Effective Data Transmission And Streaming In Cognitive Radio Networks

Mr.S.Loganathan[1], S.Abinaya[2], M.JesimaYasmeen[3], T.Kalpana[4]
[1]Assistant Professor, Dept Of Electronics and Communication Engineering
[2, 3, 4]Dept Of Electronics and Communication Engineering
[1, 2, 3, 4]Paavai Engineering College,Namakkal,Tamilnadu.

Abstract- *In this paper, we are going to propose a method for effective data transmission and streaming in cognitive radio networks. With the rapid development of digital communication, the demand for spectral resources is increasing and the building of cognitive radios is the right solution for that. Cognitive radio networks are designed to use the licensed spectrum when it is not used by the primary users. By that we can achieve energy efficiency, less power consumption and much more transmitted information. In this paper, we are going to employ the primary radio network channel algorithm for allocation to deliver the video with high quality and low delay. Here, the compression of frames is done by using the Versatile video coding that provides the fitting pattern to reduce the bandwidth requirement effectively. This compression technique will give a better transmission with a high compression ratio in a cognitive radio network by means of tradeoff among the quality, bit rate and decoding time. The simulation result gives an improvement in the detection of channel in the cognitive radio network and the delay can be reduced with high quality.*

I. INTRODUCTION

Cognitive Radio (CR) technology is developed to overcome the spectrum scarcity due to rapid development in wireless networks. With huge development in communication applications, the spectrum becomes more congested and the need for data rate is also highly increased. Radio spectrum is a limited resource and the service is allocated by fixed spectrum alignment.So, some frequencies are heavily used and some other band frequencies are weakly used.The number of devices or users using the unlicensed spectrum is higher which results in spectrum scarcity.

To overcome the spectrum demand issue, cognitive radio networks are designed to utilize the licensed spectrum which is not used by licensed users. CR is a promising technique to improve spectral utilization. Spectrum is allocated dynamically in the CR networks which further increases the spectrum utilization. In spectrum sensing mechanism, it has been disrupted by emulation of primary user or forging of spectrum sensing by the secondary users. Thus, the nodes may possess false data due to presence or absence of primary user. Also, secondary users sensing scheme leads to primary user's emulation attack. These needs to be compromised.

Here, the unlicensed users are going to use the spectrum of the primary users which is not in use. It senses the spectrum and finds the vacant spectrum available in the network. Then, it chooses the best spectrum present which meets the required quality of service by the secondary user. The unlicensed users leave the spectrum as soon as the licensed user returns.

The ability to improve the spectral efficiency, enhance network efficiency and serve the telecommunication user with high quality of user services is performed by the application of Versatile video coding technique which is used for the compression of frames. The capabilities of CR allow for optimization of various systems and environmental parameters which include transmission frequency, waveform, interference and bandwidth performance. Versatile video coding offers the highest compression efficiency of all types of video codes present.

It is particularly appropriate for higher resolution video stream based on the nature of its coding tools. Though we have other advanced methods of video and image transmission techniques like HEVC, they do not meet the exact bit rate reduction which is being achieved in the versatile coding method. Therefore, we are going to employ the primary radio network channel algorithm to deliver the high-quality video with extreme low delay.

In our proposed system, we design the cognitive radio networks with versatile video coding technique. It reduces the effect of primary user emulation attack and the secondary user's data falsification attack thereby increasing the efficiency the information being transmitted. For lossless effective data transmission and streaming, we simulated the versatile video compression methodology which helps in better improvement in the detection of the idle channel in the cognitive radio network and the delay is completely reduced to the maximum with high quality transmission.

II. LITERATURE SURVEY

As we are going to do the channel allocation for streaming in the cognitive radio networks. We took many references for that like a survey of cooperative spectrum sensing to know the rapid growth of the wireless communication and its demand. We observed the classification and framework of the cooperative sensing to improve the efficiency of the system. There are three ways in the cooperative sensing classification. They are centralized, distributed and the relay assisted. The knowledge base of the cognitive cooperative sensing includes the radio environment map, channel gain map, power spectral density map, received signal strength profiles, primary user activity and statistics and primary user localization & tracking. In cognitive radio, the sensing time is proportional to the number of samples that we take. So, an efficient model can be created by this proportionality. The energy efficiency of the cognitive radio is can be improved by the threshold interferences at the primary and secondary level. The calculations of the sound to noise ratio to the peak power has provide a lot of information about the energy efficiency. The energy efficiency and spectrum utilization can be increased by increasing the secondary users than the available channels.

The video coding for streaming can be done by using a simplified block structure and some advanced coding techniques. The entropy coding is done by context based arithmetic coder. It has the difference like zero tree coding that is used to indicate the significance of coefficients and motion vector information. This provides a better chrominance performance and quality with high resolutions.

The performance of cognitive spectrum sensing based on the energy detector in fading channels reveals the various effects due to the fading in the multipath channels. The transmitted signals are received with multiple reflections, scattering and diffractions and it also provokes the fluctuations in the phase and amplitude of the signals in a wireless channel. The fading will decrease the energy detector measurements. Then the best performance is observed for the lognormal fading.

HEVC is a compression standard with higher compression efficiency. It has been designed as a replacement of the prior standard advanced video coding. It achieves the better compression performance with a higher encoding complexity. This algorithm reduces the coding unit possibilities and the number of reference frames that to be checked. This saves the time efficiently in different high definition video resolutions with different frame rates. The radio spectrum management is a limited source controlled by regulations and the recognized authorities. They allocate radio spectrum by assigning the channels to specific users with licenses for use the specific wireless technologies. The cognitive radio cycle consists of the radio spectrum, acting, sensing and deciding. There are different metrices used in this for the performance evaluation of the cognitive system.

The software defined radio avoids the frequent modification in the hardware structure with the use of software defined protocols. This implementation of energy-based spectrum sensing method in cognitive radio by GNU is an effective way for real time transmission. This can be also applies for simultaneous transmission of multiple way signals and use of multiple frequency band.

Cognitive radio networks provide high bandwidth to mobile users via heterogenous wireless architecture and dynamic spectrum access techniques. Basically, it avoids the congestion by changing the unused radio spectrum that is not noted down by engaged through a licensed user. This is the most promising and efficient technique for the paper utilization of each and every band. Threshold used depends on the noise variance. It cannot differentiate between the interference from the other secondary users sharing the same channel and with the primary user. Its performance degrades under low signal to noise ratio or with noise uncertainty.

The migration from high definition to ultra-high definition is already underway. The increase of picture spatial resolution, the ultra-high definition provides increased color by introducing a more color gamut and also better contrast. The involved operations in this are pixel based without inter sample or temporary dependency. The dynamic metadata are produced by high definition radio decomposition process and remain internal to the distribution process. They need not to be conveyed to the rendering device. They have many features like preserved quality of the content, single layer with metadata, direct SDR compatibility, limited complexity and distribution code agnostic. There are some intermediate layers between the application layer and physical layer. For a stationary host this act is a good option where the communication protocol is systematic. It is defined according to the environment where it is located. The application of USRP is usedin prototyping and for research applications but it deployed in many commercial and defense systems. This enables to transmit and receive a video file with a loop from transmitter to receiver using GMSK modulation.

III. THEORETICAL BACKGROUND

Versatile Video Coding

We propose an efficient method to facilitate the communication users to utilize the unused spectrum of the licensed users. Versatile Video Coding is mainly focussed for next-generation video coding standardization far outperforms the HEVC standard in the coding efficiency. Video is the main drive force of bandwidth use, standing for over 80 per cent of theconsumer Internet traffic. Video compression is a critical one of many available multimedia application, it is necessary to storage or transmission of the digital video over the band-limited networks.

We use the two popular video encoding methods that is supported by more modern devices and also browsers. They are H.265 and H.264 which are versatile video coding base standards. Out of these two encoding methods, H.265 (VVC) gives better compression, at higher resolutions such as 1080p or 4k.

Video Compression

Video compression and content quality are the areas to be resolved for high. Predominantly, the video usage over the internet is on the upsurge and the user's requirement for high resolution and more quality is increasing. Consequently, a big effort has made for video coding technologies and also for quality monitoring. Video Compression is a process of reducing the size of an image or video file by exploiting spatial and temporal redundancies within an image or video frame and across multiple video frames.

Many earlier methods were studied to evaluate the available compression technologyand required things for the next-generation video compression. The VVC algorithm possess above 50% better compression rate for the same perceptual quality, with support of lossless compression. It contains the ability to change the resolutions from 4K to 16K. It also supports YCbCr with 10 to 16 bits for a component, BT.2100 it is a wide color gamut and also a high dynamic range (HDR) of more than 16 stop of peak brightness, auxiliary channels for depth and transparency, variable and fractional frame rates .Encoding complexity of several timesthat of HEVC can be expected, dependon their quality. The decoding complexity is being expected to be about twice that of HEVC.VVC development is made using the VVC Test Model (VTM) by NS2 network simulator.

For application in the multimedia field it demands more bandwidth for the transmission. For video it needs more storage and bandwidth in uploading and downloading. Therefore, VVC is used for compressing the file for some compression ratio. In this the image is divided into n*m blocks and every block p=nm had a pixel value of A= {A_1, A_2, A_3…. Ap}

Then, we can calculate the first and second samples and their variance by using the equations,

$$\bar{A} = \frac{1}{p}\sum_{i=1}^{p} A_i$$

$$\overline{A^2} = \frac{1}{p}\sum_{i=1}^{p} A_i^2$$

Variance $\sigma^2 = A^2 - (A)^2$

For a design of only one-bit quantized value, we set the threshold value as A_{th} and the output levels can be encoded as a, b.

Let L=A_i's greater than the threshold value (A_{th}).

If $A_i > A_{th}$,output is b = $\bar{A} + \sigma\sqrt{\frac{p-L}{L}}$

Otherwise, output is a = $\bar{A} - \sigma\sqrt{\frac{p-L}{L}}$

Sensing the alteration in the data may affect the estimation of global decision for access the licensed spectrum of cognitive radio.So, we assume the presence of j number of secondary users, malicious users, and normal users. Secondary users sensing the primary by using the received signal x(t)={x_1(t), x_2(t)…, xj(t)}. According to the binary sensing report the jth secondary user can be given as

$$L_j(K) = \begin{cases} 1 & x(t) > \lambda, \\ 0 & x(t) < \lambda \end{cases}$$

Where λ is the threshold value and K represents the time interval.

Secondary users senses and sends one bit of local sensing report to the fusion center that takes a global decision based on the rules. The decision O(K) is given as,

$$O(K) = \begin{cases} 1 \ , \sum_1^j L(j) \geq M \\ 0 \ , \sum_1^j L(j) < M \end{cases}$$

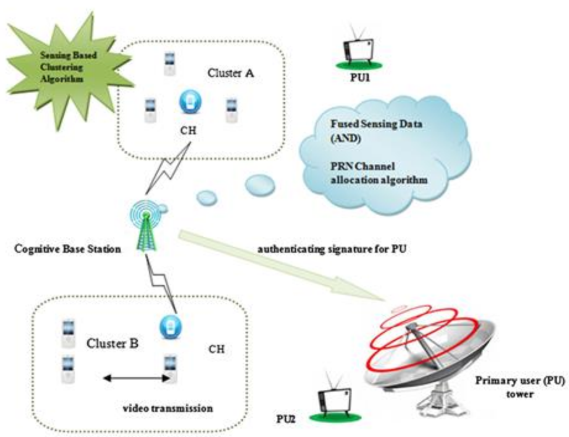
Spectrum Sensing from Licensed Users

In a cognitive radio network, the secondary users areallowed to use licensed spectrum band when the primary user or licensed user isabsent in the cognitive radio. Energy is consumed by these secondary users are utilizing the licensed spectrum band before give the access to the primary user. Here, we give access to SU's to consume theprimary users network by spectrum sensing in a cognitive radio network.

The secondary users detect the free channel present in the transmission network. By means of sensing the primary user's regular usage pattern, we can predict the number of channels which is freely available without involving any kind of transmission and reception during a certain period of time. The energy consumption, network usage rate and the regular working pattern in each region of the primary user's activity is analyzed and presented. Thus, it is easy for unlicensed users to utilize the free region when they are not in use.

Sensing and Hypothesis Model

The sensing is done by considering the radio channel parameters such as transmission channel characteristics, interference level, noise level, spectrum availability, power availability, etc... which is done in frequency and time domain. It can done in code and phase domains also. The system consists of primary users like PU= $\{PU_1, PU_2, \ldots PU_i\}$. These are stationary users like our TV towers. In addition, we are having the j number of secondary users in both the licensed and unlicensed spectrum under the control of base stations. Whenever there is a need for end users, we can associate these to the groups for effective communication.



The unlicensed users or SU's need to continuously monitor the spectrum for the presence of the licensed users (PU). If the PU is absent for a particular time, the SU can use the spectrum for transmission till their PU appears. Once the PU appears again, the SU yield that spectrum for the PU and should change to some other unused spectrum. This implies that the SU's should continuously monitor the entire spectrum for an opportunity to use a channel that is not being used by the PU. The unused spectrums may be available in two cases either a temporal unused spectrum or a spatial unused spectrum. A unused spectrum appears when a PU does not transmit while a particular of time period and the SUs can use the spectrum for that time. A spatial not used spectrum appears when the PU transmits within area and the SUs can use that spectrum outside that area. The spectrum sensing performance is affected however by the noise uncertainty, shadow and multipath fading.

In spectrum sensing techniques we introduce the hypothesis test, based on which the performances of the techniques are tested. The hypothesis model is as follows:

H0:y(t)=n(t),
H1: y(t) = h*x(t) + n(t)

where y(t) is the received signal, x(t) is the primary user signal, n(t) is additive white Gaussian noise and h is the channel gain of the primary user. The hypothesis H0is a zero hypothesis means that there is no licensed signal present where H1 indicates the presence of the primary signal.

Sensing Based Cluster Formation

In cooperative spectrum sensing, more than one SU and is committed with sensing and suggestion of the global result based on the SU of local reports. This leads to overhead in the fusion center which demean the network performance. As multiple SUs senses the same channel, cooperative sensing required more energy to perform. To address these issues, we propose sensing based cluster formation; the whole network is organized several clusters on consideration of sensing ability of cognitive radio. Energy discernment is used for local sensing because of its simplicity and fast identification. At time Ts, cognitive radio senses the frequency range fi, since it receives the discrete time signal X(t) in this range. Based on the receive signal strength, hypothesis testing can be used to find out whether it is a noise signal or information. In traditional binary sensing, two levels of hypothesis testing (H_0, H_1) derived from received signal are given as,

$$x(t) = \begin{cases} n(t), & H_0 \\ hs(t) + n(t), & H_1 \end{cases}$$

Hypothesis H_0 declares as noiseonly is present in that frequency rangef_i.Noise occupation than with signal in f_i is given as H_1.

Our proposed concept is first select cluster head (CH) on the basis of the high probability of both node's SINR ρ_n and a number of not active channel C at a specified range of sensing time Ts .Before they enter into cluster and their past history, every node has sensed and identified a different number of not active channels Ci .In Number of cluster heads define the number of cluster. Next elected CH broadcasts their request message (REQ) into its one-hope neighbor nodes. In the REQ message, node's information about transmission range and energy level is intimated. CH would construct a cluster that contains only nodes which replied (REP)to the request of CH. Indirect communication between cluster member and fusion center obtained through cluster head less the chances of overhead at fusion center.

Channel Allocation to SU

Resource management controls the assignment of bandwidth and channel then in order to achieve spectral efficiency. Spectral efficiency is defined as the rate of information transmitted over given bandwidth and channel or save the spectrum in CRN.

We consider the cochannel interference and the adjacent channel interference when sharing with others. In traditional networks, fixed channel allocation has been inefficient for growing world of networking.

Control message of sensing reports and channel status information are to be transmitted over a common channel for all secondary nodes, also known as a control channel. In CRN, SU is allowed to sense and utilize theinactive authorized spectrum is under control by the cognitive base station. CBS had completely finished the status of the channel using local sensing reports. CBS will allocate a channel to SU, If channel status is free. To select worthy SU to stabilize the utilization of spectrum holes, CBS study three parameters: packet size, required bandwidth and node's SINR. The new system of CRN has a total M primary channel assigned to utilize N channels. These N channels are periodically sensed by j SUs and send a report to fusion center which decides the spectrum as not active or busy. Another responsibility of fusion center is to allocate a free channel to any one SU. Therefore the relation between the packet size (S), rate of transmission (R) and execution time (T) is given as,

$$R = S/T$$

SINR refers the ratio of RSS (P) to interference (I) and noise (N) at the receiver. Every node has a unique SINR that dependent on background noise and interference of another simultaneous communication is given as,

$$\text{SINR}, \rho = P/1+N$$

B_n is the width of the frequency band that is enough to ensure the transmission of the grade required. The equation for estimate the required bandwidth of FM/frequency division multiplexing modulation,

$$B_n = 2M + 2DK$$

Where M is the modulation frequency, D is peak deviation value and K is a numerical factor that varies with allowable signal distortion. The node with a high priority value, μ is given access to primary channel first. The pseudo code for PRN channel allocation algorithm is as shown below:
Pseudo code for PRN channel allocation algorithm

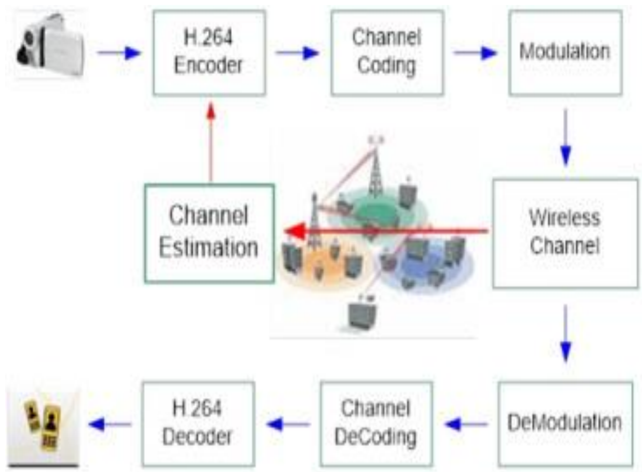
Input: A_n, SU_j

Available channel $A_n = \{A_1, A_2 \ldots\ldots\ldots\ldots A_n\}$, $SU_j = \{SU_1, SU_2 \ldots\ldots\ldots SU_j\}$

- For SU_j, compute μ
- Sort the SU_j in ascending order based on the value of μ
- Assign A_n to SU_j
  Estimate R for channel
- If R is desired,
  N++;
  J++;
  Continue for assignment next channel
- Otherwise
  0nly N++, go to channel assignment

Frame Compression

The video coding support compression across frames in the bitstream format. The block matching of frames and other encoding steps are not such necessary which is one of the advantage of using versatile coding. Thus, the video coding possess some specifications of having some freedom to optimize and innovate in their choice with better streaming characteristics.



The need for compression is the demanded bandwidth and buffer storage. By video versatile coding the image can be recorded and broadcasted in a compressed form with less bandwidth and memory. Video coding is can be employing as intraframe and residual frame coding. The video compression should have to attain the features like (a) spatial and temporal redundancy should have to be removed and (b) the residual frames have to be transmitted. In our proposed method, redundancy is mitigated and hierarchical VVC method is employed for encoding the difference frame using Huffman encoding. We know Huffman encoding is a lossless compression that produce the output in variable length table

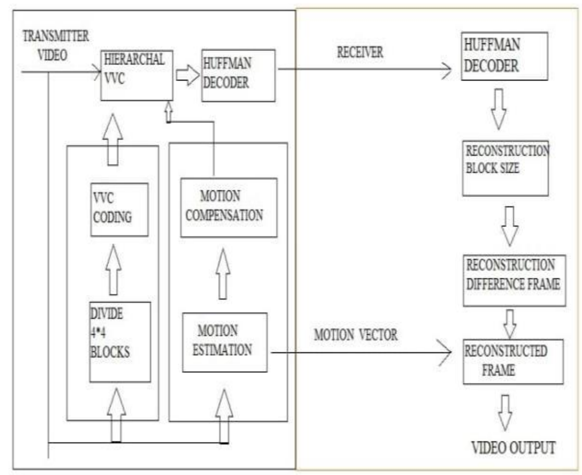
Stage 1:

VVC method to reduce the redundancy in spatial and to predict the pixel values of A_L and A_M, called as intraframe prediction. Image can be partitioned into blocks b of n*m and it can be estimated with the neighboring of B_L and $B_{M.}$

$$B_1(r,c)= \frac{vd}{vd+hd}va_h+\frac{hd}{vd+hd}va_v$$

where, B_1 represents first constructed block from neighboring hd and vd denoted as the horizontal and vertical distance between (r, c) and * on the same column of that. va_v and va_h represent the values of vertical and horizontal * marked position. Estimation error is given as,

$B_e(r,c)=B(r,c)-B_1(r,c)$



Residual frame B_e can be obtained by representing the quantization levels Q which contains the number of zeros, positive and negative values.

Pseudo code for obtaining quantization+ level:

Input ={Pixels $A_{e,I}$,Block size Z, L= number of pixels greater than threshold}

B_e had pixels $A_{e,I}$ ={ $A_{e,1}$,$A_{e,2}$,…..,$A_{e,z}$}

Step 1: Computethe sample moments

Mean $m_1= \frac{1}{z}\sum_{i=1}^{i=z} A_{e,i}^2$ and $m_2= \frac{1}{z}\sum_{i=1}^{i=z} A_{e,i}^2$

Variance $\sigma^2 = m_2 - m_1^2$

Step 2: Check $A_{e,I} \geq$ TH

The Output Quantization levels can be given as

$b=m_1 + \sigma\sqrt{\frac{Z-L}{L}}$

Otherwise,

$a=m_1 - \sigma\sqrt{\frac{L}{Z-L}}$

Stage 2:

The motion Compensation can reduce the temporal redundancy, prediction of interframe can be done by matching the pixel blocks. Motion estimation can be replaced by octagon-based search method for less time utilization. The residual frame can be obtained after intraframe and interframe. We performed the determination of motion vector for each block with its neighbor blocks, in which neighbor blocks (L and M blocks) are taken as a reference frame. Let the intensity level of pixels in current frame n is represented by $A_n(i, j)$. The sum of absolute difference (SAD) between block (p, q) and the block of the previous frame (p +x, q+y) is estimated as, SAD=$\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} | f_n(p+i,q+j)-f_{n-1}(p+x+I,q+y+j)|$

Motion vector of block (p, q) is,

$M_v(p,q)=\arg\{\min(SAD(p,q))\}$

Motion vector Mv is estimated for all the blocks in frame n.

Step 2.1: Minimum values are set as initial search centre(ISC).
Step 2.2: Construct the two specified patterns of SQP (square pattern) and theCP (cross pattern) around the ISC withhold of size (R) = 2.
Step 2.3: Using these patterns, find the winning point that means a minimum of Mv for the next step.
Either winning point is in the center of the pattern (SQP or CP), Size R = R^- and repeat step 2.2.
When R = 0, the searching process should be stopped.
Step 2.4: Return the motion vector Mv to blocks in the frames.

Stage 3:

Versatile video coding is used for low bit rate encoding. It validates a, b from the stage 1 with a threshold and producing a bit stream that represents the quantization level. Bitstream is defined as a sequence of 1's and 0's since it is the mean of a block.

Depending on whether output values {a, b} less than or equal to the threshold, block mean value of a block is either 0 or 1. Frames with mean value as 1 are decomposed into the subdivisions of 8*8 and stage 1 are repeated.

Stage 4:

Huffman Encoding: Here, an encoding table is derived from the number of frequent occurrences of the symbol 0 and 1 and then sorted. Huffman coding generates prefix code for representing every symbol.

Features and Advantages of VVC

Some of the noticeable and outstanding features of versatile video coding are as follows:

1 Error-free Data Transmission

Unlike other video transmission techniques, we can have error-free transmission and reception of videos seamlessly.

2 Energy Consumption

The VVC technique offers very low energy consumption of video coding (encoding & decoding) for long time usage.

3 Usage Pattern

The unlicensed users can predict the licensed user's regular usage pattern of the spectrum. Once the pattern or the region which is free is detected, it can use the same spectrum frequently.

4 Parallel Processing

The optimized implementation and parallel processing being used in VVC further reduces the complexity of encoding and decoding process. Also, the bandwidth requirement is completely reduced.

5 Sensing Time

The fast and efficient sensing time is one of theadvantages which reduces discomfort to the users with reduced interference issues.

6 Bitrate Reduction

The compression performance is above (40-50) % bit-rate reduction compared to HEVC and other existing base standards at the same subjective video quality. In addition, VVC needs only half the bit rate of High Efficiency Video Coding (HEVC) to achieve the same quality and compression.
VVC standard thus increases the state of the video compression and has unprecedented application versatility. It has better flexibility to enable the applications such as 360-degree omnidirectional immersive multimedia, sharing of remote screen, cloudcollaboration, gaming cloud, and region-based extraction and merging. It also offers improved quality encoding for ultra-high definition (UHD) and high-dynamic-range (HDR) video as well as conventional video coding applications. VVC is considered to be one of the emerging techniques which has revolutionised the wireless telecommunication systems.

VVC reduces the amount of data necessary to enable high-quality video for an unprecedented range of new and existing applications. The compression performance of VVCenables the result of UHD services at bit rates used to carry high definition (HD) services. Half of the required bit rate for a video quality will also ease pressure on global networks also providing better streaming services.

Major benefits of versatile video coding in cognitive radio networks includes,

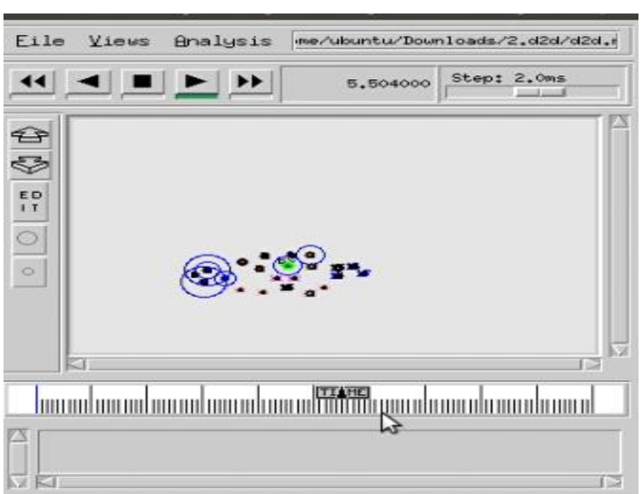
- Very quick and accurate detection of the unused spectrum.
- Optimized search as the cognitive network need not to search in all the regions rather than in one particular region.
- Very low investment as the cognitive radio uses the unlicensed spectrum.
- Reduced synchronization error which reduces the problem of false deduction of signals or spectrum range.

Thus, our proposed system, Efficient data transmission in cognitive radio networks by versatile video coding expands the range of technical options available and will continue to provide better transmission and reception applications and services worldwide which further enables to provide a connected world.

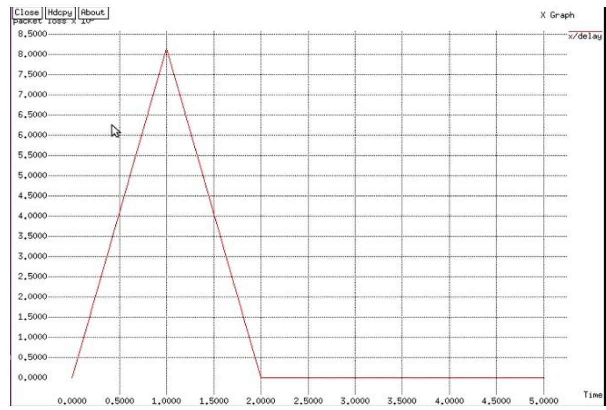
IV. RESULTS AND DISCUSSION

Additionally, for video streaming application, the proposed system employed VVC compression technique which reduces the time required for the decoding process. According to the simulation results, high packet delivery ratio and channel rate can be achieved with increased number of secondary users by using PRN channel allocation algorithm.

PARAMETER	VALUES
Transmission area from 3 to node (7)	4.2926832288728036
Distance from node 3 to node (4)	88.061135320866697
Transmission area from 3 to node (4)	-1.7611353208666998



The CRN network is split into four clusters with an unequal number of nodes by using sensing-based clustering algorithm. The secondary nodes have a mobility of 100 m per sec, are moved in random waypoint mobility model in which nodes are mobile in simulation boundary of 600*500 m. The traffic sources of source and destination used in transmission are uniformly distributed with constant bit rate.



V. CONCLUSION

In this project, we presented a secure cognitive radio network by reducing the effect of data trafficking. In the proposed technique, cognitive base station allocates authority to the primary user to access the licensed spectrum using versatile video coding, thereby avoiding anomaly SU without utilizing the spectrum. We detected data falsification attackers and eliminated them from participating in decision making by using the hamming algorithm. Simulation results obtained clearly indicate less probability of rejection, acceptance for miss detection of spectrum holes and error probability when compared to the existing approaches. According to the simulation results, high packet delivery ratio and channel rate can be achieved with increased number of secondary users by using channel allocation algorithm.

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