Data Packet Optimization Incognitive Radio Sensor Network Using Ofdm

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Research Article

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DATA PACKET OPTIMIZATION INCOGNITIVE RADIO SENSOR NETWORK USING OFDM

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Abstract
Cognitive Radio (CR) is a novel concept that enables wireless devices to detect and adapt to their surroundings in order to enhance communication quality. The cognitive radio sensor network (CRSN) has proved to be a cost-effective solution to the spectrum constraints that wireless sensor networks (WSN). Optimizing the optimum packet size is regarded to be an essential energy constrained issue to address the practical implementation of CRSN out of all the difficulties. Small packets generate data traffic in device-to-device communication, a flexible way for transferring data in wireless networks, while big packets may cause data bit corruption, requiring retransmission at a greater frequency. This will not allow access from the secondary network to the main network, since it may cause further disturbance. To maximise the WSN's energy efficiency, the optimum packet size for CRSN should be utilised while keeping the same degree of interference as the primary licenced users (PU). The purpose of this article is to examine formulations for small, medium, and large packet sizes in order to determine the optimum packet size for adaptive CRSN. To do so, CR requires a flexible physical layer capable of carrying out the necessary tasks. This article examines the performance of CR systems that use the Orthogonal Frequency Division Multiplexing (OFDM) technique, which is a possible transmission technology for CR. Interference delays are minimised, and the channels are ultimately utilised effectively. This article shows that medium-sized packets are the optimum choice for achieving the greatest performance on the Cognitive Radio Sensor Network (CRSN). The Jellyfish Search Optimization algorithm (JSO) and the hybrid Momentum Search Algorithm (MSA) are hybridised, and results are achieved. This makes it possible to calculate precise packet sizes. The suggested approach decision outperforms existing methods like the Group Sparse Optimization algorithm and the Throughput Maximization Algorithm. The MATLAB / SIMULINK Platform were used to get the results.

Keywords: Cognitive radio sensor network, wireless sensor networks, Orthogonal Frequency Division Multiplexing, JSO, packet size, MSA

1. Introduction
Wireless communication has ushered in a revolution in data networking, communications, and the realisation of integrated networks. It has enabled widespread use of cordless networks, personal computers, wireless LANs, radio networks, cellular and mobile systems, at any time and from any location [1]. These wireless networks are comprised of a large number of wireless sensors that are used to monitor and evaluate the system's physical and environmental characteristics. The sensor field of a wireless sensor network is made up of a limited number of tiny sensor nodes grouped roughly in one field. For a specific WSN application, the sensor panel utilises detected information from sensor nodes [2]. A sensor node's primary job is to assess physical conditions, process incoming data, and send it to the sink node. A sink node is a kind of node that may gather data from a sensor field and send it to another node for processing [3].

Wireless networks have expanded at an exponential rate, which has resulted in a rise in system interference issues. The obvious lack of bandwidth is a major obstacle. The new idea of a crucial technology, Cognitive Radio, solved this first and primarily essential problem (CR). Cognitive radio is a smart radio network that outperforms traditional radio in terms of capabilities [4-5]. These CR features may help wireless networks address problems including congested spectrum communication in ISM bands, decreased interference, and interference avoidance. Overlay, underlay, and interweave are the three kinds of channel information used. There is a possibility of interruption due to the new channels and frequencies. When the interference is smaller than typical frequencies, underlay arises [6-7]. This is known as overlay, and it occurs when new frequencies enhance the quality of old frequencies. The system's idle and underutilised bands are absorbed by the new frequencies in interweave. The cognitive radio uses these network techniques to integrate additional frequencies into the current spectrum [8].

The idea of cognitive radio entails assigning frequencies to secondary users using existing signal processing techniques. The operational concept of cognitive radio, a developing new technology, must satisfy specific requirements, including the utilisation of data in frequencies, channel flexibility, non-disturbance of main users, and high-quality transmission [9-10]. As a result, one such successful method is to effectively utilise the same frequency ranges with technical abilities. Cognitive radio can detect channels that may be reached from the field and modify the settings to allow several unused frequencies to be accessed at the same time. It makes advantage of current channels' free frequency bands as well as cognitive systems that are not related to conventional radio [11].

Cognitive Radio Sensor Networks (CRSN) emerged as a new method of addressing the same problems found in conventional networks as a result of some of these noteworthy characteristics of CR. A cognitive radio transceiver and sensing system network (CRSN) is described as a network of closely arranged sensor nodes [12-14]. It can detect an event, locate accessible channels, and creatively link to other nodes so that the characteristics may send a signal to a distant sink right away. In addition, CRSN nodes must handle additional difficulties that CR functions face, such as band sensing, administration, and handoff [15]. One of the most
significant problems to be addressed is optimising the packet size for CRSN, among other things. In reality, under adaptive channels, tiny packets provide superior outcomes and minimise disturbance to the main user (PU). Headers and trailers, on the other hand, carry a lot of overhead and therefore waste energy [16-18]. Large packet volume, on the other hand, boosts throughput and tape consumption for the secondary user at the cost of higher packet loss risk under the same channel circumstances. The optimization of packet sizes is a popular subject in WSN research. Several research have been conducted in order to improve energy economy in terms of power and data rates, however an experiment using CR and dynamic spectrum access revealed that fixed-size packets get better throughput than variable-size packets [19-20]. In WSNs, the phrase "energy dissipation" is often used. As a result, optimising all elements of sensor network communication and networking is the primary objective.

In this work, we use simulation to investigate the optimization of packet size with the energy efficiency issue in CRSN. Our goal is to find the CRSN packet size that maximises energy economy while maintaining the same level of interference for primary users, while allowing for the most tolerable discrepancies between the actual event signal and its value at the sink node. Because efficiency is the most important metric in sensor networks, it is the primary objective for packet size optimization. The rest of the paper is structured as follows. The related studies on wireless sensor networks and improvements are discussed in Section II. The new technology of the CRSN structure has been shown in block diagrams and explored in depth in Section III. In Section IV, we used this model to determine the constraints and construct the optimum packet size with the most efficient energy. In Section V, the results produced by its performance are analysed, and remarks are addressed. Finally, in Section VI, there is a conclusion.

2. Related Survey

Different research papers focused on packet delay, noise, and channel interference analysis utilising various methods and aspects are accessible in the literature. Some of the reviews were followed,

Vasylyshyn, et al. [21] developed a modified Singular spectrum analysis (SSA) technique for calculating OFDM (orthogonal frequency division multiplexing) routes. The adaptive SSA differs from the standard SSA in that it reduces noise more at a consistent pricing level. The suggested method was evaluated for ways to enhance it. The enhanced performance of the method incorporated in the channel evaluation issue is confirmed by the simulation results and the computation of the bit error rate.

A radio frame examined by Easwaranet al. [22] has no similarity to the permitted usage of a frequency band. Many driving, long-distance, and transmission telecommunications standards utilise OFDM, a multi-cycle regulation procedure. Through spectral detection, CR was utilised to decrease ISI. In most instances, the OFDM-based cognitive radio spectrum provides a greater maximum-to-average performance ratio, sluggish data transmission, and large side flaps. The
paper's primary aim was to keep a predetermined gap between non-linearity and the intended outcome for rapid distant communication.

Based on orthogonal frequency division multiplexing, Singh et al. [23] demonstrated the application of copula theory for cooperative spectrum sensing (CSS) for primary users (PU) (OFDM). Secondary users (SUs) utilise autocorrelation detectors (ADs) to identify PU in a distributed identification paradigm was explored. The observations were assumed to be reliant on various SUs and therefore on the decision statistics in the presence of PU. When copula theory was employed instead of the usual situation of independence when depending on statistical choices, a substantial increase in recognition performance was found.

El Bahi et al. [24] created a low-cost SDR prototype to show a two-spectrum detection technique for detecting the presence of OFDM necessary user signals. Methods such as semi-blind, SVD, and energy detector were all put to the test. In the prototype, two Universal Software Radio Peripherals were utilised, which were programmed using LabVIEW software. Calculating the likelihood of detection under different channel conditions and SNR levels was used to assess the detectors' performance (Signal to Noise Ratio).

Kong, et al. [25] examined the uplink attainable rate of secondary users (SUs) in cognitive radio networks based on underlay orthogonal frequency division multiplexing, where the SUs randomly access the main network's subcarriers. To minimise interference, primary base stations (PBSs), such as cellular base stations, may not be placed close to each other in practise. In this instance, we use a -Ginibre point process to describe the PBSs' spatial distribution, which reflects the PBSs' repulsive positioning. It is believed that each SU adjusts its transmit power as a function of the average interference level to the closest PBS produced by the SU to reduce SU-induced interference in the PBS.

3. System Methodology

The primary aim of this model is to reduce the size of the data packet during transmission in Cognitive Radio. This system employs a time-saving technique for detecting the spectrum and determining the best data packet size for transmission. OFDM aspires to fulfil the two major criteria of cognitive radio in comparison to previous spectrum detection techniques. Reducing channel interference and PDR are two of them. The flow chart for the proposed system is shown in Figure 1.
3.1 Spectrum Sensing using OFDM
Orthogonal Frequency Division Multiplexing (OFDM) is a signal waveform or modulation that performs a variety of tasks for data communications. Because of its distinct benefits over other conventional methods, OFDM is utilised in many high-rate wireless communications systems. The acquisition of spectrum and the effective utilisation of spectrum are two of Cognitive
Radio's most important needs. The fundamental FFT function in OFDM makes spectrum acquisition in the frequency range easier. FFT transfers signals from the frequency domain to the time domain using this method. As a result of the reuse of the technology existing in the FFT cores, the complete time-frequency network of the operational spectral band may be scanned without the need for additional hardware or calculation. As a result, FFT is included into the received signal. Using the FFT output, the receiver attempts to determine whether there is a main user on the tape. In the end, it limits the hardware needs and the computational evaluation. Furthermore, by simply turning off certain subcarriers where main users present, the waveform may be readily modified. After scanning the spectral band and indenting the active principal users, the following step is to keep the free channels available. For improved usage, it's critical to be able to utilise the idle licenced channels. Because of the unique structure of this signalling, the OFDM method provides a flexible mechanism for altering the spectrum. We may prevent interference by inactivating those subcarriers that are presently utilised or will be used by the main users using a specified mask.

In a 2D square region of size axa, network nodes are evenly dispersed. With the same capacity, the main network has more data channels. Each cluster master node and numerous model sensing nodes are physically linked, dividing the working region into clusters. The ideal sensor node is self-powered and diverse, producing several kinds of data packets depending on the precision of the measurements collected. The two kinds of traffic that exist are real-time (RT) and non-real-time (NRT). The first represents the most essential data flow, which must be prioritised during transmission to prevent interference.

On an ideal cluster node, the master node is in charge of collecting traffic and performing some essential CR duties. The master node's buffer is thought to be infinite since the amount of packets isn't limited. The licencing channel has a consistent environment in terms of radio bandwidth and physical features. The communication between the master node and the base station (BS) may be altered using the licenced spectrum, which is done through various radio channels of the main network, since communication inside each cluster happens all at once using the unlicensed spectrum. The control messages are connected via a common control channel (CC). Because of the short lengths between them, the other channels between the ideal node and the master node are deemed error-free. The framework's approach is mirrored in the network's adaptive nature. In this case, end nodes may utilise the CR-based centre procedure since the normal WSN workflow would significantly reduce their performance. The sensor node in the alternative flow delivers data to the master node instead of the original cluster head (CH).

3.2. MAC Protocol

The MAC protocol is also useful in multi-channel and multi-transceiver network systems. The MAC sublayer formerly recommended that each node have its own transceiver for each channel. In CR networks, the number of channels accessible varies from node to node, and each node may have several channels. As a result, CR networks do not support separate transceivers for each
Similarly, numerous MAC protocols have been described before that demand that channels be connected depending on traffic demand. All of these protocols need numerous transceiver nodes. All of the aforementioned protocols do not work for this model since the set of channels existing in each node of the CR network may vary depending on location and time.

As we all know, for wireless communication between the nodes, the two coordinates must select a data transmission route. Our approach does this by sending control packets over a common channel and meeting the receiver on that channel to choose the data channel for conversation. The CR network is said to have indented the control channel in this instance. Nodes may be in one of three states at any one time: broadcast, receive, or idle. As a common control, an inactive node is utilised. When a node interacts with its intended receiver, this is known as end-to-end communication. Control messages are exchanged between the control channel and the data channel utilised for end-to-end selection throughout this procedure. These nodes will switch to the selected data channel for data transmission at the conclusion of this procedure. Hidden terminals between nodes are minimised by prioritising channels during data transmission. Each node maintains a restricted number of channels based on the priority of its neighbours. If channel "Ch" has the greatest priority among the other channels of the node in the list kept between nodes A and B, it is regarded the best appropriate channel for communication between nodes A and B.

### 3.3. Mathematical Modeling in OFDM

The data symbols are all the same:

\[ y(r) = y(0), y(1), y(2), \ldots, y(R-1) \quad 0 \leq r \leq R-1 (1) \]

The symbols' serial form is changed in parallel, and the Fourier IFFT inverse fast transformation for each symbol is given as,

\[ Y(r) = Y(0), Y(1), Y(2), \ldots, Y(R-1) \quad 0 \leq r \leq R-1 (2) \]

As a result, the following mathematical formula is used to represent the modified composite signal OFDM:

\[ S(r) = \sum_{s=0}^{R-1} Y(o) \eta c^{s+mgro} \quad 0 \leq O \leq Is (3) \]

Where,

- \( S(o) \) is the OFDM modified composite signal,
- \( Y(o) \) is the IFFT information signal,
- \( \eta \) is the carrier distance,
- \( Is \) is the time symbols.

If the symptoms match the disease, they are orthogonal. To prevent occasional interference, \( Is.\eta = 1 \times X \) is put between symbols. As a result, the modified OFDM signal \( ZG \) may be expressed as,
\[ S_{ZG}(r) = \sum_{n=0}^{R-1} Y(o)c^{v2n^{p\alpha}} + ZG \] (4)

Where,

\( S_{ZG}(o) \) is the OFDM signal that is sent out. The signal that was received is written as

\[ H(o) = l(o) S_{ZG}(o) + R(o) \] (5)

Here,

\( H(o) \) indicates the signal received on the \( O \)th subcarrier, \( l(O) \) is the channel coefficient on the \( O \)th subcarrier, and \( R(O) \) is the noise on the \( O \)th subcarrier. The chain's unbiased response is:

\[ l(O) = \sum_{k=-o}^{w=1} \beta(o - \lambda_k) \] (6)

Here,

\( c_k \) is the latency, \( \lambda_k \) is the attenuation factor, and \( W \) is the number of routes.

To detect the spectrum, the incoming signal is compared to the threshold. If the transmitted power exceeds the threshold value, a presumption is made about whether or not detection occurred. The mathematical formula for the time-varying autocorrelation function is:

\[ J_{aa}(o, \lambda) = C[a(o)a^\ast(o + \lambda)] \] (7)

Where \( a(o) \) is a continuous signal with a zero mean. The cyclic property makes advantage of the gathered signal's periodicity to rule out the main user who computes the spectral correlation function (SCF).

\[ H_a(p) = \int_{-\infty}^{\infty} J_a(\lambda)e^{-v2\pi\lambda^pu\pi} \] (8)

The spectral correlation's primary benefit is that it differentiates between noise and transmission signal energy. Regardless of the fact also that PSD does not duplicate signal cytostatic characteristics, they are transferred into Fourier's SCF while altering the periodic correlation. It is based on two components' spectral redundancy. The cyclic spectral density is measured using a Fourier version of the conventional correlation technique to produce the correlation method.

\[ H_a^\infty(p) = \sum_{\lambda=a}^{\infty} J a(\lambda)e^{-v2\pi\lambda} \] (9)
After that, the final SCF for the received signal $a(o)$ may be computed using

$$H_a^x(p) = \lim_{l \to \infty} \lim_{q \to \infty} H_{AI}^x(p)(\eta I)$$

(10)

Each secondary user chooses between two successive hypotheses that represent the presence and absence of the primary user signal in the authorised frequency range in order to identify spectral gaps in cognitive radio by scanning the spectrum.

$$\begin{cases} L_0 : a_k(o) = r_k(o) \\
L_1 : a_k(o) = l_k h(o) + r_k(o) k = 1, \ldots, R_d \end{cases}$$

(11)

Where $a_k(o)$ represents the received signal of the $o$ th secondary user, $R_d$ denote the number of secondary users, $H(o)$ is the sent signal of the main user, and $l_k$ represents the channel gain between the PU and the $o$ th SUs.

4. Evaluation of Packet Size Using Hybrid Momentum Search Algorithm with Jellyfish Search Optimization

The suggested Momentum Search Algorithm is based on the principles of momentum and motion and is done artificially and in real time. The problem's limits are also the system's limitations. The system is made up of a number of solution bodies that show their location in space as well as the dimensions of the various solutions. Fitness function is proportional to body mass, which is linked to its location. As a result, bodies in better positions (solutions) have more bulk and are more difficult to transition from to lighter bodies with less physical function. Each iteration, a different outer body collides with all of the solution bodies, moving them to the heavier body on average. The collision's direction is determined by the solution bodies' positions as well as the location of the body with the best fitness function in this iteration. When the Jellyfish Search Optimization method is used with the Momentum Search Algorithm, the best results are achieved. The Jellyfish Search (JSO) optimization is a metaheuristic method inspired by jellyfish behaviour in the sea. Monitoring ocean currents, their motions inside jellyfish swimmers (active and passive movements), a time mechanism for switching between these movements, and their convergence in jellyfish blooms are all part of jellyfish search behaviour. To regulate the parameters provided in the data error value minimization, the work employs the JSO method. Profit parameters are used in the study as jellyfish float. The flow chart for hybrid MSA with JSO is shown in Figure 2.
Start

Generate the initial parameters packet size, delay and throughput

Objective function evaluation

The best and worst values is determined by equation (13)

The mass of the external body is updated in equation (14)

Update the position of all bodies

Meeting end of criterion?

Yes

Return best solution

No

Initialize the parameters

Evaluate and set the best one $y^*$

$O < O_{Max}$

Yes

Evaluation and updating the best

$O++$

No

Return $y^*$

Figure 2: Flow chart for proposed Hybrid MSA with JSO

Step 1: Initialization

To evaluate precipitation, frequency, number of channels, and delay, several conventional measuring techniques are utilised as inputs.

$$a_k(o) = (a_k^{(1)}(o),...,a_k^{(n)}(O),...,a_k^{(l)})$$

(12)

Step 2: Fitness Evaluation
The crowd's fitness function is regarded as its objective function. The weights are calculated using the gradient extract technique, and modifications to the network are performed to reduce the output inaccuracy. On the output neuron, the output error function is defined as follows:

\[ a^{(v)}_{\min} \leq a^{(v)}_k(o) \leq a^{(v)}_{\max}, k = 1, \ldots, n \quad (13) \]

**Step 3: Hybrid MBA with JSO to update the position**

Better solutions have more mass, while poorer solutions have less mass, causing them to gravitate toward the better ones. The following equation is used to determine the mass of bodies at the start of each cycle. The premise behind this formula is that the optimal solution has the smallest fitness function.

\[
N_v(o)^{(\text{MSA})} + X_i^j(0 + 1)^{(\text{JSO})} = \frac{\text{fit}(o) - \text{Worst}(o)}{\text{best}(o) - \text{Worst}(o)} + X_i^j(o) + \gamma + \text{rand}(0,1)*(ub + Lb) \quad (14)
\]

**General working process of JSO algorithm**

Three idealised rules underpin the proposed optimization algorithm: 1. Jellyfish travel in a swimmer or follow the ocean current, and the "timing mechanism" regulates the transition between these two modes of movement. 2. Jellyfish swim about in the water looking for food. They are increasingly drawn to areas where there is a plentiful supply of food. 3. The location and the associated goal function influence the quantity of food eaten.

**Step 4: Evaluation the better one**

Increase the momentum as the gradient rises. This is where the most up-to-date procedure is updated.

\[ Q^{(n)}(o) = N(o)R^{(n)}_k(o) \quad (15) \]

**Step 5: Repeat the above steps until the network reaches the desired value.**

Adaptive Momentum is a technique for avoiding network oscillations while searching for the global minimum on the fault surface. It aids in the descent by smoothing the route. After the preceding steps have been performed, the goal function is used to get the best outcomes. The procedure is continued until the maximum number of iterations has been achieved.

**5. Results and Discussion**

Due to the usage of the Momentum Search Algorithm and the Jellyfish Search Optimization Algorithm connected to CRSN, OFDM has a low communication latency at the nodes. And, as stated in the implementation section, increases efficiency by calculating
communication vibration, number of packets received, and dynamic rate dynamic places. Noise and interference between one channel and the next channel are also reduced when the proper pocket size is chosen. The latency is also decreased, allowing the channels to consume more data while using less energy. The suggested method's optimum values are shown in table 1.

**Table 1: Optimal values of the proposed method**

| Parameters                        | Values     |
|-----------------------------------|------------|
| Total Subcarriers                 | 52         |
| Data Subcarriers                  | 48         |
| Subcarrier Frequency (KHz)        | 31252.5    |
| Total Bandwidth (MHz)             | 1.25       |
| User Capacity (No. of users)      | 64         |
| Guard Period                      | 512        |
| Data rate for each user (Kbps)    | 39         |
| Guard Interval Time (μs)          | 0.8        |

Throughput is the total number of packets received by the destination node in bits per second. Due to the dynamics of the environment and the density of the nodes in CRSN, packets of various sizes may be produced. In comparison to other current techniques, the suggested method throughput has excellent results. When compared to the Group Sparse Optimization algorithm and the Throughput Maximization algorithm, the proposed approach produces much superior results. The x axis represents the number of channels, while the y axis represents the throughput. The Jellyfish search Optimization method and the hybrid Momentum Search Algorithm are both very efficient. The planned study's throughput is shown in Figure 3.

![Figure 3: Comparison Graph for Throughput](image)

PDR is calculated by dividing the total number of packets received at the destination node by the total number of packets transmitted by the source node. Fixed slot durations result in fewer packets reaching the target node in CRSN since the amount of packets arriving at nodes is
varied. This causes a node's latency and queued packets to rise, affecting PDR. Packets may be lost or delayed owing to packet collisions between the data frame and the beacon, resulting in a lower PDR. The BS calculates the latency by estimating the PDR of a node based on the relative length, such that more packets reach the target node in less time. When compared to current techniques, this substantially raises the PDR. On the X axis, the number of cognitive sensor radio networks is shown in the figure below. In comparison to the suggested techniques TMA and GSO, the present method has a greater pocket delivery ratio. The Y axis indicates the size of the pocket. The results are excellent for a pocket size. There are a huge number of outputs without any interruptions in pocket sizes ranging from 325 bits to 450 bits. To minimise latency and node loss, OFDM with CRSN consumes a high number of channels without interrupting transmission. Graph 4(a) shows the pocket size comparison graph, whereas graph 4(b) shows the OFDM signal graph (b).

![Graph 4(a) Comparison graph for Pocket size](image)

![Graph 4(b) OFDM Signal graph](image)

Figure 4:(a) Comparison graph for Pocket size

Figure 4:(b) OFDM Signal graph

The SNR on the X axis and -operative chance of detection on the y axis are used to determine the co-operative likelihood of detection. The technique suggested produces excellent results. On the X axis, the suggested system has an SNR of 10 and a Co-operative probability of detection of
0.38. When the SNR on the X Axis is 20, the co-operative probability of detection on the Y Axis is 0.05. When the SNR on the X Axis is 50, the co-operative probability of detection on the Y Axis is 0.85. When the SNR on the X Axis is 50, the co-operative probability of detection on the Y Axis is 0.58. When the SNR on the X Axis is 60, the co-operative probability of detection on the Y Axis is 1. In figure 5 depicts the co-operative likelihood of detection.

Figure 5: Comparison Graph of Cooperative probability of Detection vs SNR

SNR is on the X axis, while Probability Error is on the Y axis in the graph below. -15dB to -5dB denotes the suggested technique. On the Y axis, probability was evaluated up to 1.5. The unit dB is used to represent SNR. The standard level of the probability Error is 1.2. Graph 6(a) depicts the likelihood of mistake, whereas graph 6(b) depicts the graph of the node 1 and 2 signals (b).

Figure 6:(a) Graph of Probability Error vs SNR
Figure 6: (b) Graph of Node 1 and 2.

Figure 7 shows a comparison graphic of the channel. The Group Sparse Optimization Algorithm and the Throughput Maximization Algorithm are compared to the present Proposed Algorithm. In which the suggested system is connected to the internet without interruption. On the X axis is Frequency, while on the Y axis is Magnitude.

Figure 7: Comparison graph of Frequency Vs Magnitude squared

Figure 8 depicts a graph with six channels. The X axis represents power, whereas the y axis represents probability. When the probability is provided, it is expressed as a percentage of 10.0000 with an average power of 3.575. When the probability is 1.0000, the average power is 6.750, and when the probability is 0.1000, the average power is 8.305. When the probability is 0.0100, the average power is 10.201. When the probability is 0.0010, the average power is 10.208. When the probability is 0.0001, the average power is 10.209. 6.974 dBW is the maximum output power. -3.229 dBW is the average power.
The frequency is shown on the x axis, while the magnitude is shown on the y axis in Figure 9. The frequency is measured in megahertz (MHz) and the power is measured in decibels (dBc). It is granted six channels, indicating that one channel does not interfere with another. Table 2 shows the optimal frequency and power levels.

| Channel | Frequency (MHz) | Power (dBc) |
|---------|----------------|-------------|
| 1       | 0.06125         | -15.84      |
| 2       | 0.11375         | -42.15      |
| 3       | 0.18375         | -7.21       |
| 4       | 0.23625         | -1.96       |
| 5       | 0.2975          | -10.84      |
| 6       | 0.37625         | -23.63      |

These six channels' frequency and power are specified. The first channel has a frequency of 0.06125 MHz and a power of -15.84 dBc, whereas the second channel has a frequency of 0.11375 MHz and a power of -42.15 dBc.
MHz and a power of 42.15.15 dBc. The third channel frequency is 0.18375 MHz and the power is -7.21 dBc. The fourth channel frequency is 0.23625 MHz and the power is -1.96 dBc. The fifth channel frequency is 0.2975 MHz and the power is -10.84 dBc. The sixth channel frequency is 0.37625 MHz and the power is -23.63 dBc. It is apparent from these that a channel does not become a source of interference in another channel. According to the above-mentioned findings, the proper pocket size was discovered, which increased efficiency and increased the pocket distribution rate while also decreasing node drop. Because there are no interruptions of various channels during channel sharing, the channel is used without interruption noise. At low power, the channel also consumes more. Pocket waste and delays are reduced, allowing customers to clearly consume the channel.

6. Conclusion

OFDM is an appropriate modulation method for a large global data transmission, and it will become increasingly important in the future as wireless networks become more reliant on it. In many circumstances, including single and multi-cell settings, OFDM beats CDMA. OFDM can accept up to 2 - 10 times more users than CDMA in a single cell network, and up to 0.7 to 4 times more users in a multi-cellular network. An OFDM connection is performed using simulations, with a small number of real tests carried out on a low bandwidth base-band transmission. The difference in user capacity between OFDM and CDMA was dependent on whether or not cell sectorization and voice activity detection were used. This technology outperforms earlier methods which used a cellular array of frequencies to reduce interference by using the most precise spectral sensing approach. The channels in this suggested CR protocol may adapt to changes in the environment during transmission. Packet length and size were also decided during transmission in earlier standards. We tweaked the packet size in this system until we found the most efficient data packet size for transmission. The resistance of OFDM to multipath delay spread, channel noise, peak power clipping, and start time inaccuracy are the only four major performance requirements that have been studied so far. The difficulties that may arise when this method is utilised in a multiuser network is one significant area that has yet to be explored. The receiver will require a broad dynamic range to handle the considerable signal strength variations across users, which may be an issue. This research focused on OFDM, which is the most feasible system.

Declaration:
I declare that all the information I have given in the manuscript is true.

Conflict of Interest:
The authors declare that we have no conflict of interest.

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Data availability Statement:
Data analyzed in this study were a re-analysis of existing data, which are openly available at locations cited in the reference section.
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