

Using mature components from previous work on experimental reactive and proactive protocols, the WG will develop two Standards track routing protocol specifications:

- Reactive MANET Protocol(RMP)
- ProactiveMANETProtocol(PMP)

If significant commonality between RMRP and PMRP protocol modules is observed, the WG may decide to go with a converged approach. Both IPv4 and IPv6 will be supported. Routing security requirements and issues will also be addressed.

The MANET WG will also develop a scoped forwarding protocol that can efficiently flood data packets to all participating MANET nodes. The primary purpose of this mechanism is a simplified best effort multicast
forwarding function. The use of this protocol is intended to be applied ONLY within MANET routing areas and the WG effort will be limited to routing layer design issues.

The MANET WG will pay attention to the OSPF-MANET protocol work within the OSPF WG and IRTF work that is addressing research topics related to MANET environments.

ISSN: 2005-4262 IJGDC

Characteristics of MANET's:

- In MANET, each node acts as both host and router. That is it is autonomous in behavior.
- Multi-hop radio relaying- When a source node and destination node for a message is out of the radio range, the MANETs are capable of multi-hop routing.
- Distributed nature of operation for security, routing and host configuration. A centralized firewall is absent here.
- The nodes can join or leave the network anytime, making the network topology dynamic in nature.
- Mobile nodes are characterized with less memory, power and light weight features.
- The reliability, efficiency, stability and capacity of wireless links are often inferior when compared with wired links. This shows the fluctuating link bandwidth of wireless links.
- Mobile and spontaneous behavior which demands minimum human intervention to configure the network.
- All nodes have identical features with similar responsibilities and capabilities and hence it forms a completely symmetric environment.
- High user density and large level of user mobility.
- Nodal connectivity is intermittent.

II. RELATEDWORK

2.1 An Energy Efficient Cluster-heads Re-usability Mechanism for Wireless Sensor Networks

Authors: Syed Kamran Haider

Publication: IEEE Conference on Network Engineering 2019

Syed Kamran Haiderhave proposed an energy efficient CH selection scheme to optimize the overall lifetime and average energy consumption of a WSN cluster. The proposed technique significantly increases the lifetime of WSN and provides a solution to the problem of unbalanced energy consumption in the WSNs[1]. The main highlighted contributions of the paper are as follows:

• An energy efficient scheme has been proposed that equips the BS with a group of CHs, selected from a WSN cluster.

• The idea of the mobile sink has been utilized to decrease the delay and to efficiently cater to the low power state of the CH during the hand-off stage.

• To prolong the network survival time, each CH changes its state to sleep mode and perform energy harvesting after reaching the hand-off threshold level.

• Syed Kamran Haider have incorporating the use of harvesting energy to enhance the reusability of each CH node, enduring the sleep mode[1]

2.2Energy optimal scheduling of multichannel wireless sensor networks for wireless metering

Authors: S. Kumar, H. Lim, and H. Kim

Publication: Electronics, Information, and Communications (ICEIC), 2016 International Conference on, pp. 1–5, IEEE, 2016

S. Kumar, H. Lim, and H. Kim addressed the issues of energy consumption and path distance from the source to the destination in MANET. They proposed a multipath routing protocol based on AOMDV called as, Power Aware Ad-hoc On Demand Multipath Distance Vector (PAAOMDV). The proposed protocol updates the routing table with the corresponding energy of the mobile nodes. As this was a multipath protocol, it shifts the route without further overhead, delay and loss of packets. The simulation results showed that PAAOMDV performs well compared to AOMDV

Routing protocol after introducing energy-related fields in PAAOMDV [9]

ISSN: 2005-4262 IJGDC

2.3Earthquake early warning system by IoT using wireless sensor networks

Authors:A. Alphonsa and G. Ravi

Publication: Wireless Communications, Signal Processing and Networking (WiSPNET), International Conference on, pp. 1201–1205, IEEE, 2016

In [6] A. Alphonsa and G. Ravi considered path duration and energy awareness to accomplish certain QoS constraints as to reduce the route discovery procedures. Even though energy saving and path duration and stability are two contrasting efforts and to satisfy both of them can be very difficult. The authors proposed a novel routing strategy which tries to account for link stability with a minimum rate of energy consumption. In order to verify the accuracy and accomplishment of the proposed algorithm, an optimization formulation technique was designed along with a routing protocol called Link-stability and Energy-aware Routing (LAER) protocol. The performance of proposed protocol was compared with PERRA, GPSR, and E-GPSR, in terms of packet delivery ratio, normalized control overhead, link duration, node lifetime, and average energy consumption.

2.4A study of supercapacitor charge redistribution for applications in environmentally powered wireless sensor nodes

Authors:H. Yang and Y. Zhang

Publication: Journal of Power Sources, vol. 273, pp. 223–236, 2015

H. Yang and Y. Zhang proposed an energy efficient routing protocol that conserves energy of the mobile nodes enhancing the lifetime of the MANET. It is an On demand routing protocol based on adaptive fuzzy threshold energy (AFTE). The experimental results were compared with the Load-Aware Energy Efficient Protocol (LAEE) protocol proposed by the same authors. The results clearly showed that AFTE performs better compared to LAEE. The average network lifetime was enhanced upto 13% considering first node failure, 15% considering 50% node failure and 23% considering 100% node failure compared to LAEE [5].

2.5 Hybrid Multihop Partition-Based Clustering Routing Protocol for WSNs

Authors: Chaoming Wang, Yuan Zhang, Xuewen Wang and Zhiyong Zhang

Publication: International Conference ,IEEE, 2017

In this paper, a Hybrid Multihop Partition-Based Clustering routing protocol (HMPBC) is proposed which can fit specific environment, meet interests and needs, balance network load and prolong the network lifetime. In HMPBC, both the single-chain structure within cluster and the cluster heads selection depending on residual energy are operated by self-organization, and the region minimum spanning tree structure among clusters is enablished by base station.The proposed protocol is simulated in MATLAB with the network model of 200mx200m, 400 nodes. Simulation results show that HMPBC has 33.31% and 39.70% longer lifetime, smaller fluctuations of average energy consumption of each node per round, more precise measurement of zone parameters than LEACH MLOR and EEHMCS.

III. PROPOSED METHODOLOGY

In this project we propose two algorithms to cope with the non-uniform load distributions in MANETs: a light weight distributed dynamic channel allocation (DCA) algorithm based on spectrum sensing, and a cooperative load balancing algorithm in which nodes select their channel access providers based on the availability of the resources.

ISSN: 2005-4262 IJGDC

We apply these two algorithms for managing non-uniform load distribution in MANETs into an energy efficient real-time coordinated MAC protocol, named MH-TRACE. In MH-TRACE, the channel access is regulated by dynamically selected cluster heads (CHs).

MH-TRACE has been shown to have higher throughput and to be more energy efficient compared to CSMA type protocols.

Although MH-TRACE incorporates spatial reuse, it does not provide any channel borrowing or load balancing mechanisms and thus does not provide optimal support to non-uniform loads.

The DCA algorithm approaches the problem of non-uniform load distribution from the perspective of the channel coordinators. The same problem can also be approached from the perspective of the other nodes in the network.

Using cooperative nodes smooth's out mild non-uniformities in the load distribution without the need for the adjustments at the channel coordinator side. The load on the channel coordinators originate from the demands of the ordinary nodes. Many nodes in a network have access to more than one channel coordinator. The underlying idea of the cooperative load balancing algorithm is that the active nodes can continuously monitor the load of the channel coordinators and switch from heavily loaded coordinators to the ones with available resources. These nodes can detect the depletion of the channels at the coordinator and shift their load to the other coordinators with more available resources. The resources vacated by the nodes that switch can be used for other nodes that do not have access to any other channel coordinators. This increases the total number of nodes that access the channel and hence increases the service rate and the throughput. Cooperative load balancing does not alter the clustering structure, and it is desirable over selecting an additional frame at the CH.

In MH-TRACE, each CH operates in one of the frames in the superframe. Since the number of data slots is fixed, the CH can only provide channel access to a limited number of nodes. Due to the dynamic structure of MANETs, one CH may be overloaded while others may not be using their data slots. In that case, although there are unused data slots in the super frame, the overloaded CH would provide channel access only to a limited number of nodes, which is equal to the number of data slots per frame, and the CH would deny the channel access requests of the others. Thus, the system needs a dynamic channel allocation scheme to provide access to a larger number of nodes.

ISSN: 2005-4262 IJGDC

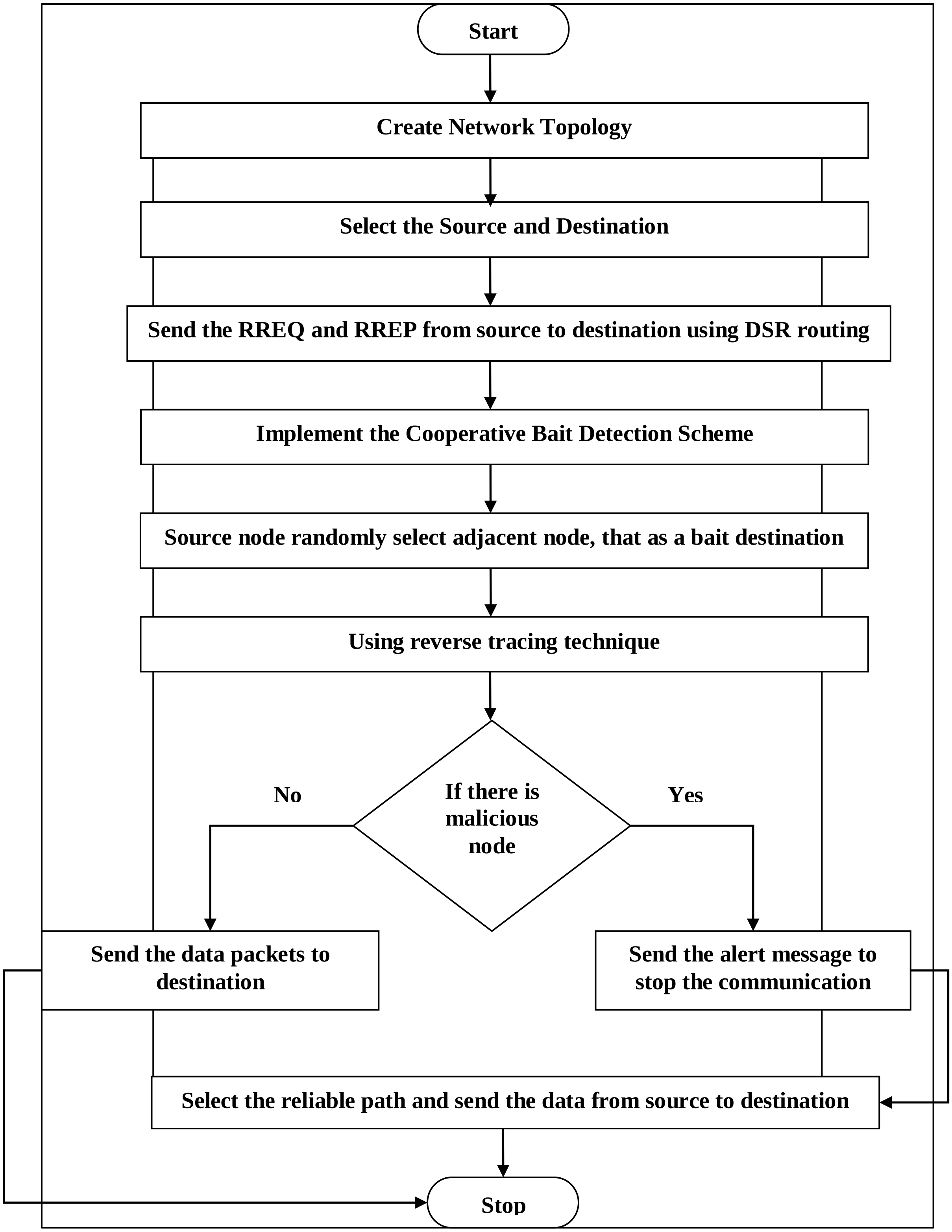

Fig:3.1 Architecture block diagram of project flow

IV.ALGORITHMS

Algorithm:Distance Calculation

```
for {set i 0} {$i<$val(nn)} {incr i} {
        set NL($i) [list]
        set x_pos1 [$n($i) set X_]
        set y_pos1 [$n($i) set Y_]
        for {set j 0} {$j<$val(nn)} {incr j} {
                if {$j!=$i} {
                        set x_pos2 [$n($j) set X_]
                        set y_pos2 [$n($j) set Y_]
                        setx_pos [expr $x_pos1-$x_pos2]
                        sety_pos [expr $y_pos1-$y_pos2]
                        set v [expr $x_pos*$x_pos + $y_pos*$y_pos]
                        set d [exprsqrt($v)]
                        setnd($i,$j) $d
                        puts "Distance from $i to $j:$d"
                        if {$d < 350} {
                        $n($i) add-neighbor $n($j)
                }
                }
        }
   set neighbor1 [$n($i) neighbors]
   foreach nb1 $neighbor1 {
   set now [$ns now]
   puts "The neighbor for node $i are:$nb1"
   setidv [$nb1 id]
puts "$idv"
lappend NL($i) $idv
}
}
```

Algorithm:Route Discovery

```
puts $rt "~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~"
puts $rt "RouteFrom      RouteTo                  Route"
puts $rt "~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~"
        for {set des 0} {$des<$val(nn)} {incr des} {
                for {set j 0} {$j<$val(nn)} {incr j} {
                        if {$des!=$j} {
                                lappend route($j,$des) $j
                                for {set i 0} {$i<$val(nn)} {incr i} {
                                        setflg($i) 0
                                }
                                set s $j
                                setflc 0
                                set RN $s
                                puts "Route from $j to $des"
```

ISSN: 2005-4262 IJGDC

```
                while {$RN!=$des} {
                        puts "RN:$RN"
                        foreachrn $NL($RN) {
                                if {$rn==$des} {
                                        setflc 1
                                }
                        }
                        if {$flc==1} {
                                set RN1 $des
                        } else {
                                set x_pos1 [$n($des) set X_]
                                set y_pos1 [$n($des) set Y_]
                                setdL [list]
                                set t [$ns now]
                                foreachrnod $NL($RN) {
                                        set x_pos2 [$n($rnod) set X_]
                                        set y_pos2 [$n($rnod) set Y_]
                                        setx_pos [expr $x_pos1-$x_pos2]
                                        sety_pos [expr $y_pos1-$y_pos2]
                                        set v [expr $x_pos*$x_pos+$y_pos*$y_pos]
                                        set D2 [exprsqrt($v)]
                                        lappenddL $D2
                                        set dis($des,$rnod) $D2
                                }
                                set distance [lsort -real $dL]
                                foreach di $distance {
                                        puts "D: $di"
                                }
                                setsdist [lindex $distance 0]
                                puts "mindis: $sdist"
                                foreachni $NL($RN) {
                                        if {$sdist==$dis($des,$ni)} {
                                                set RN1 $ni
                                                setflg($ni) 1
                                                puts "Node:$RN1"
                                        }
                                }
                        }
                        set RN $RN1
                        puts "Source $j"
                        puts "DES:$des"
                        lappend route($j,$des) $RN
                        puts "$RN"
                }
                puts $rt "$j            $des            $route($j,$des)"
        }
    }
}

puts "Enter the Source node (Except CH nodes: 84 19 76 56 53 86) : "
```

ISSN: 2005-4262 IJGDC

```
flushstdout
setsn [gets stdin]
puts "Enter the Destination node (Except CH nodes: 84 19 76 56 53 86) : "
flushstdout

setdn [gets stdin]
$ns at 0.3 "$n($sn) label Source"
$ns at 0.3 "$n($dn) label Destination"

for {set i 0} {$i<$val(nn)} {incr i} {
        $n($i) color hotpink
        $ns at 0.0 "$n($i) color hotpink"
}

procRandomInteger {min max} {
return [expr {int(rand()*($max-$min+1)+$min)}]
```

Algorithm: Cluster Head Selection (or) Channel Coordinator Selection

```
setCHlist [list 84 19 76 56 53 86]
set m 0
foreach CH $CHlist {
        incr m
        $ns at 0.1 "$n($CH) color deeppink"
        $ns at 0.1 "$n($CH) add-mark m10 $c($m) hexagon"
        set flag($CH) 1
```

Algorithm: Cluster Member Selection

```
set k 0
foreachclh $CHlist {
        incr k
        setclm($clh) [list]
        foreachnel $NL($clh) {
                if {$flag($nel)==0} {
                        # puts "Neighbor($clh) : $nel"
                        lappendclm($clh) $nel
                        set flag($nel) 1
                        $ns at 0.2 "$n($nel) color $c($k)"
                }
        }
}
```

Algorithm: Channel Allocation

```
set i 0
foreachch $CHlist {
        incr i
        setchn($ch) chan($i)
        foreach cm $clm($ch) {
                set chn1($cm) chan($i)
                # puts "Channel($cm):$chn1($cm)"
        }
```

ISSN: 2005-4262 IJGDC

```
        puts "Channel of ClusterHead($ch): $chn($ch)"
}
```

Algorithm: Data Transmission

```
set null2 [new Agent/LossMonitor]
set source $sn
set time [expr $time+0.1]
foreachrtnd $route($sn,$dn) {
        $ns attach-agent $n($rtnd) $null2
        set cbr2 [attach-cbr-traffic $n($source) $null2 200 0.05]
        $ns at $time "$cbr2 start"
        $ns at $time "ActiveMode $source"
        $ns at $time "ActiveMode $rtnd"
        $ns at $time "$ns trace-annotate \" IS slot carry the routing information when send the data\""
        $ns at $time "$ns trace-annotate \" route:$route($sn,$dn)\""
        $ns at $time "$ns trace-annotate \" The Source node $sn send the Data to the Destination node
$dn\""
        $ns at [expr $t+3.5] "$cbr2 stop"
        set source $rtnd
}
proc record {} {
        global ns null2 pktrcpktls E2E enec array names val array names Eini array names energy
        set now [$ns now]
        set time 0.5
        setpktr [$null2 set npkts_]
        set e2e [$null2 set lastPktTime_]
        setpls [$null2 set nlost_]
        settrpt [expr $pktr+$pls]
        settec 0
        for {set i 1} {$i<$val(nn)} {incr i} {
                setecv [expr $Eini($i)-$energy($i)]
                settec [expr $tec+$ecv]
                setEini($i) $energy($i)
        }
        puts $enec "$now $tec"

        puts $pktrc "$now $pktr"
        puts $pktls "$now $pls"
        puts $E2E "$now $e2e"
        $ns at [expr $now+$time] "record"
}
```

V.MODULES DESCRIPTION

Setting Up the Network Model

In the first module, we develop the network configuration module. The nodes are randomly distributed in a sensing field. We are using mobile ad hoc network (MANET). This is the infrastructureless network and a node can move independently. In a MANET, each node not only works as a host and also acts as a router. We can find the communication range for all nodes. Every node communicates only within the

ISSN: 2005-4262 IJGDC

International Journal of Grid and Distributed Computing
Vol. 13, No. 2, (2020), pp. 305 – 322

range. If suppose any node out of the range, node will not communicate those nodes or drop the packets.

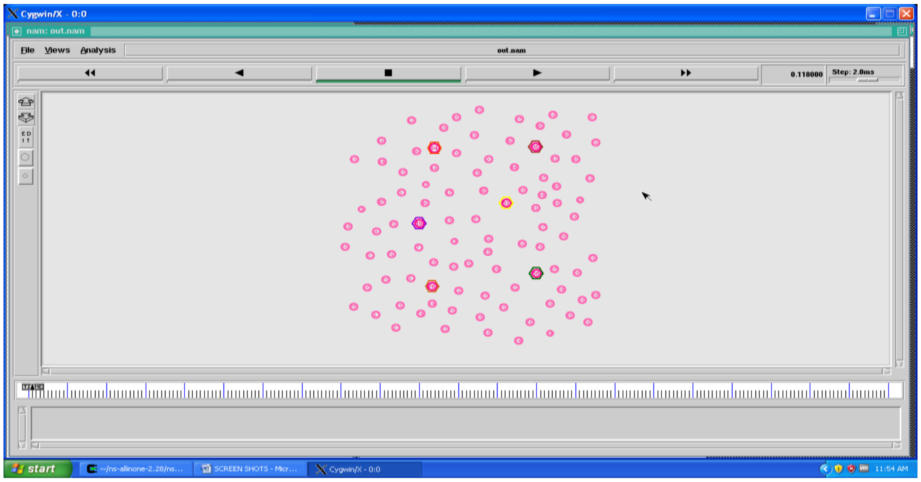

Fig: Topology view in NAM

Generating Clusters and Cluster Heads

Ones the topology is generated neighbor discovery will be implemented to perform clustering also the distance calculation method will be used to calculate the distance between nodes so the cluster heads can be selected from the list of nodes. This step will completely initialize the topology so simulation can be started.

In MH-TRACE, certain nodes assume the roles of channel coordinators, here called cluster-heads. All CHs send out periodic Beacon packets to announce their presence to the nodes in their neighborhood. When a node does not receive a Beacon packet from any CH for a predefined amount of time, it assumes the role of a CH. This scheme ensures the existence of at least one CH around every node in the network.

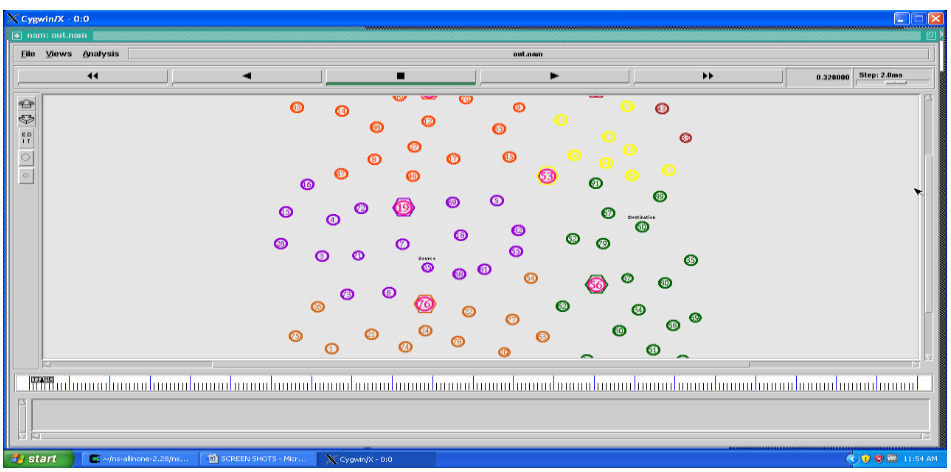

Fig Cluster and Cluster Heads Generation

Data Transfer

We proposed a new multipath routing protocol which is a combination of clustering and neighbor. In a normal scenario, when a RREQ is broadcasted by a source node, more than one route to the destination will be found and the data packets will be forwarded through these routes without knowing the routes' quality. By implementing the proposed algorithm on the same scenario, the route selection will be totally different. When a RREQ is broadcast and received, the source node will have three (3) types of information in order to find the shortest and optimized route path with minimized energy consumption.

ISSN: 2005-4262 IJGDC

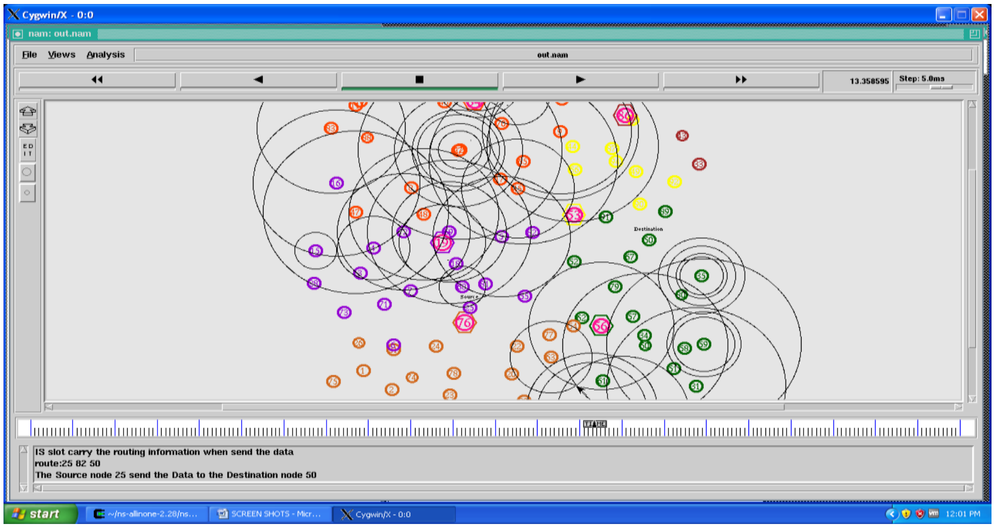

Fig: Process of Data Transmission

Performance Analysis

We can evaluate the performance of simulation. The size of the region over which the nodes are located, the number of nodes in the network, and their data generation patterns are all important in optimizing the design parameters. We are using the graphs for evaluate the performance. We choose the evaluation metrics: Packet Delivery Ratio, Packet Loss Ratio, and E2E-End to End Delay, Energy Consumption. Packet delivery ratio – it is the ratio of the number of packet received at destination and number of packet sent by the source, End-to-End delay – the average time taken for a packet to be transmitted from the source to destination, The packet loss ratio**-** represents the ratio of the number of lost packets to the total number of sent packets.

VI.RESULT ANALYSIS

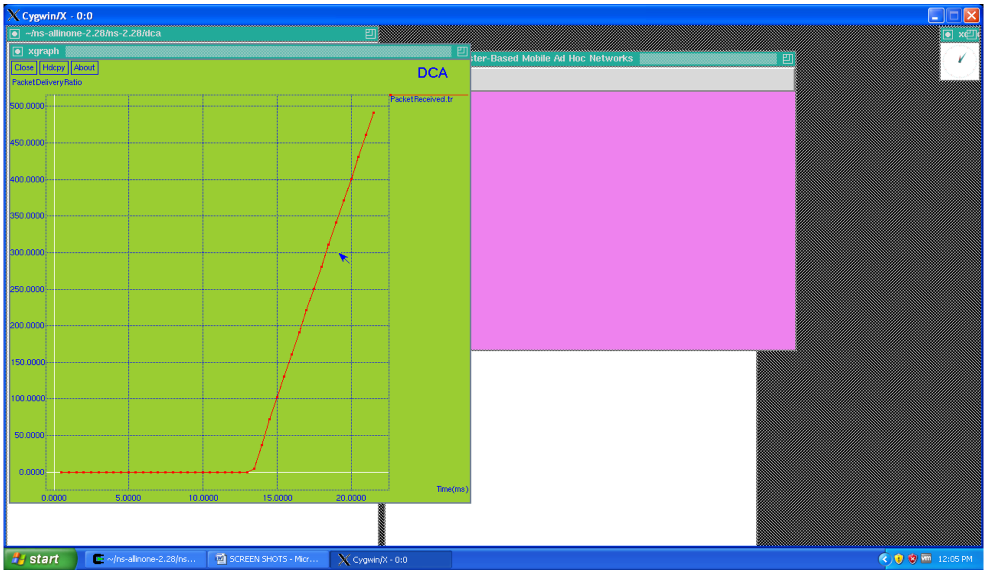

Fig: Packet Delivery Ratio

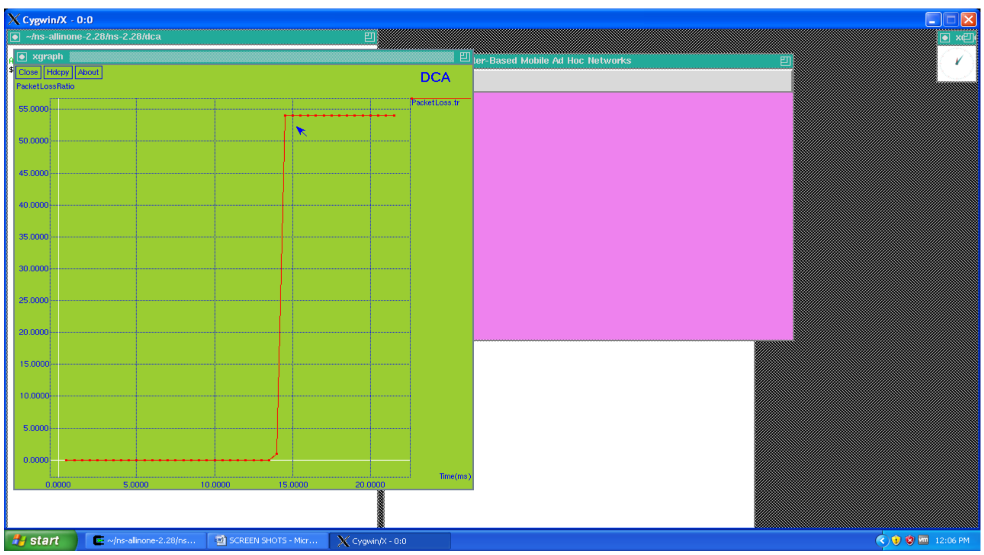

Fig: Packet Loss Ratio

ISSN: 2005-4262 IJGDC

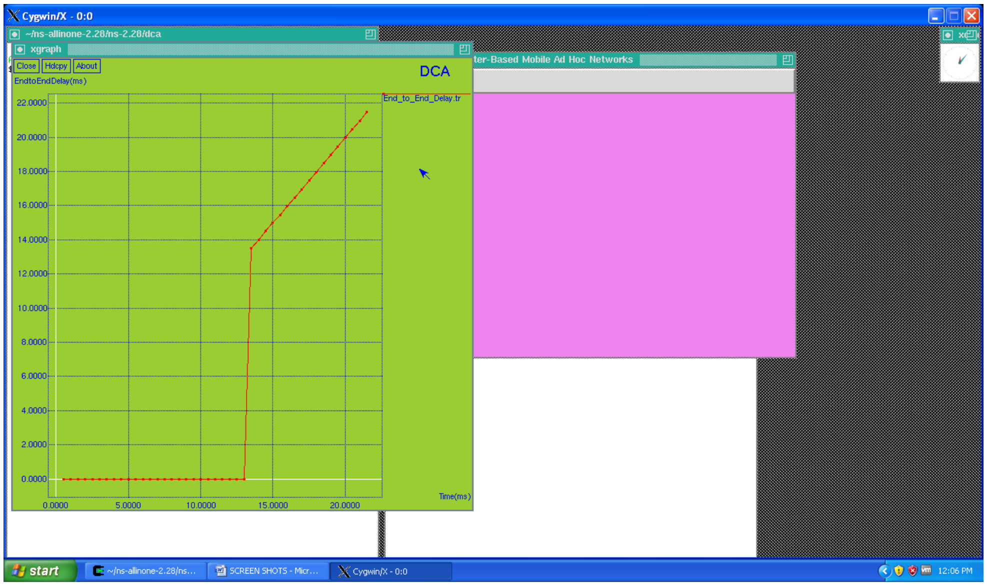

Fig: End To End Delay

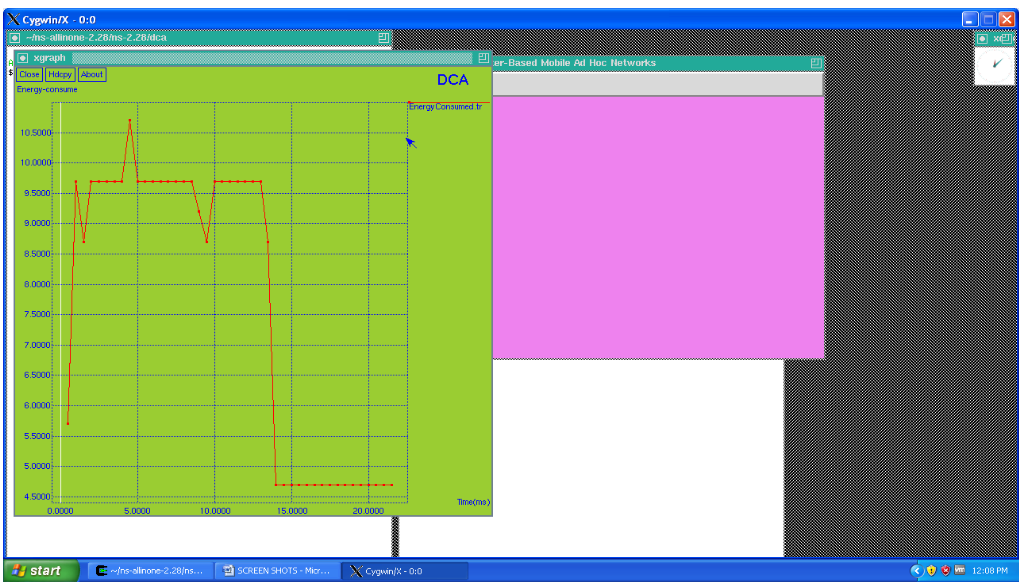

Fig: Energy Consumption

Comparison of existing system and proposed system

Parameter	Existing System	Proposed System
Packet Delivery Ratio	Low	High
Packet Loss Ratio	High	Low
End to End delay	High	Low

ISSN: 2005-4262 IJGDC

Energy Consumption	High	Low

VII.CONCLUSION

In this paper, we studied the problem of non-uniform load distribution in mobile ad hoc networks. We proposed a lightweight dynamic channel allocation algorithm and a cooperative load balancing algorithm. The dynamic channel allocation works through carrier sensing and does not increase the overhead. It has been shown to be very effective in increasing the service levels as well as the throughput in the system with minimal effect on energy consumption and packet delay variation. The cooperative load balancing algorithm has less impact on the performance compared to the dynamic channel allocation algorithm. We showed that these two algorithms can be used simultaneously, maximizing the improvements in the system. The combined system has been shown to perform at least as well as the systems with each algorithm alone and performs better for many scenarios. Both of the algorithms as well as the combined system also have a fast response time, which is on the order of super frame duration of 25 ms, allowing the system to adjust under changing system load. We proposed a novel MAC protocol, CDCA-TRACE, that combines dynamic channel allocation and cooperative load balancing algorithms into the TRACE framework. CDCA-TRACE, which controls channel utilization through the dynamically selected distributed channel coordinators, is compared to beacon enabled IEEE 802.15.4 in GTS mode of operation and IEEE 802.11, which controls channel utilization in a fully distributed manner. The carrier sensing mechanism enables CDCA-TRACE to select the channel coordinators more effectively compared to IEEE 802.15.4.

Future Scope

In this paper we have not investigated the effects of upper layers such as the routing layer, and instead focused on the MAC layer capability and local broadcasting service. Packet routing has a significant impact on the load distribution. Local link layer broadcasting service is directly used by some routing algorithms such as network flooding. Moreover, it can be used alongside with network coding and simultaneous transmission techniques for cooperative diversity. In general, joint optimization of the MAC and routing layers may enable even more efficient solutions. Investigation of the effects of routing is left as future work.

REFERENCES

[1] Sayed Kamran Haider,Muhammad Ali Jamshed,AiminJiang,AndHarisPervaiz,“An Energy Efficient Cluster-heads Re-usability Mechanism for Wireless Sensor Networks”IEEE Conference on Network Engineering 2019.

[2] Ms. Monali K.Fulbandhe, Prof. NutanDhande, Prof. Manoj Lade,” Methodologies to improve Energy Efficiency in WSN: A Review” *Journal of The Gujarat Research Society ISSN:0374-8588.*

[3] Ms. Monali K.Fulbandhe, Prof. NutanDhande ,” Techniques to improve Energy Efficiency in Wireless Sensor Network*” International Journal of Future Generation Communication and Networking Vol.13 No.1, (2019).*

[4] W.-Y. Chung, B. G. Lee, and C. S. Yang, “3d virtual viewer on mobile device for wireless sensor network-based rssi indoor tracking system,” Sensors and Actuators B: Chemical, vol. 140, no. 1, pp. 35–42, 2009.

[5] B. Hu, W. Chen, and J. Zhou, “High performance flexible sensor based on inorganic nanomaterials,” Sensors and Actuators B: Chemical, vol. 176, pp. 522–533, 2013.

ISSN: 2005-4262 IJGDC

[6] H. Yang and Y. Zhang, "A study of supercapacitor charge redistribution for applications in environmentally powered wireless sensor nodes," Journal of Power Sources, vol. 273, pp. 223–236, 2015.

[7] A. Alphonsa and G. Ravi, "Earthquake early warning system by IoT using wireless sensor networks," in Wireless Communications, Signal Processing and Networking (WiSPNET), International Conference on, pp. 1201–1205, IEEE, 2016.

[8] I. E. Commission et al., Internet of things: wireless sensor networks. IEC, 2014.

[9] L. A. Grieco, G. Boggia, S. Sicari, and P. Colombo, "Secure wireless multimedia sensor networks: a survey," in 2009 Third International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies, pp. 194–201, IEEE, 2009.

[10] S. Kumar, H. Lim, and H. Kim, "Energy optimal scheduling of multichannel wireless sensor networks for wireless metering," in Electronics, Information, and Communications (ICEIC), 2016 International Conference on, pp. 1–5, IEEE, 2016.

[11] M. A. Jamshed, O. Amjad, and E. Zeydan, "Multicore energy efficient scheduling with energy harvesting for wireless multimedia sensor networks," in Multi-topic Conference (INMIC), 2017 International, pp. 1–5, IEEE, 2017.

[12] C. Wang, Y. Zhang, X. Wang, and Z. Zhang, "Hybrid multi hop partition based clustering routing protocol for WSNs," IEEE Sensors Letters, vol. 2, no. 1, pp. 1–4, 2018.

[13] Y. Zou and K. Chakrabarty, "Sensor deployment and target localization based on virtual forces," in INFOCOM 2003. Twenty-Second Annual Joint Conference of the IEEE Computer and Communications. IEEE Societies, vol. 2, pp. 1293–1303, IEEE, 2003.

[14] D. He, N. Kumar, J. Chen, C.-C.Lee, N. Chilamkurti, and S.-S.Yeo, "Robust anonymous authentication protocol for health-care applications using wireless medical sensor networks," Multimedia Systems, vol. 21, no. 1, pp. 49–60, 2015.

[15] S. Poduri and G. S. Sukhatme, "Constrained coverage for mobile sensor networks," in Robotics and Automation, 2004.Proceedings.ICRA'04.2004 IEEE International Conference on, vol. 1, pp. 165–171, IEEE, 2004.

[16] S. Hosseinirad, M. Alimohammadi, S. Basu, and A. Pouyan, "Leach routing algorithm optimization through imperialist approach," International Journal of Engineering, Transactions A: Basics, vol. 27, no. 1, pp. 39–50, 2014.

[17] O. Younis and S. Fahmy, "HEED: a hybrid, energy-efficient, distributed clustering approach for Ad-hoc sensor networks," IEEE Transactions on mobile computing, vol. 3, no. 4, pp. 366–379, 2004.

[18] J. R. Srivastava and T. Sudarshan, "A genetic fuzzy system based optimized zone based energy efficient routing protocol for mobile sensor networks (OZEEP)," Applied Soft Computing, vol. 37, pp. 863–886, 2015.

[19] W. Ke, O. Yangrui, J. Hong, Z. Heli, and L. Xi, "Energy aware hierarchical cluster-based routing protocol for WSNs," The Journal of China Universities of Posts and Telecommunications, vol. 23, no. 4, pp. 46–52, 2016.

[20] S. Tyagi and N. Kumar, “A systematic review on clustering and routing techniques based upon LEACH protocol for wireless sensor networks,” Journal of Network and Computer Applications, vol. 36, no. 2, pp. 623– 645, 2013.

[21] D. Jia, H. Zhu, S. Zou, and P. Hu, “Dynamic cluster head selection method for wireless sensor network,” IEEE Sensors Journal, vol. 16, no. 8, pp. 2746–2754, 2016.

[22] M. Rayenizadeh, M. K. Rafsanjani, and A. B. Saeid, “Cluster head selection using hesitant fuzzy in wireless sensor networks,” in 2018 6th Iranian Joint Congress on Fuzzy and Intelligent Systems (CFIS), pp. 139–141, IEEE, Feb 2018.

[23] K. A. Darabkh and L. Al-Jdayeh, “A new fixed clustering based algorithm for wireless sensor networks,” in 2018 14th International Wireless Communications Mobile Computing Conference (IWCMC), pp. 71–76, IEEE, June 2018.

[24] N. Jain, S. Das, and A. Nasipuri, “A multichannel CSMA mac protocol with receiver-based channel selection for multihop wireless networks,” in Proc. 10th Int. Conf. Comput. Commun. Netw., 2001,pp. 432–439.

[25] A. Nasipuri and S. Das, “Multichannel CSMA with signal power based channel selection for multihop wireless networks,” in Proc.52nd Veh. Technol. Conf., 2000, vol. 1, pp. 211–218.

[26] J. So and N. H. Vaidya, “Multi-channel MAC for ad hoc networks: Handling multi-channel hidden terminals using a single transceiver,” in Proc. 5th ACM Int. Symp. Mobile Ad Hoc Netw. Comput.,2004, pp. 222–233.

[27] K. Tang and M. Gerla, “Mac layer broadcast support in 802.11wireless networks,” in Proc. 21st Century Mil. Commun. Conf.,2000, vol. 1, pp. 544–548.

[28] J. Zhu, and S. Roy, “MAC for dedicated short range communications in intelligent transport system,” IEEE Commun. Mag., vol. 41,no. 12, pp. 60–67, Dec. 2003.

[29] Wireless LAN Medium Access Control (MAC) and Phys. Layer (PHY)Specifications, IEEE Standard 802.11-2007, Jun. 2007.

[30] M. Torrent-Moreno, D. Jiang, and H. Hartenstein, “Broadcast reception rates and effects of priority access in 802.11-based vehicular ad-hoc networks,” in Proc. 1st ACM Int. Workshop Veh. Ad Hoc Netw., 2004, pp. 10–18.

[31] J. Xie, A. Das, S. Nandi, and A. Gupta, “Improving the reliability of ieee 802.11 broadcast scheme for multicasting in mobile ad hoc networks,” in Proc. IEEE Wireless Commun. Netw. Conf., 2005,vol. 1, pp. 126–131.

[32] X. Ma, and X. Chen, “Performance analysis of IEEE 802.11 broadcast scheme in ad hoc wireless LANs,” IEEE Trans. Veh. Technol.,vol. 57, no. 6, pp. 3757–3768, Nov. 2008.

[33] V. H. MacDonald, “Advanced mobile phone service: The cellular concept,” Bell Syst. Tech. J., vol. 58, pp. 15–41, 1979.

[34] E. Standard, “Global system for mobile communications (GSM) standard for mobile phones,” 1990.

ISSN: 2005-4262 IJGDC

[35] I. Katzela, and M. Naghshineh, "Channel assignment schemes for cellular mobile telecommunication systems: A comprehensive survey," IEEE Pers. Commun., vol. 3, no. 3, pp. 10–31, Jun. 1996.

ISSN: 2005-4262 IJGDC