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# Machine Learning Techniques for 5G and Beyond

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**ABSTRACT:** Network embedding successfully maintains the network structure by assigning network nodes to low dimensional representations. A considerable amount of progress has recently been achieved in the direction of this new paradigm for network research. In this study, we concentrate on classifying, analyzing, and pointing out the future directions for network embedding techniques research. We begin by summarizing the purpose of network embedding. We talk about network embedding and how it relates to traditional graph embedding methods in a cognitive radio context. Following that, we give a thorough overview of a variety of network embedding techniques in a methodical way, including advanced information preserving network embedding techniques, network embedding techniques with side information, and approaches that preserve structure and properties. Additionally, many methods of network embedding assessment as well as certain practical online tools, such as network data sets and software, are explored. In our last section, we cover the foundation for utilizing these network embedding techniques to create a successful system and identify some possible future paths.

## I. INTRODUCTION

Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An *asset* can be tangible (a house, car, cash, land) or intangible (intellectual property, patents, copyrights, branding). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved.Blockchain is important **to** Business runs on information. The faster it's received and the more accurate it is, the better. Blockchain is ideal for delivering that information because it provides immediate, shared and completely transparent information stored on an immutable ledger that can be accessed only by permission network members. A blockchain network can track orders, payments, accounts, production and much more. And because members share a single view of the truth, you can see all details of a transaction end to end, giving you greater confidence, as well as new efficiencies and opportunities.

### 1.1 COGNITIVE RADIO

An adaptable, intelligent radio and network technology called cognitive radio (CR) may automatically detect available channels in a wireless spectrum, change transmission settings to allow for simultaneous operation of many communications, and also enhance radio operating behavior. Cognitive radio makes use of a variety of technologies, including Software Defined Radio (SDR), which substitutes an intelligent software package for outdated hardware components like mixers, modulators, and amplifiers and adaptive Radio, where the communications system monitors and adjusts its own performance.

### 1.2 THE DIMENSIONS OF A COGNITIVE RADIO

It should come as no surprise that the two essential elements that make a radio cognitive are provided by the two essential technologies required to create a CR. These are capable of flexibility (provided by SDR) and intelligence

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(supplied by ISP). This component is also seen in various states of complexity or promise. Because of this, CR is difficult to define. Instead, chromium will have a wide range of capabilities, from the most basic to the most sophisticated (e.g. a Mitola radio). The varied CR grades can be better understood by using a matrix that is entirely dependent on RF flexibility and intelligence; see parent one. The important thing to remember is that an advanced sort of CR cannot exist without all of these elements, regardless of whether or not they are strictly orthogonal or connected in some other manner. The most intelligent gadget in the world won't be able to make intelligent decisions if it lacks the RF flexibility to learn about its surroundings (such as a broadband antenna). On the other hand, if a tool lacks the intelligence to make use of the statistics it is getting, it isn't worth anything.

**1.3 THE BENEFITS OF COGNITIVE RADIO**

One common benefit provided by cognitive radios, or rather cognitive stacks, is variety in terms of frequency, energy, modulation, coding, space, time, polarization, and so forth in order to enhance the likelihoods of spectrum efficiency through the use of a dynamic combinatorial approach. Here, it is necessary to draw a contrast between traditional selection methods that SDR may also apply. These SDR methods won't be tuned for spectrum performance but QoS from the single channel, meaning there won't be any space taken up by spectrum sensing. MIMO (Multiple Input, Multiple Output) is an illustration of a spectrum sensing selection process that integrates spatial and time variety by utilizing and forecasting spectrum features. Examining and putting different combinations of diversity strategies to use seemed challenging and probably will be.

**1.4 WORKING OFCR**

Remember that flexibility refers to both hardware/software flexibility as well as general cognitive components, not just RF flexibility, and that it extends past the physical layer into the different OSI levels. Higher OSI levels do not require extremely sophisticated or demanding hardware. It provides an illustration of a complex transatlantic relationship. Remember the satellite television for navigation when it's time to perform an astounding act to place anything in orbit around the Earth. The crucial communications generation is a radio relay (commonly called a "range" or "bent" pipe), which is not much larger than an electrical gadget. Don't forget the submarine cable; it is nothing more than a very long optical fiber with installed signal enhancers. There are many copper cables used on the link that connects to the internet and PSTN. Speakers, microphones, monitors, and cameras are all examples of interfaces to the person, which are ordinary objects. On the other hand, the intellect that tends to develop those methods is unquestionably also quite subtle. Connection creation, maintenance, and termination are not always simple tasks. ISP is far more relevant to the community, transport, and session levels than to the physical layer.

**1.5 APPLICATIONS & SHARING POSSIBILITIES**

Mostly as a standalone service (rather than an adjunct to contemporary services). It takes into account the most likely uses of CR, potential spectrum sharing arrangements with present licensees, and most likely recipients of sharing. Members of the radio industry were asked to participate in this study's discussion on CR's potential. The meetings' discussions on the various CR applications are summarized in Table 1. The hidden node issue and the absence of a system reliability guarantee are the most frequent issues for CR applications. The largest technological hurdle for CR is the hidden node issue. Depending on the use, it has varying properties. For instance, a well-distributed network of mobile nodes would be required to solve the hidden node problem in a broadcast network in the context of the Mobile Video Services application. Using time-sharing plans or a band manager would ensure the minimal reliability required by the CR system in terms of reliability. Regulations for CR systems and an economic study of CR applications are also required. The Emergency Radio System application, which is most likely to have a worldwide impact, requires the CR system regulations in particular.

## II. LITERATURE SURVEY

Clinical Knowledge: The Art and Science of Evidence beyond Measures and Numbers In this study, Kirsti Malterud et al. offer Medical professionals assert that science is the foundation of their field. Although the principles of evidence-based medicine are widely acknowledged, clinical judgments and patient care strategies are based on much more than merely the findings of well designed studies. Interpretive action and interaction—aspects that entail communication, attitudes, and experiences—constitute clinical knowledge. Since they only include questions and phenomena that can be controlled, quantified, and tallied, traditional quantitative research approaches provide a restricted access to clinical knowledge. It's important to look into, discuss, and challenge an experienced practitioner's tacit knowledge as well. In order to explore social events as they are perceived by people in their natural environment, qualitative research methods

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systematically gather, organize, and analyze textual data gathered through discourse or observation. Qualitative research may help us grasp medical science more thoroughly. The area of medicine is currently using qualitative research techniques. 1,40 Over the past several years, a number of studies of various quality—some by well regarded medical journals—have been published. Research on health care frequently uses techniques from anthropology or psychology, such as participant observation (eg, in-depth interviews). 35,41 Qualitative research on dialogue and patient-doctor interactions Research on general practice has been presented in 8, 9, 10, 25, and 30. Cross- or interdisciplinary methods provide the possibility of seeing medicine from a different conceptual perspective, but they also present difficult hurdles for communication and cooperation across established cultural barriers. [1]

Medical Data Mining: Clinical Data Warehouse Knowledge Discovery Clinical databases have amassed a substantial amount of data about patients and their medical issues, according to the hypothesis put out in this research by Jonathan C et al. This data's relationships and patterns may provide new medical insights. Unfortunately, very few techniques have been created and used to unearth this secret knowledge. In this work, a sizable clinical database was searched for relationships using data mining techniques, sometimes referred to as knowledge discovery in databases. Utilizing exploratory factor analysis, information gathered on 3,902 obstetrical patients was assessed for variables that could be responsible for premature birth. The researchers chose three criteria for more investigation. The procedures for mining a clinical database, including data warehousing, data query and cleansing, and data analysis, are described in this study. Observations and outcomes in prenatal care and other areas of medicine may be better understood as a result of recently discovered correlations uncovered in clinical databases like these. Prematurity continues to be the most prevalent cause of low birth weight and the accompanying morbidity and death, despite the many risk score systems and preterm birth prevention initiatives established in the 1980s. Because the causes of preterm birth have not been completely identified, existing risk score methods and preterm birth prevention initiatives are insufficient. More precise prospective trials of preventative measures may be possible with a more reliable model of premature birth. [2]

Data mining techniques are used in an intelligent system for predicting heart disease. In this study, Sellappan Palaniappan et al. make a proposal. The healthcare sector gathers enormous volumes of data, which are regrettably not "mined" to reveal hidden information for wise decision-making. Finding hidden linkages and patterns is frequently underutilized. Advanced data mining methods can assist to change this. In this study, a prototype Intelligent Heart Disease Prediction System (IHDPS) was created by combining Decision Trees, Naive Bayes, and Neural Network data mining approaches. Results indicate that each approach has a special advantage in achieving the specified mining aims. Traditional decision support systems cannot respond to complicated "what if" questions, but IHDPS can. The chance of people developing heart disease may be predicted using medical profiles including age, sex, blood pressure, and blood sugar. It permits the establishment of crucial knowledge, such as patterns and correlations between medical aspects connected to heart disease. IHDPS is a user-friendly, scalable, dependable, and adaptable Web-based system. It uses the.NET platform for implementation. Utilizing three data mining classification modeling approaches, a prototype system for heart disease prediction is created. The algorithm retrieves secret information from a historical database of heart diseases. The models are created and accessed using the DMX query language and functions. A test dataset is used to train and evaluate the models. The models are evaluated using the Lift Chart and Classification Matrix approaches. In response to the predicted state, all three models are capable of extracting patterns. Nave Bayes, followed by Neural Network and Decision Trees, appears to be the most successful model for predicting people with heart disease. Based on data exploration and business intelligence, five mining goals are identified. In comparison to the trained models, the goals are assessed. Each of the three models has its own advantages in terms of the simplicity of model interpretation, availability of comprehensive information, and accuracy in providing answers to complicated questions. Out of the five objectives, Naive Bayes, Decision Trees, and Neural Networks could each achieve four of them. Results from Decision Trees are simpler to read and comprehend even when they are not the most efficient model. Only Decision Trees offer the drill through functionality to get extensive patient information. Decision Trees performed worse than Naive Bayes because it was unable to identify all of the important medical factors. It is more challenging to comprehend how properties created by neural networks relate to one another. [3]

Applications of Data Mining Methods in Healthcare and Heart Attack Prediction This work by K. Srinivas et al. makes a proposal. The healthcare industry is typically thought of as "information rich" yet "knowledge poor." Within the healthcare systems, there is a lot of data. Effective analytic tools, however, are lacking, making it difficult to find hidden links and patterns in data. Data mining and knowledge discovery have many uses in the corporate and scientific worlds. The implementation of data mining techniques in the healthcare system can yield useful insights. In this paper, we briefly evaluate the possible use of rule-based, decision tree, naive Bayes, and artificial neural network classification-based data mining approaches to a large volume of healthcare data. Huge volumes of healthcare data are gathered by the business, but they are regrettably not "mined" to find hidden information. for the preparation of data and wise decision-making The naïve creedal classifier 2 (NCC2) and one dependency enhanced naive Bayes (ODANB) classifiers are employed. This is a naive Bayes extension to imprecise probabilities with the goal of producing reliable classifications even while working with tiny or insufficient data sets. Finding hidden linkages and patterns is frequently underutilized. The chance of people developing heart disease may be predicted using medical profiles including age, sex, blood pressure, and blood sugar. It permits the establishment of crucial knowledge, such as patterns and correlations between medical aspects connected to heart disease. We investigated the issue of constricting and summarizing various data mining techniques. We concentrated on applying several algorithms to forecast combinations of various goal parameters. In this research, we use data mining to provide a smart and useful heart attack prediction algorithm. First, in order to effectively anticipate heart attacks, we have created a method for extracting meaningful patterns from heart disease data warehouses. The frequent patterns with values larger than a certain threshold were selected for the valuable prediction of heart attack based on the estimated significant weight age. Based on data exploration and business intelligence, five mining goals are identified. The objectives will be assessed in comparison to the trained models. All of these models were capable of providing complicated predictions for heart attacks. [4]

Heart Failure: Machine Learning Techniques For Diagnosis, Severity Estimation, And Adverse Event Prediction In this study, Evanthia E. Tripoliti et al. make a proposal. Heart failure is a dangerous ailment with a significant prevalence (approximately 2% of adults in industrialized nations have it, and patients over 75 years old have more than 8% of them). 3-5% of hospital admissions are related to occurrences involving heart failure. In their clinical practice, healthcare providers' first reason for admission is heart failure. The expenses are quite substantial, accounting for up to 2% of all healthcare expenditures in affluent nations. It takes extensive data analysis, early illness diagnosis, severity evaluation, and early adverse event prediction to create a successful disease management plan. This will slow the disease's course, enhance patients' quality of life, and lower the related medical expenses. Machine learning approaches have been applied in this direction. The purpose of this work is to provide the most recent machine learning approaches used for heart failure evaluation. More precisely, models are developed that forecast the occurrence of heart failure, estimate its subtype, evaluate its severity, and forecast the existence of adverse events including destabilizations, readmissions to the hospital, and mortality. To the best of the authors' knowledge, this is the first time a review that covers every facet of heart failure care has been given. Heart failure (HF) is not a disease, but rather a complicated clinical condition. Since it affects the ventricle's capacity to fill or expel blood, it inhibits the heart from meeting the body's circulatory needs. As a result of structural and/or functional cardiac or non-cardiac problems, it is characterized by symptoms like shortness of breath, ankle swelling, and exhaustion that may be accompanied by indicators like high jugular venous pressure, pulmonary crackles, and peripheral edoema. High rates of morbidity and death are linked to the dangerous illness known as HF. The European Society of Cardiology (ESC) estimates that 3.6 million adults worldwide receive a new HF diagnosis each year, bringing the total number of adults with HF to 26 million. 17–45% of HF patients pass away during the first year, while the remainder patients do so within five years. About 1-2% of total healthcare expenses are attributable to HF management, and the majority of these costs are associated with frequent hospital hospitalizations. [5]

## III. EXISTING SYSTEM

The system of existing adaptation mechanisms is typically reactive; it only responds when a tangle occurs. Due to inexperienced networking and profitable
business models, this largely restricts the network's ability to produce intelligent and effective solutions. By utilizing spare or underutilized spectrum, Cognitive Radio Networks (CRNs) increase spectrum usage. Unauthorized users have access to likened spectrum when authorized users experience the least amount of interference.

## IV. PROPOSED SYSTEM

The suggested solution uses PSO (particle swarm optimization) with OLSR Optimized Link State Routing. There will be several nodes that need to be created in order to link the proposed methodology for connecting packet transmission; data received packets, and the energy view grab. High end-to-end latency and shortened network life. It is possible to embed and pair nodes. If network embedding is seen as a method of learning network representations, the development of the representation space may be further improved and restricted to particular nodes.
**OLSR**The Optimized Link State Routing System (OLSR), which may also be utilised on other wireless ad hoc networks, is an IP routing protocol that is tailored for mobile ad hoc networks. OLSR is a proactive link-state routing protocol that finds and then spreads link state information across the mobile ad hoc network via hello and topology

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control (TC) messages. Using the shortest hop forwarding pathways, individual nodes compute the next hop destinations for every other node in the network. Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS) are two link-state routing protocols that choose a chosen router on each link to carry out topology information flooding. A different strategy is required to optimize the flooding process in wireless ad hoc networks since there is a distinct concept of a connection and packets can and do leave the same interface. The OLSR protocol performs distributed election of a set of multipoint relays and finds 2-hop neighbour information at each node via Hello messages (MPRs). Nodes choose MPRs in such a way that there is a path from each of their 2-hop neighbours to the node they have chosen as an MPR. The TC messages with the MPR selectors are then sourced from these MPR nodes and forwarded.

**PSO** Particle swarm optimizations algorithm (PSO) is a later-expanded non-parametric classification technique. Regression and classification are two uses for it. The input in both situations consists of a data set's pbest fitness nearest training examples. Whether particle swarm optimization is applied for classification or regression will affect the results: In particle swarm optimization classification, a class membership is the result. A majority of an item's neighbours vote to classify it, with the object being given to the category that has the most members among its closest neighbours (pbest fitness is a positive integer, typically small). The item is just put in the class of the one nearest neighbour if pbest fitness = 1. The outcome of particle swarm optimization regression is the object's property value. The values of pbest fitness' closest neighbors were averaged to produce this value. With particle swarm optimization, all computation is postponed until after the function has been evaluated and the function is only locally approximated. Since this technique depends on distance for classification, normalising the training data can significantly increase accuracy if the features reflect several physical units or have distinct sizes. Assigning weights to neighbour contributions may be a helpful strategy for both classification and regression, making the closer neighbours contribute more to the average than the farther neighbors.

**4.1 NETWORK CONSUTRUCTION MODULE:**

The network embedding used in this module is used to convert the original network space into a low-dimensional vector space. Finding a mapping function between these two spaces is the fundamental issue. Some techniques presuppose that the mapping function be linear, such as matrix factorization. But because a network forms in a complex, highly nonlinear way, a linear function might not be sufficient to transfer the original network to an embedding space. Deep neural networks are undoubtedly excellent possibilities if looking for an efficient non-linear function learning model because of their enormous accomplishments in other domains. The main difficulties are how to apply network structure and property-level restrictions to deep models, as well as how to make deep models suit network data. To overcome these difficulties, certain representative techniques—including SDNE, SDAE, and SiNE—propose deep learning models for network embedding. Deep neural networks are renowned for their benefits in offering end-to-end solutions, too, at the same time.

**4.2 MATRIX FACTORIZATION ROUTE ANALYSIS MODULES:**

The adjacency matrix, where each column and each row represent a node and the matrix entries indicate the relationships among nodes, is frequently used in this module to represent the topology of a network. A node can be represented by a row or column vector, but this results in an N-dimensional representation space, where N is the total number of nodes. In contrast to the N-dimensional space, the goal of network embedding, which aims to learn a low-dimensional vector space for a network, is to ultimately find a low-rank space to represent a network. In this sense, the solution to this issue can naturally be achieved by applying matrix factorization techniques, which share the same objective of learning the low rank space for the original matrix. Due to its superiority for low-rank approximation in the family of matrix factorization models, Singular Value Decomposition (SVD) is frequently used in network embedding. The benefits of non-negative matrix factorization as an additive model make it widely used.

**4.3 BAND MAJOR DIFFERENCES MAANGEMENT MODULE:**

This module's assistance The assumptions and goals of network embedding and graph embedding are very different. As previously indicated, network embedding aims to facilitate network inference as well as reconstitute the original networks. Reconstruction of the graph is the primary purpose of graph embedding methods. The embedding space discovered for network reconstruction is not always suitable for network inference, as was previously noted. As a result, graph embedding may be thought of as a particular instance of network embedding, and recent advancements in network embedding research have focused more on network inference. Additionally, graph embedding primarily functions on graphs built from feature-represented data sets, where the closeness of nodes conveyed by the edge

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weights is well specified in the original feature space. As opposed to this, network embedding mostly utilizes naturally occurring networks, such as social, biological, and e-commerce networks.

**4.4 STRUCTURE PRESERVING NETWORK NODE GROUPING AND DATA SHARING MODULE:**

In this module, network architectures may be divided into several categories and shown at various granularities. Neighborhood structure, high-order node closeness, and network communities are some of the frequently used network structures in network embedding. For learning node representations in a network that can maintain node neighbor structures, Deep Walk is presented. In a brief random walk, Deep Walk finds that the distribution of nodes resembles the distribution of words in natural language. This insight led to Deep Walk using the Skip- Gram model, a popular word representation learning approach, to learn the representations of nodes. To generate a set of walk sequences, Deep Walk specifically uses a truncated random walk on a network, as shown in Fig. 4. Following Skip-Gram, Deep Walk aims to maximize the probability of the neighbors of node vi in this walk sequence for each walk sequence with the formula s = fv1; v2;::; vsg.

## V. RESULT AND ANALYSIS

The transmission channel in Cognitive Radio Networks is likened to the main users (PUs), whereas secondary users (SUs) can only access the channel opportunistically when the PUs are inactive, that is, when the PUs are not using the channel. A SU transmission must be stopped every time a PU becomes active since the SUs use the channel opportunistically. The amount of time needed to finish the SU's carrier (carrier Time) relies on the quantity and size of the PUs' transmissions when an SU needs to send several packets (for example, in a record transmission) or when a packet may be too large. The carrier time is, by definition, the period of time from the instant that the data (such as a packet or a report, depending at the community stack layer), reaches the top of the SU transmitting queue, until the instant that its transmission ceases. Provider time is a significant CRN measure since it takes the PUs' degree of interest into account. We represent in these paintings the operational period of a cognitive radio network operating on a GSM channel. Wi-Fi communication where the transmission or reception characteristics are changed to communicate effectively without interfering with authorized users Changes to parameters are entirely dependent on the active monitoring of a number of variables in the radio environment (e.g. radio frequency spectrum). The use of software-defined radio frequency spectrum makes this strategy possible. Spectrum sensing: Identifying unutilized spectrum and utilizing it without endangering other users. Spectrum management involves capturing high-quality photographs of the available spectrum to meet user communication needs. Maintaining uninterrupted communication on needs while switching to a better frequency is known as spectrum mobility. Spectrum sharing: Providing concurrent CR users with an honest method of scheduling spectrum. Complete cognitive radio and spectrum-sensing cognitive radio are the two main types of cognitive radio. All factors that a wireless node or community may be aware of are taken into account in complete cognitive radio. Cognitive radio using spectrum sensing finds the practicable radio frequency channels. The following key benefits of dynamic spectrum access may also be enjoyed by a WSN made up of sensor nodes equipped with cognitive radio: a. Opportunistic channel utilization for burst visitors When a WSN sensor node detects an event, a flow of packet bursts is generated. In parallel, a large number of nodes in the event region of densely distributed sensor networks seek to gather the channel. This raises the likelihood of collisions, which lowers the general communication dependability since packet losses induce excessive strength use and packet postponement. In order to avoid those potentially stressful circumstances, sensor nodes having cognitive radio capabilities may be able to enter several opportunity channels on the go. Using versatility to reduce power usage the wireless channel's time-varying nature causes power consumption due to packet losses and retransmissions. Sensor nodes with cognitive radio capabilities could be able to alter their operating conditions to fit channel conditions. This feature can help decrease the amount of strength needed for transmission and reception by improving transmission efficiency. Dynamic spectrums are allowed access to: The current WSN installations favor fixed spectrum allotment. However, WSN must operate in unlicensed bands or get a spectrum lease for a recognized band. A spectrum lease typically comes with exorbitant fees, which might raise the deployment's overall cost. Additionally, that runs counter to WSN's fundamental design principles. However, a variety of technologies, including IEEE802.11 Wi-Fi local area community (WLAN) hotspots, PDAs, and Bluetooth devices, also use unlicensed bands. As a result, sensor networks have a difficulty with congested spectrum. Opportunistic spectrum access techniques must thus be used in WSN as well in order to maximize network performance and be able to work well with various types of clients.

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## VI. CONCLUSION

Currently, 2G users will create an unquestionable level of habitation that may essentially rule out CR. However, if the switchover to 3G services continues, the band may have reduced habitation rates and hence be more suited to a variety of CR services.Our suggested approach offers improved accuracy and optimization.The GSM findings exhibit substantial fluctuation depending on the estimated degree of occupancy, although they could be appropriate for CR services that require "silent hours." The high degree of occupancy now being created by 2G users may leave little opportunity for CR. The GSM band, on the other hand, may have lower occupancy levels and hence be more appropriate for a variety of CR services if the amount of migration to 3G services persists. Results for CR similar to those predicted for the UMTS expansion band scenario will occur should GSM usage decline to the point that operators wish to re-farm the GSM bands to 3G services. In every case, the UMTS Expansion bands outperformed the GSM frequency in terms of call volume. This is maybe understandable given the lower occupancy of these bands, but it also demonstrates the huge variety between bands that might be further investigated using data from other bands that are now accessible. Due to the non-linearity of the BHT formula, where a larger number of lines allows a higher percentage of traffic volume than a smaller number of lines, taking several bands together will offer a larger additional call volume than the sum of the call volumes achieved by the consideration of isolated bands if the CR operates across bands. Since the DECT band's combination OFDMA/TDD scheme will show significant portions of the spectrum occupied even for a low duty cycle, or a low occupancy, it was determined that the DECT band was not beneficial for CR concerns. The simulated system is currently unable to take use of TDD schemes with empty slots since the CR method being employed only provides sensing in the frequency domain.

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