Journal of Science and Technology
ISSN: 2456-5660 Volume 4, Issue 5, Sep-October 2019, PP 01-06
www.jst.org.in

Performance Analysis of Cognitive Radio Network Using Enhanced Stimulated Annealing Algorithm

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***Abstract*:** *This document presents the optimization of quality of service for unlicensed subscribers anticipating the QoS of the primary users as well. The concept of cognitive radio came into existence for the exclusive use of the unused spectrum space by the licensed users. The unlicensed user or the secondary users use the unoccupied spectrum spaces of licensed user's spectrum for the effective usage of the spectrum. The use of live streaming, Voice over Internet protocol(VoIP) and multi media applications which are delay sensitive applications throughout the session. The constraints like delay and throughput and the quality of service are affected due to these applications. To overcome these constraints the tradeoff between these parameters must be employed. In this paper, an extension to the non-work conservation policy is implemented in Cognitive radio network(CRN) by using the optimization algorithm known as Enhanced stimulated annealing(ESA) algorithm to bring forth the tradeoff between delay and throughput.*

Keywords: *Cognitive Radio, Delay, Enhanced stimulated annealing Algorithm, Optimization, Throughput, Trade-off.*

I. Introduction

With the growth in the digital age, nowadays spectrum usage has risen drastically. The use of spectrum has the most prominent position to play in the world of communication. The technology called cognitive radio has developed by the IEEE 802 LAN / MAN Standard Committee (LMSC) and released in 2011. It is an intelligent radio that can change the parameters in accordance to the perceived availability of the spectrum in its operating environment. Cognitiveradio supports the cognitive users also known as the secondary users or the unlicensed user and can provide them unused spectrum space to effectively use the underutilized band frequencies. A cognitive radio (CR) has the capacity (cognitive capacity), from the nearby environmentto detect and collect data (e.g., transmission rate, bandwidth, energy, modulation, etc.) as well as to adjust operating parameters to ideal results quickly [1]. The cognitive cycle has three phases. They are (i).spectrum sensing, (ii). spectrum management, (iii). spectrum mobility, (iv). spectrum sharing. The cognitive cycle is as shown in the following figure 1.

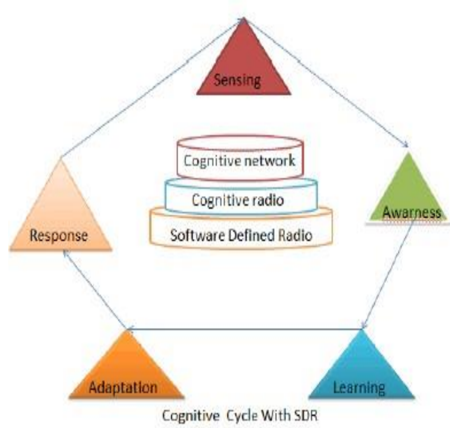

Figure 1: Cognitive cycle

The spectrum sensing is the process to sense the spectrum holes in the frequency range of the system in which the cognitive radio is implemented. Spectrum sensing detects spectral holes and allocates for the opportunistic transmission of CR users. In [3] Multiple sensors for unified spectrum detection, while a multi-energy detector system and various adjustable thresholds for cooperative spectrum measurement were described in [4]. Furthermore,the spectrum management is to choose

the best channelswhich are available and arrange the connectivity with other users to this channel. The spectrum management is all about avoiding the interference and providing QoS in spectrum environment. Along with provisioning of seamless connectivity nevertheless of the licensed subscribers. The spectrum mobility is regarding the handoff during the licensed user activity on the allotted channel might require users to alter their working channel bands.

A significant condition of mobility management protocols is to provide data on the span of a spectrum handover. Whenever the cognitive user changes its operating frequency these network protocols changes the parameters. This leads to the guaranteed clean and rapid shift with a minimum depletion of the QoS during handovers.The current spectrum sharing research is intended at addressing these problems and can be categorized into four elements: design, conduct of spectrum allocation, method of spectrum communication, and range. The following sketch explains the inter-network and intra network spectrum sharing i.e., figure 2.

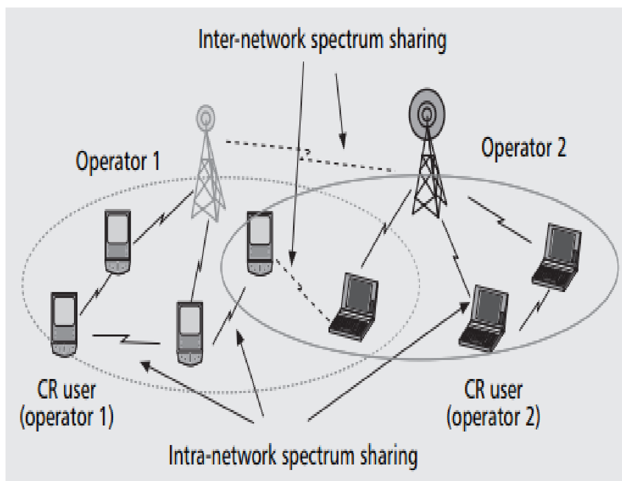

Figure 2: Spectrum sharing

II. Organization Of The Frame Work

In this paper we have considered the cognitive radio network as sketched as below figure 3. The network incorporates of two users i.e., Primaryusers (PU) and secondary users (SU) and a standard destination. The PU is furnished with a queue, Qp for the primary user packets and likewise SU is furnished with a queue, Qs meantfor the secondary user packets and the Qsp which is intended for the packets

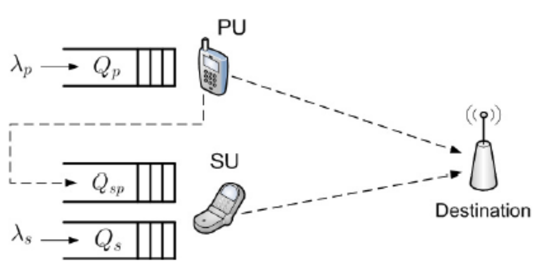

Figure 3: System organization

over headed from the PU packets. The packetarrival rates are defined as λp and λs using random process of Bernouliwhere $0 \leq \lambda p \leq 1$ and $0 \leq \lambda p \leq 1$.The evolution of the length of the jth queue ischaracterized asQjt+1 = (Qtj – Ytj) + + Xtj, for j ∈ {p, sp, s} ……. (1)When a primary user uses the channel to propagatethe packets through Qp towards the destination, thepackets are received by the destination a positiveacknowledgment (ACK) is send to PU indicating thatthe packets are received successfully. In this scenariowe assume that the system is interference free channelby using the high detection probability detectors at theMAC layer. The probability of successful packetreception i.e., the probability of no linkage outage,between the primary user (PU) and the destination, thesecondary user (SU) and the destination, and the PUand the SU are indexed by hpd, h_{sd} and h_{ps},respectively. In this layer the PU can be detected for itsIdle or the busy states using the detecting sensors atthe secondary users.

2.1 When the PU is reserved

Basically, when the PU transmittes the packetstowards the destination, there exists three probablecases:

(i). If the destination receives the packets and sendsback an acknowledgement to the PU that the packetsare decoded perfectly by the destination neverthelessof whether the SU decoded the packets or not.

(ii). If the packets are decoded by the SU as well as thedestination, then the packets are stored in QSP withprobability denoted by ‘a’. If accepted by the SU then itacknowledges the source and the packets are releasedfrom the Qp.

(iii). If neither the SU nor the destination, then thepackets are remained in the Qp for retransmission.

2.2. When PU is not busy

If the channel is occupied by the SU through Qs withthe probability ‘b’ or from the queue Qsp with probability‘1-b’. Otherwise the packets are dropped, and the PUis idle. The condition that the PU is busy, and the slotis under utilized is said to be the WC cooperative policy.

III. Implementation Of Design

The service rates of the PU and SU are formulated as below from the service rate of Qp is μp,

$$\mu p = hpd + (1 - hpd)\ hps\ a$$

and similarly, the service rate of Qs is μs,

$$\mu s = b\ hsd(1 - \lambda p/\mu p)$$

whereas the service rate of Qsp is formulated as

$$\mu sp = (1 - b)\ hsd\ (1 - \lambda p/\mu p).$$

The average queue lengths of the QS, Qp and Qsp are indicated by Np, Nsp and Ns individually. These queue lengths are derived from the application of Pollaczek-Khinchine formula [8] with Bernoulli arrival rate which is represented by λp using discrete time M/M/1 queue in the MATLAB using communication tools.

The Inequalities of the stability of the queue is formulated such that the network would be operated accordingly. That is

$$\lambda p < \mu p,\ \lambda s < \mu s,\ \lambda_{sp} < \mu_{sp}.$$

Likewise, the average delays of the primary and cognitive user are formulated using little’s law such that

$$Dp = (Np + Nsp)/\lambda p,\ Ds = Ns/\lambda s$$

For defining the secondary user throughput, the optimization problem is considered as follows. Here we optimized the problem of maximizing the SU throughput with the PU delay constraint. Here is the formula that the problem is framed:

$$Q1: \max bhsd \left(1- (\lambda p / \mu p)\right)$$

a,b

$$s.t.\ 0 \leq a \leq 1,$$

$$0 \leq b \leq 1,$$

$$\mu p = h\, pd + (1 - h\, pd)\, hps\, a,$$

$$(Np + Nsp)/\lambda p \leq \psi \ [8]$$

The paper is mainly focused on the concept to improve the QoS even with cognitive user while using the applications like Voice over internet protocol, live streaming and some other media applications like screen sharing etc. Parallelly providing the licensed user with the efficient communication channel.

The suboptimal policy and the WC policy are principled with the conditions such as arrival rates and the probabilities of the channel as follows: h pd = 0.3, h ps = 0.4, hsd = 0.8. Now coming to the Primary delay constraint, the Threshold limit plays a important role where $\psi = 10$. The problem Q1 is a non-convex function which is converted to quasi convex function to solve in an iterative process with $\psi = 10$ and $\lambda p = 0.2$ and $\lambda s = 0.4$.

IV. Stimulated Annealing And Its Advantages

It is a process purely based on the staticalmechanics and Annealing is a process in which the metallic substance is heated up and cooled to make it stronger than before. The stimulated annealing algorithm here used to solve scheduling process in the cognitive radio to avoid delay and to improve the performance of the service. It is very clear that the stimulated annealing process is the best answer for the optimization than the conventional algorithms used. Enhanced stimulated annealing process involves the following steps:

(i) The tasks on the system are distributed Arbitrarily and assess the weight of the scheme (using the OFso) for ‘n’ number of times.
(ii) Find the average weight of n-unit weights discovered in portion 1.
(iii) To conduct multi-thread annealing, select a limit proportion so that any instance with a unit weight higher than 1/5 times of ‘n’ value (provided) above the median is chosen as a seed.
(iv) Collect as many seeds as possible.
(v) Apply for each seed the simulated annealing method.
(vi) Select the allocation with the minimum weight of the scheme.

Here the temperature is a parameter used to indicate the acceptance ratio in the given system and initial parameter value is fixed such that the proportion of the worst moves of given system is minimum.We suggest a fresh simulated annealing method depending on the concept of estimating each chain's temperature depending on the likelihood of accepting the goal. The evolution of acceptance probability during optimization follows an acceptance schedule: initial value, chain length, final value (or stopping condition) and decrement rule.The system weight enhancement for Enhanced stimulated annealing process is much greater than the simple stimulated annealing procedure as follow in the below equation μ [Enhancement(Enh_SA)]>μ [Enhancement(SA)] . SA is sensitive to the variation of the cooling factor.When the cooling factor increases, the enhancement from the initial system weight and the execution time also increase.

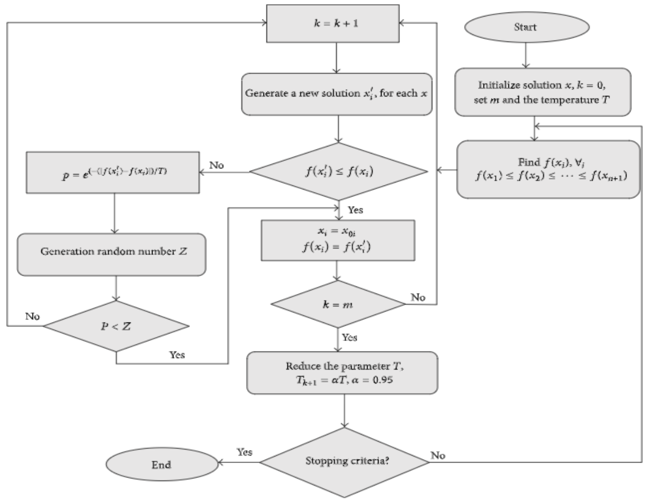

Figure 4: flowchart for Enhanced stimulated annealing(ESA)

In addition, the enhancement from the initial system weight and the execution time were found to increase with the increase of the cooling factor for the simulated annealing algorithm.

V. Summary of Results

The following are the graphical representations of the average delay packet versus arrival rate at SU packets, the stable throughput region graphs and the graph that illustrates the average packet delay of the licensed and unlicensed users.

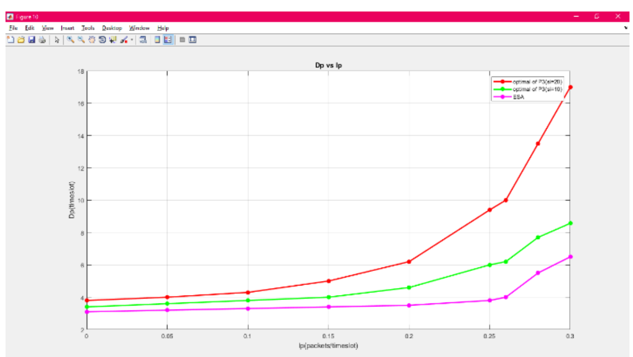

Figure 5: Graph that illustrating the Delay of PU Vs arrival rate on PU with predefined conditions and threshold.

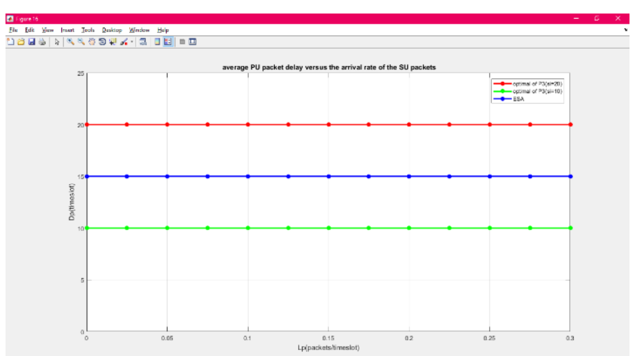

Figure 6: Graph illustrating the average PU packet delay Vs average SU packet delays comparing with the implementation of ESA.

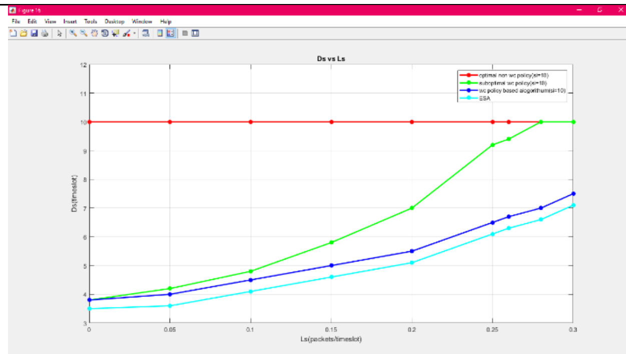

Figure 7: Graph that illustrates the arrival rate and the delay on SU with predefined conditions and threshold.

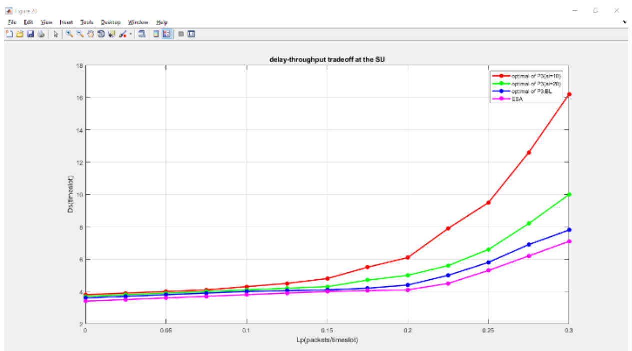

Figure 8: Graph illustrating the Delay and throughput trade off at the SU considering licensed users Delay constraint with a ψ=10.

VI. Conclusion

The implementation of the ESA over the conventional work conservative algorithm and the non-work conservative algorithm flowered in best tradeoff between the controversial parameters. The tradeoff or theimprovementis about 10%.Theresult is finalized based on the threshold parameter at different value of average packet delay that the licensed subscribers can withstand. The parameters such as arrival rates and the probabilities of the spectrum used are asfollows:

h pd = 0.3, hps = 0.4, hsd = 0.8

References

[1] Haykin, Simon. (2005). Haykin, S.: Cognitive radio: Brain-empowered wireless communications. IEEE JSAC 23(2), 201-220. Selected Areas in Communications, IEEE Journal on. 23. 201 - 220. 10.1109/JSAC.2004.839380.
[2] Adel M. Elmahdy, Amr El-Keyi, Tamer ElBatt, Senior Member, IEEE, and Karim G. Seddik, Senior Member, "Optimizing Cooperative Cognitive Radio Networks Performance with Primary QoS Provisioning", IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 65, NO. 4, APRIL 2017.
[3] J.kanti, G. S. Tomar, and A. Bagwari, "A novel multiple antennas based centralized spectrum sensing technique," in Transactions on Computational Science, vol. 10220 of Lecture Notes in Computer Science, pp. 64–85, Springer, Berlin, 2017.
[4] A. Bagwari, G. S. Tomar, and S. Verma, "Cooperative spectrum sensing based on two-stage detectors with multiple energy detectors and adaptive double threshold in cognitive radio networks," Canadian Journal of Electrical and Computer Engineering, vol. 36, no. 4, Article ID 6776586, pp. 172–180, 2013.
[5] L. Kleinrock, Queueing Systems: Theory, vol. 1. New York, NY, USA: Wiley, 1975.
[6] Ben-Ameur, Walid.(2004). Computing the Initial Temperature of Simulated Annealing. Computational Optimization and Applications.29.369-385.10.1023/B:COAP.0000044187.23143.bd.
[7] G.E. Nasr, A. Harb and G. Meghabghab
"Enhanced Simulated Annealing Techniques for MultiprocessorScheduling" Proceedings of the 12th International FLAIRS Conference.
[8] MohdRizam Abu Bakar, Abdul Jabbar KhudhurBakheet, Farah Kamil, Bayda Atiya Kalaf, Iraq T. Abbas, and Lee Lai Soon, "Enhanced Simulated Annealing for Solving Aggregate Production Planning," Mathematical Problems in Engineering, vol. 2016, Article ID 1679315.
[9] M. Ashour, A. A. El-Sherif, T. ElBatt, and A. Mohamed, "Cognitiveradio networks with probabilistic relaying: Stable throughput and delaytradeoffs," IEEE Trans. Commun., vol. 63, no. 11, pp. 4002–4014,Nov. 2015.
[10]A. M. Elmahdy, A. El-Keyi, T. ElBatt, and K. G. Seddik, "On optimizingcooperative cognitive user performance under primary QoSconstraints," in Proc. IEEE Wireless Commun. Netw. Conf. (WCNC),Apr. 2016, pp. 1–7.