# Optimized throughput and minimized energy consumption through clustering techniques for Cognitive Radio Network

**Anant R. More , M.S.G. Prasad , Wankhede Vishal A**

***Abstract:*** ***The most important problem in contemporary wireless network is radio resource usage with the limited range of radio signals. In the high frequency bands, radio resources can be used less because it increases the delay in network and reduces the packet delivery ratio. Estimating path and sending data by using the available resources in network are the closed application of wireless network. By using CR Network in the system one can be able to achieve the closed cooperation, better performance and lower complexity. In order to enhance the proficiency, the Routing should be considered jointly with the resource allocation. One of the objectives of doing this is to minimize the energy consumption by using limited resources and Spectrum. The CR Network would be the most popular wireless network in the field of wireless technology as it may solve the problem of spectrum scarceness, under-utilization & resource allocation. In the proposed algorithm for CRN, path has been created between source node and destination node in such a way that path causes least interference to other nodes and gets the maximum throughput & minimizes the delay. This Paper presents the simulation environment in order to obtain efficient Spectrum Allocation or Resource Allocation of the available spectrum for CRN, Performance gains in terms of throughput and minimum end-to-end delay. The algorithm is implemented using NS2 tool.***

***Index Terms: WMN, CRN, Spectrums, Clusters.***

## I. INTRODUCTION

A wireless mesh Network i.e. WSN is an upright network used for communication purpose through different nodes. The different things in WMN are that, its highly mobile Network can do communication frequently. Due to dynamic nature, the nodes change its network architecture continuously [1]. A WMN is more reliable than other and offers redundancy. In MWN when one node is not working still other node communicate with each other directly or indirectly so that they can share their information and maintain their property.

Typically, a Mesh Network uses the stable mesh routers for accessing the data which is also known as access point for two networks Communication. These stable access points are main part of WMN which plays important role with it communication not possible [02-03]. Each Access point Node is able to connect through its access point & share the information whereas mesh network communicates directly through the access point.

In WMN structure, CRN can be used to maximize the available resources & spectrum utilization and made them available to other things. The WMN is used to cover the maximum area so one can utilize it as maximum as possible [2]. Using wireless mesh networks, we are able to reduce the complexity & cost of wire which we are using for communication. WNS is mostly used in the field of business where site continuously block or it's not available. It is also used in general area where we need to transfer the data through different channel. WMN are most reliable and able to get high throughput. Wireless Mesh Networks able to provide high connectivity between indoor & outdoor network in this WMN able to provide high quality output without changing anything between network & without adding any extra cost. It is also able to use in public sector to provide the reliable data without any redundancy.

Cognitive Radio Network (CRN) is a reactive, adaptable radio network technology which can dynamically detect the available nodes in a wireless frequency spectrum and changes transmission parameters and enable availability of more wireless communication channel that are in the network & improve the radio network operation [4].

By adding to operation on CRN it improves its utilization of frequency bands & other parameters so one can get more outcomes. These parameters include delay, PFA ratio, throughput & Energy consummation. This can be worked as an autonomous environment that can be accessed to get more efficiently work from CRN. The CRN observed its own in continuous manner with radio frequency that can be gain from other. Then this output can be used by CRN for other communication so safe, reliable and efficient communication in WMN is possible. Figure 01shows the working concept of CNR. Thus using CNR in WMN structure, maximum output in less time can be achieved. It can deliver the required data with good quality in less time with maximum output [05].

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**Mr. Anant R. More**, Ph.D. Scholar, K.L.E.F. Guntur A. P. India.
**Dr. M.S.G. Prasad**, Head of Department, ECE, KKR Institute of Technology & Sciences, Tamilnadu, India.
**Dr. Wankhede Vishal A.**, Professor and Head of Department, E&TC, SNJBs K.B. Jain CoE, Chandwad, Nashik, India & Research Supervisor, K.L.E.F., A. P. India

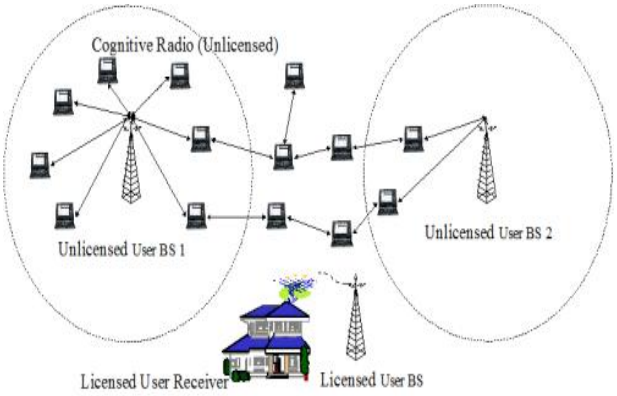


**Figure 01: CRN Architecture**

*Objectives:*

To optimize utilization of radio frequency & resources to get the maximum throughput in less time.

To improve the efficiency of resource allocation to gain the maximum Packet delivery Ratio.

To develop a routing protocol like spectrum Routing using Joint Resource Allocation and Routing Techniques.

## II. MOTIVATION

Smart Radio system that is CRN is combined with WMN, continuously changes in the network and path of massages is possible and so the different radio frequency channels will be available each time while sending the data between the two nodes on path along with the dynamic nature of the Mesh Network. [8].

The key roles of cognitive radios are,

Power Control: it can be utilized for different kinds of spectrums sharing to get the maximum power in secondary interface so that it helps to primary user for getting throughput & protect Primary user [20].

Spectrum sensing: Finding the unused spectrum and dividing it with other without affecting secondary user. Due to this, detection of the unused spectrum and maximum utilization of it is possible. Detecting primary user is not our work but detect the node those are not utilized & used it is the most important task [15-16].

Transmitter detection: CRN is able to detect regularly the transmission time required for communication. There are different methods are used to find the transmission time [07-08].

Energy detection: In WMN energy detection used to show the Present or absences of energy in network just by observing the signal received & send in network. This detection method is simple method to detect the system energy.

Cyclostationary-feature detection: This method is more user-friendly which can be use easily for BPSK , QPSK , OFDM etc. to get maximum outcome [21]. However, noise signals (especially, white noise) do not show cyclostationary conduct. Due to uncertainty in noise, Cyclostationary can be used by single or mutlicycle structure.

Cooperative detection: it works on the basis of sharing information those node shares their information with other so can get maximum resource utilization.

Null-space based CRN: In WMN the CRN detect the blank space in two nodes and transmit the data through that network without interfacing with primary user.

Spectrum management: By finding the most available nodes in network that has good capacity for communication, communication with other without disturbing the primary user is possible [6]. CRN can find on the basis of good energy band so we are able to get good quality outcome in less time according the requirement. So node management system required to get efficient output.

The Radio Resource Management (RRM) is the framework level management of radio resources, co-channel interference and other radio transmission parameters in wireless communication systems, such as cellular networks, wireless local area networks and wireless sensors Networks. It includes the different parameters and Algorithm such as how users can be allocated in system, Transmission time, throughput, energy consumption etc. In order to enhance the proficiency, the Routing should be considered jointly with the resource allocation, main objective of doing this research is to minimize the energy consumption by using limited resources and Spectrum. The RRM is the multi-hop management system instead of point to point communication [10]. The RRM system mostly used by systems those provide the multi-hop network like as cellular systems and broadcast networks covering large areas homogeneously.

Generally different cellular network changes GSM frequency to LTE frequency to gain the maximum speed in less bandwidth [17]. Its follow the same rules like,

- Static & Dynamic data frequency management
- Inter-cell radio resource management
- Channel allocation System by using different method.

In radio resource management (RRM) for wireless and cellular networks, encompasses a channel allocation schemes from wide range of functions which allocate bandwidth and communication channels to router, system access point & end point [10]. The main thing is to gain a maximum system spectrum efficiency in bit/s/Hz/site by adopting frequency reuse, but still there is assurance for a certain quality of service with reasonable co-channel interference and adjacent channel interference between nearby cells [11].

Channel-allocation technique follows one of following sorts of schemes:

1. Fixed: This method use to allocate the fix path & Channel to network.

2. Dynamic: This method use on demand channel allocation method

- Its allocate the different channel on time
- It selects the cluster & frequency on time
- Spread spectrum

3.Static Channel Allocation

Fixed Channel Allocation or Fixed Channel Assignment (FCA) allows each cell is specified a fix channel system. FCA use the normal system allocation method that allocate the channel manually, which is a

difficult job in frequency-division multiple access (FDMA) and time-division multiple access (TDMA) systems [12].

These systems are very sensitive if we want sharing of information with other on same network. The second disadvantage of the system is that the nodes in the system are fixed and as its static system everything is predefine. Due to it may get traffic problem so that some call may get disconnect due to heavy traffic in fix network. We can reduce the FCA problem by sharing the information with DCA node so can get maximum outcome by using Mobile Switching Center (MSC).

*Dynamic Frequency Allocation*

Dynamic Frequency Allocation (DFA) can be employed on dynamic wireless network system through different access points. Those access point able to find paths between the dynamic network . DFA is supported by the IEEE 802.11h wireless local area network standard. DFA is also mandated in the 5470-5725 MHz U-NII band for radar avoidance [2].

Dynamic Channel Allocation or Dynamic Channel Assignment (DCA) would be more efficient way of allocating the channel in which channel not allocate Permanently to devices, that can be allocate according requirement of node. The cluster formation & Channel allocation can be done by using following steps,

Use the frequency of primary channel that are available

For it break the cluster groups on the biases of above step

After finding the channels according to their frequency divide it & form a cluster.

In last send the data though channel head through the network by using limited resources.

In DCA system we need to maintain the real time data so can get the actual outcome and able to allocate the data on time requirement. The main advantage of system is to allocate the node on time so can able to use maximum frequency as possible.

*Spread spectrum*

It is an alternative method to Complex channel allocation. It uses different method of allocating channel to system on the bases of less frequency equipment. So the frequency problem is reduced on call by using spread spectrum and FDMA [13], for example IS95 and 3G systems. It also have base stations which are controlled centrally that carry other node information that can be used at the time of channel allocation so can allocate efficient channel to system while traffic load simply by allocating different thing to devices by assign the altering path .

*DCA on a packet-by-packet basis*

Due to rapid changing nature of DCA network, this system works on the basis of sending data through different packets. Examples of these algorithms which work on basis of allocating different channel with packet-by-packet delivery system. The following Figure 02 show the delivery of packets,

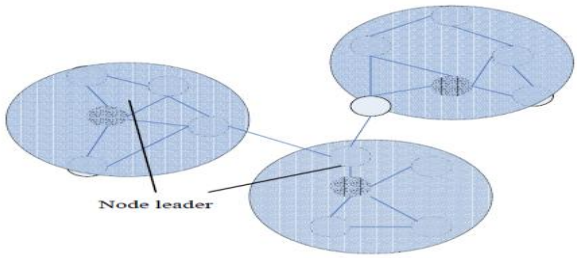


**Figure 02: Clustered Routing for Packet to Packet Delivery**

## III. PROPOSED WORK

Finding path & sending data by using the resources available in network are close application of wireless network. By using CR Network in our system we are able to achieve the close cooperation, better performance and lower complexity. In order to enhance the proficiency, the Routing should be considered jointly with the resource allocation. One of the objectives of doing this is to minimize the energy consumption by using limited resources and Spectrum. Research Plan of the work is as follows,

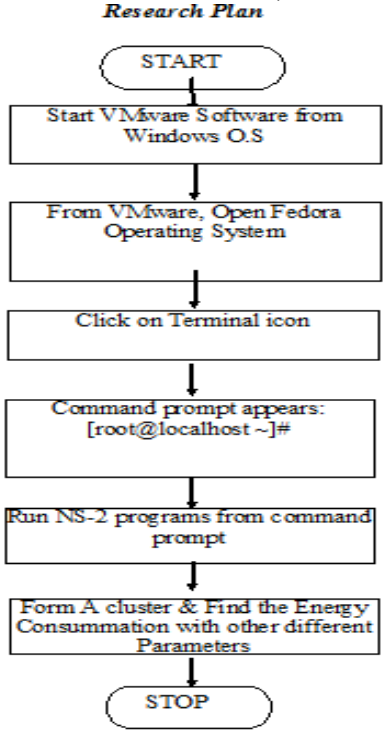


**Figure 03: Flowchart for formation of a cluster to calculate the energy consummation.**

The CR Network is the most popular wireless network in the field of wireless technology as it can solve the problem of spectrum scarcity by efficient manner of resource allocation [12]. In this, the clustering method is used to get maximum outcome. By using this method we reduces the energy consummation & improve the collaboration of network node, this system consists of different method like finding node, forming cluster & deciding the cluster and finally sending data though different channels.

The Following Figure 04 shows the Clustering of Network.

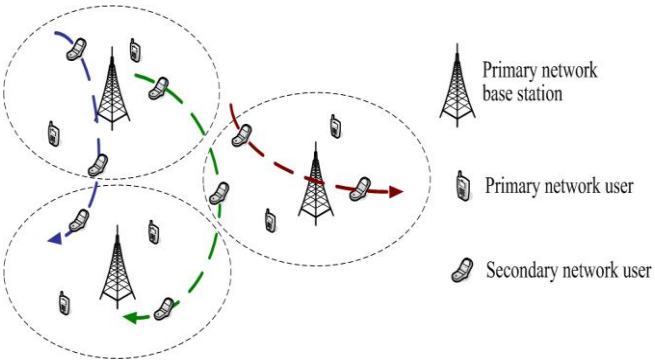


**Figure 04: Clustering of Network**

*Clustering Algorithm*

#ALGORITHM FOR AFRESH ARRIVING NODE

STEP 1:

Broadcasting of a signal to all its neighbor nodes in the Radio range;

Transmission Speed of Data within Node = 30 kbps

On basis of above we store the receive data in table that can be used in future communication.

STEP 2:

Collect all the information in one block like number of node in system, energy consume & number of data received & send

*BEGIN {*

*senddata = 0;*

*recvdata = 0;*

*Add node to cluster ;*

*}*

SPEP 3:

*If (Primary node already exists in neighborhood Cluster)*

*{*

*Request for joining the Cluster;*

*Else*

*a new cluster formation and declare itself as the Cluster-head;*

*}*

By using above algorithm we got the following result by dividing the network into number of clusters each carry one cluster head,

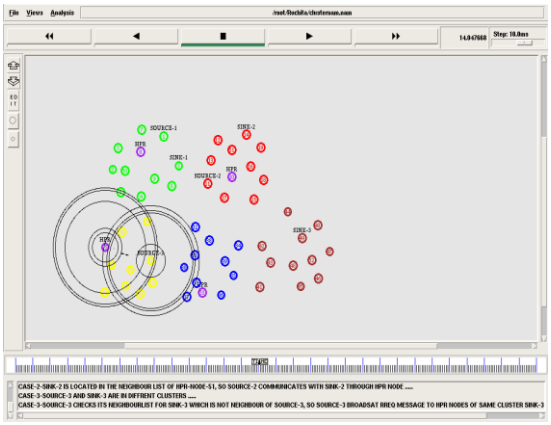

**Figure 05: Resource Allocation using Clustering**

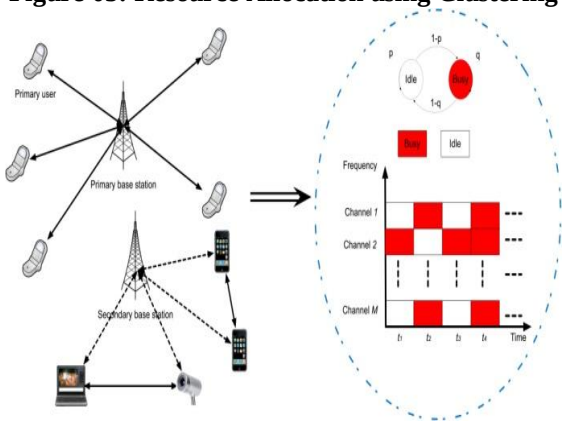


**Figure 06: cognitive radio Network with primary & secondary base station.**

In starting Stage CRN nodes not join the Cluster in network but in further process they select the one node as a cluster head on the basis of most reliable node in one cluster having good sensing capability. In the CRN system channels are available on the basis of energy use & consume in the system.

## IV. RESULTS AND DISCUSSIONS

The Modeling & simulation results of cognitive radio networks using clustering calculate the following parameters:

1. Spectrum sensing & detection of Errors.
2. Resources Allocation.
3. Measurement and modeling of spectrum usage.
4. Throughput of spectrum utilization.
5. PDF Ratio.
6. Energy Consumption.
7. Reduces the Delay.

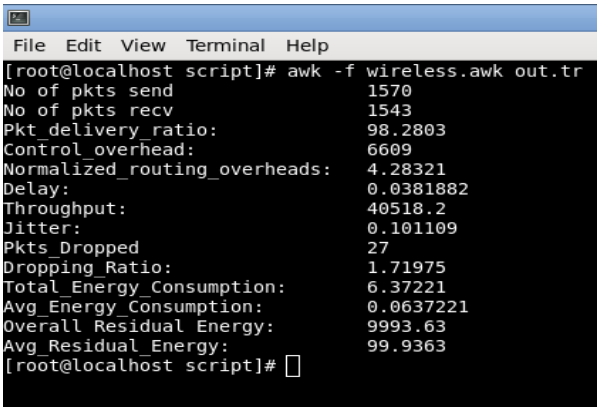


**Figure 07: Shows the Maximum PDF Ration with less energy Consumption By using clustering Techniques**

*How PDR can be calculated:*

The packet delivery Ration can be calculated by considering the packet send by a source node & how much packet received by destination node on the bases of these we can calculate the PDF ratio

```
BEGIN {
        Send_Line = 0;
        Recv_Line = 0;
        Forward_Line = 0;
}
 $0 ~/^s.* AGT/ {
        Send_Line ++ ;
}

$0 ~/^r.* AGT/ {
        Recv_Line ++ ;
}

$0 ~/^f.* RTR/ {
        foward_Line ++ ;
}
 END {
  printf "Packect Delivery Ratio of Simple
is :";
        printf                  "Ratio:%.4f
\n",(recvLine/sendLine);
  }
```

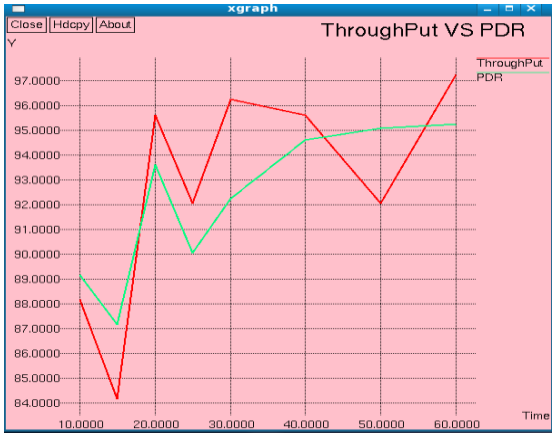


**Figure 08: Increases the PDF Ratio & Throughput.**

*How Energy can be calculated:*

Energy can be calculated by using Different parameters how much data send & received and how much time it required to deliver to it by considering the bandwidth of the system [22-23]. All details of Energy calculation is as follows,

```
# Variable Energy configuration for Nodes
set upper_limit1 99
set upper_limit2 0.9
for { set i 0 } { $i< $val(nn) } { incr i } {
set energy [expr rand()*500]
set file($i) [open energyfile($i).tr w]
puts $file($i) "$energy"
$ns_ node-config -initialEnergy $energy
set node_($i) [$ns_ node]
set p_id $i
set data_file($i) [open data_file($i).tr w]
set rand1 [expr double(rand()+$upper_limit2)]
set rand2 [expr double(rand()+$upper_limit1)]
set rand3 [expr double(rand()+$upper_limit2)]
puts $data_file($i) "$energy"
puts $data_file($i) "$rand1"
puts $data_file($i) "$rand2"
puts $data_file($i) "$rand3"
close $file($i)
close $data_file($i)
}
```

By using above Method we got the following result from where we can decide how much energy required,

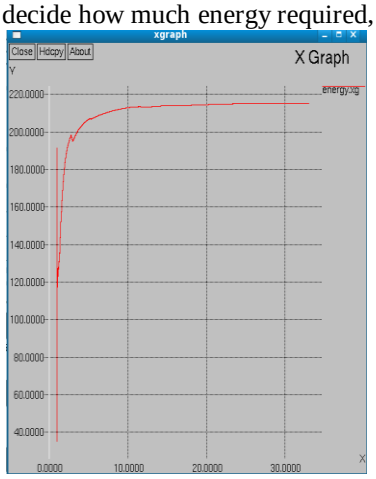


**Figure 09: Reduces the Energy Consumption by using maximum resources utilization.**

*Delay Calculation:*

Delay can be calculated by using how much packet send by sender & how much packet receive by receiver in particular time period if data receive by receiver in given time period then its good but if its required more time as compare to threshold value then it can be consider as a bad system need to update or modify the

system.

```
# Packet Delay
set delaytime 0
proc Delay { start } {
global ns_ delaytime sink24 delay
set now [$ns_ now]
set interval 0.05
set interval [expr rand()*$start+$interval]
set pakD [$sink24 set nrpkts_]
set end $interval
set delaytime [expr double($start-$end)+$delaytime]
set con [expr $start % 5]
if { $con == 0 } {
#puts $delay "$start [expr double($delaytime/$pakD)]"
}
set start [expr $start+1]
#$ns_ at [expr $start] "Delay $start"
}
```

Form above we can calculate the delay in System, Minimum delay means better system with maximum throughput, figure: 10 shows the Delay in System,

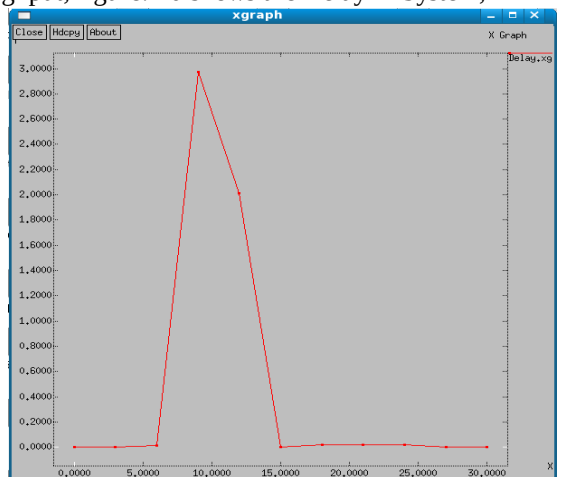


**Figure 10: Minimum Delay with Maximum throughput.**

## IV. CONCLUSION

By considering the different parameters of Cognitive Radio Network, to enhance the efficiency of resource allocation scheme, the spectrum sensing process should be considered jointly with the resource allocation in Cluster by choosing one of the cluster head. In proposed work, the limited radio-frequency spectrum resources and radio network infrastructure is utilize to get the maximum throughput and Packet delivery ratio, with the less energy consummation & less bandwidth. Better throughput in less time with minimum delay by using Cognitive Radio Network is achieved. In future, one can improve resources utilization by adding different method on CRN.

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