Performance Analysis of Cognitive Radio Networks by using Network Simulator NS-2

J.B. Bhosale, A.D. Shaligram
Department of Electronic Science, Savitribai Phule Pune University, Pune, India-411007.

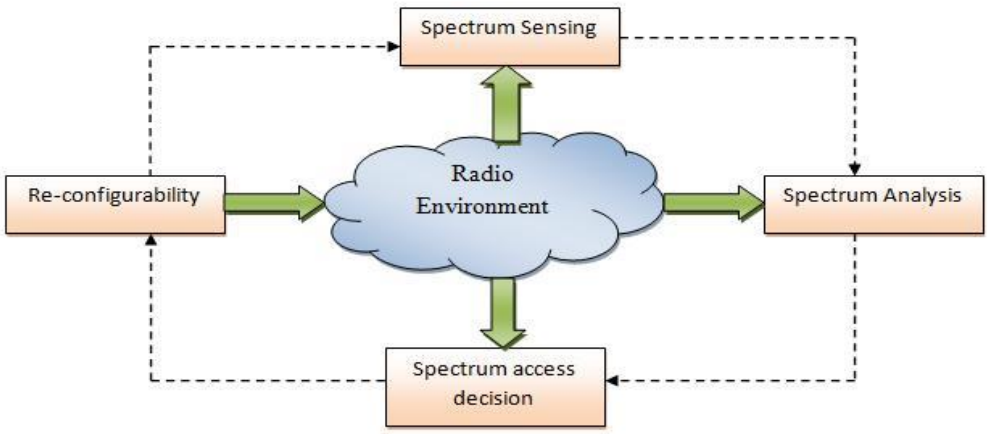
Abstract:- Wireless communication has been an emerging technology in last decade. But with all the development in this field the limitation of spectrum resources remains the main problem in this field. So, to overcome this problem of limited spectrum resources cognitive radio networks were introduced which are networks that are capable of learning through its experience and current environment and adjust itself according to the current situation. Thus the main purpose of cognitive radio networks is to make full use of available spectrum resources and apply in disaster /distress situation for emergency communication. Cognitive radio networks are capable of detecting the best available channels for their communication such that they don't interfere with other licensed or non-licensed users.

Keywords: Cognitive Radio (CR), Network Simulator NS- 2, Packet Drop,

I. Introduction

Cognitive Radio (CR) is an intelligent radio technology that utilizes the unused frequency spectrum in licensed bandwidth to improve the data transmission. It is designed in such a way that it allows secondary users to use channel without interfering with primary user. The primary user is the licensed user and secondary user is unlicensed user when the licensed user is accessing the spectrum the unlicensed user are not allowed so the secondary user has to sense the spectrum periodically to find the presence of primary user, presence of primary user is in dynamic in nature so the spectrum holes created by primary user is dynamic so the Cognitive user uses the DSA. While using the DSA routing is the challenging in cognitive radio networks.

.



Cognitive cycle .Fig.1

II. Network Simulation

Performance analysis of any network is an essential task. It helps to determine how the system is performing or any upgrading is needed to improve performance. To measure performance of the network three techniques are used

- Empirical Measurements
- Analytical Measurements
- Simulation Measurements.

Once the system is built and it is in running phase, empirical technique is used. During design and developing phase analytical and simulation technique is used. Ad hoc network is highly dynamic. It does not have any fixed infrastructure. It can be formed anywhere and anytime. The configuration of mobile ad hoc network is not stable hence simulation techniques are best option for analysis and development of scenario. Network simulator NS 2.35 is supportive tool for researchers to develop, test, and diagnose network protocols. Simulation tool is flexible, it carry out various experiments useful for further design and development. Simulation results are easier to analyses because important information at critical points can be Performance Metrics. Also performance measurement helps us to utilize network resources effectively. In the case of ad hoc network, resources are limited and hence should be used efficiently Different performance metrics used to analyze the performance of cognitive network.

Network Simulator version 2 widely known as NS-2 is a discrete event driven network simulation tool for simulation of network to study the dynamic nature of network. It is an open source solution implemented in C++ and Otcl programming languages at UCB (University Of Carolina Berkley).NS-2 provides highly modular platform for simulation of wired as well as wireless networks. NS-2 supports different network components, protocols like TCP,UDP,FTP and traffic sources like CBR etc. Results of the simulations are provided with in a trace files that contains the entire occurred event during the simulation. The output of simulation is visualized through Nam (Network Animator).

Network Simulator Metrics

ID	Metric	Definition	Formula	Value
PS	Packet Sent	Total number of packets sent by source node	Obtained from trace file	5000
PR	Packets Received	Total number of packets received by destination node	Obtained from trace file	504
DR	Delivery Ratio	Ratio of packets received to packets sent	$DR = \frac{PR}{PS} \times 100\%$	10.08%
SE	Simulation End Time	Time when simulation ended	Obtained from trace file	47.2507...
TD	Total Delivery Time	Time spent to deliver packets (PR).	Obtained from trace file	2664.14 ...
SZ	Packet Size	Size of each packet that node sends	Fixed TCL script	512 (Kb)
TP	Throughput	Average transform rate or bandwidth of route	$TP = \frac{PR}{SE} \times SZ$	5461.25 ...
THC	Total Hop Counts	Number of nodes participated to transfer data packets, i.e. total hops	Obtained from trace file	1811
AHC	Average Hop Counts	Number of hops for each data packet	$AHC = \frac{THC}{PR}$	3.593 ...
AED	Average end to end delay	Delay (or Time) spent to deliver each data packet	$AED = \frac{TD}{PR}$	5.2859 ...

III. Simulation And Performance Evaluation

This paper simulate the wireless cognitive network using NS2 simulator version 2.35 having following parameters. Simulation process and results analysis first of all, to set the topology and the configuration of nodes properties, and also properties of MAC layer for some address type, protocol type, channel type, simulation time and transmission way of wireless.

In our simulation, we used topography size 1000 m x 800 m, number of wireless nodes 15 nodes with maximum moving speed 8 m/s. We did the Simulation for 1000 sec. with maximum 6 connections at a time allowing UDP traffic. The network simulation parameters we have used for our simulation purpose shown in the following table.Simulation Parameters.

Sr.No.	Network Parameter	Value
1	No. Of Node	15
2	Topography Area	1000x800m
3	Connection Type	UDP
4	Source Traffic	CBR
5	Pay load	512
6	Routing Protocol	ADOV
7	Simulation time	1000s
8	Network Simulator	NS2.35

In order to evaluate the performance of network, packet delivery ratio, end to end delay, throughput and % packet loss are considered. These performance metrics are evaluated against 3 different networks namely networks of 10, 13 and 20 nodes. Our model 3 is compared with reference model 1 as the routing technique followed in both the models is same and its table driven routing where route for each node is stored in a table and accessed whenever required. However, routing technique followed in reference model 2 is on-demand where source node starts looking for next hop if it has packet to send.

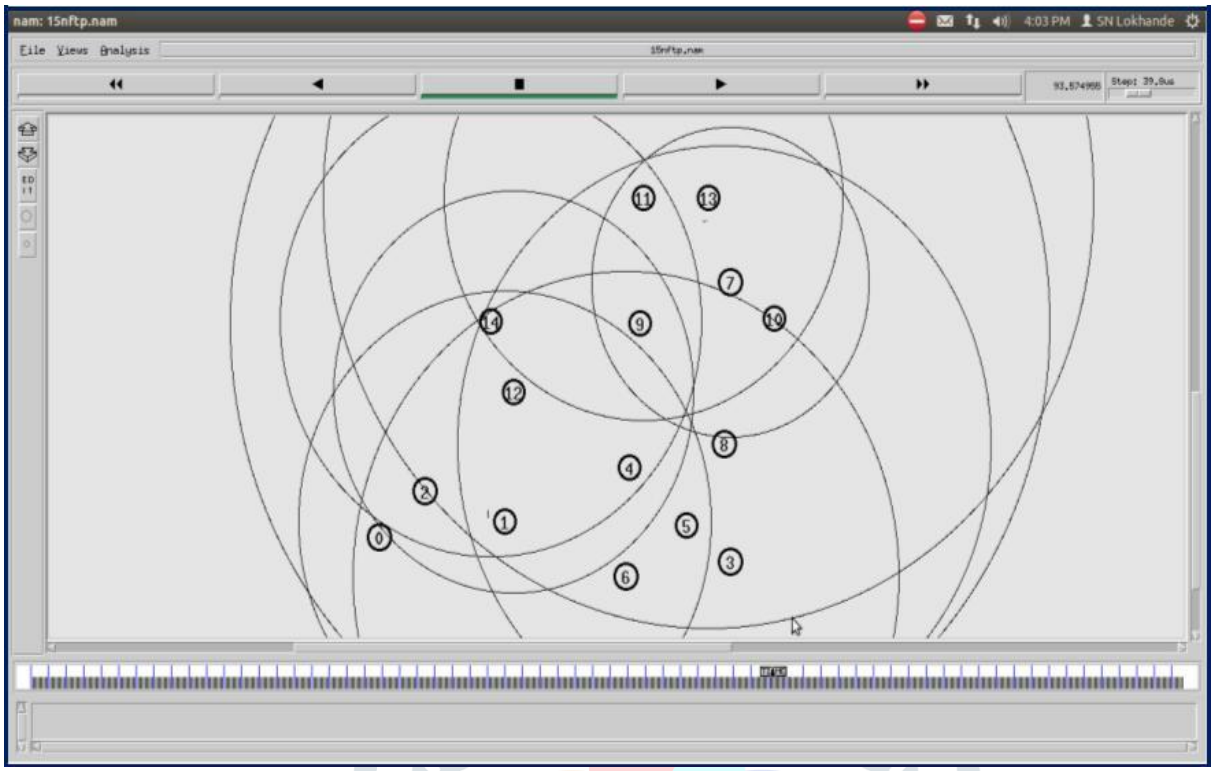


Fig. 2: Snapshot of Simulated Network

IV. Performance Metrics

The performance of the protocols depends on various inter-relating metrics . Which plays important role in analytical observation of the protocol. Following are the some important parameters which we are selected to study the performance of AODV protocols in this simulation study.

Packet Delivery Ratio: Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources.

Mathematically It can be defined as: PDR= R Size / S Size

Where, R Size is the sum of data packets received by the each destination and S Size is the sum of data packets Send by the each source.

Packet Drop (Loss) Ratio:- Packet loss occurs when one or more packets of data traveling across a network fail to reach their destination.

Throughput:-It is defined as the total number of packets delivered over the total simulation time

Mathematically, it can be defined as: Throughput = N/T ,Where N is the number of bits received successfully by all destinations and T is simulation time.

V. Experimental Result

When the simulation setup is completed, we run the network simulator, which creates two files one is Nam, which visualizes and animates the network. Other file is a trace file, which captures all the events that happened in the simulated network. To extract the data from the trace file we write the AWK script. Data obtained from AWK script is used to find different parameters which includes packet sent, packet

received, packet dropped, for CBR traffic flow. This is used to find PDR, DPR and Throughput, which are used to measure the performance of AODV protocol. Following table II shows the evaluated data of trace file which includes packet sent, packet received, packet dropped for CBR.

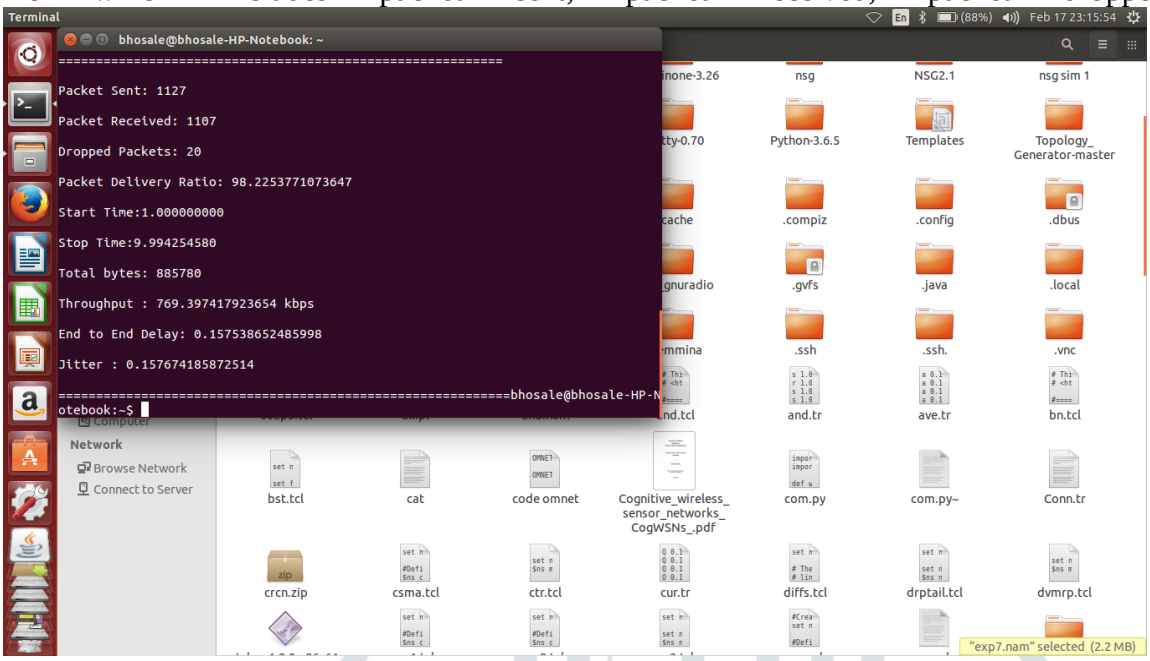
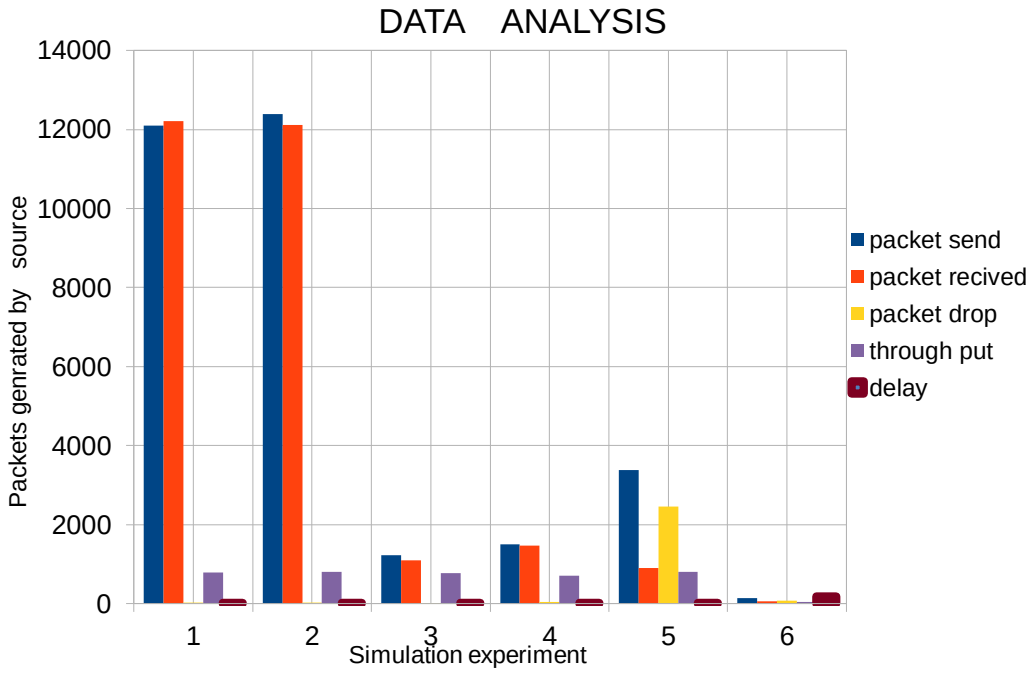


Table 2. Values of Performance Metrics

Simulations experiment	Packet Send	Packet Received	Total No of packet Dropped	Trough put	Delay
1	12102	12212	30	785	0.157
2	12392	12121	35	802	0.2
3	1227	1107	20	769	0.3
4	1511	1471	40	705	0.23
5	3378	913	2465	808	1.22
6	139	59	80	42	180



Conclusion

Cognitive Radio (CR) technology holds great promises for addressing the problems of spectrum scarcity and spectrum underutilization in order to meet the increasing demand for radio spectrum. As the objective of this research paper is to analysis the performance of the cognitive radio network using network simulator NS2 and to is network using AODV as routing protocol. we select different performance matrix. The values are obtained from the trace file generated by NS2. Using the trace file.tr the data is

processed and is used to measure the packet sent, packet received, packet dropped of different simulation network .

References:-

1) J. Mitola, "Cognitive Radio for Flexible Multimedia Communications", IEEE International Workshop on Mobile Multimedia Communications
2) Teerawat Issariyakul, Laxminarayana S Pillutla, and Vikram Krishnamurthy "Tuning Radio Resource in an Overlay Cognitive Radio Network for TCP: Greed Isn't Good", IEEE Communication Magazin, pp:57-63 (July 2009).
3) KhalidA Qaraqe, Hasari Celebi, Muneer Mohammad and Sabit Ekin, "Performance Analysis of Ad Hoc Dispersed Spectrum Cognitive Radio Networks over Fading Channels", URASIP Journal on Wireless Communications and Networking (2011).
4) https://ns2bloggers.blogspot.com/2014/04/ omparative matrices-calculation.html.
5) http://nsnam.isi.edu/nsnam/index.php/NS-2_Trace_Formats