A Note On: Cognitive Radio and It Performance Tools

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ABSTRACT
A Cognitive Radio (CR) is an adaptive and intelligent radio and also network technology that can automatically detect available channels in a wireless spectrum. It can change the transmission parameter for more communications to run concurrently and as well improve radio operating behaviour. This paper is motivated to represent the various types of cognitive radio, characteristics, functions, CR concept architecture, CR platform, performance tools, applications, advantages, futures and challenges.

Keywords **- Cognitive Radio, CR Architecture, CR Platform, Radio Frequency, Tools**.

I. INTRODUCTION

The Cognitive radio supports to facilitate interoperability such as interruption of mitigation maximization, system throughput to realize dynamically in the movement to change its operational electromagnetic environment, autonomously adjust its radio operating parameters of a radio or a computer and access to the secondary markets [1].

A cognitive radio is a radio that can change its transmitter parameters based on interaction with the environment it operates. Cognitive Radios (CR) are able to monitor sense and detect the conditions of their operating environment and reconfigure their own characteristics dynamically and to best match those conditions. Cognitive radio (CR) technology enables the radio devices to use spectrum (i.e, radio frequencies) by entirely new and sophisticated ways.

Cognitive radio uses a number of technologies including Adaptive Radio (where the communications system monitors and modifies its own performance) and Software Defined Radio (SDR) were traditional hardware components including mixers, modulators and amplifies are have been replaced with intelligent software.

Cognitive radio in its environment (ie, the outside world) is an intelligent wireless communication system that is aware of, and to learn from the environment and the internal states of the incoming RF stimuli statistical differences understanding by- building method in accordance with the corresponding changes in certain operating parameters (eg, carrier frequency, and modulation strategy-power) with two primary objectives in mind, i.e., real-time and reliable information while when and where it is needed most for more efficient use of the radio spectrum .

Cognitive Radio (CR) is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and instantly move into vacant channels while avoiding occupied ones in order to optimize the use of available Radio-Frequency (RF) spectrum while minimizing interference to other users [2].

II. LITERATURE REVIEW

K. C. Chen, Y. J. Peng et al., proposed cognitive radio network layer functions and architecture of many structures, the number of links that categorize and classify the radio link features like structures extending cognitive radio networks (number) can be set [3].

Ian F. Akyildi et al., presented the concepts of spectrum sensing, spectrum sharing and spectrum call, spectrum management and spectrum of novel distributed integration movement from the point of view of a network. Through the establishment of a common control channel with a particular emphasis is given to the integration of distributed network between CR users. Also, the network layer of the upper layer protocols based on performance and the influence of transport layer protocols are investigated [4].

Jianfeng Wang et al., provides a high level overview of cognitive (primarily from the perspective of a dynamic spectrum access), radio and cognitive radio to support the benefits of applications to bring some of the challenges yet to be resolved [5].

Beibei Wang et al., discussed recent advances in the study of cognitive radios. Cognitive radio technology basics, cognitive radio network architecture and its applications are introduced. Spectrum sensing is already in the works reviewed, and dynamic spectrum allocation and sharing are important issues to be analyzed intimately [6].

III. TYPE OF COGNITIVE RADIO

There are two type of cognitive radio namely:

- Full Cognitive Radio: Full cognitive radio is a wireless node (or network), which is considered to be viewable by every possible parameter (Mitola radio) [7].

- Spectrum-Sensing Cognitive Radio: can detect radio frequency spectrum through the channels of Spectrum-Sensing Cognitive Radio.

Cognitive radio spectrum components are dependent on the availability of other types: Licensed Band cognitive radio, IEEE 802.22 job board for wireless regional area network (WRAN a standard), which licensed users will be assigned to the bands using the capacity i.e., the UNII band or ISM band as unlicensed bands except for the unused TV channels. Unlicensed Band cognitive radio can use the same radio frequency in unlicensed areas. Spectrum Mobility cognitive radio, can be used through the process of changing frequency function. Cognitive radio networks for seamless communication needs while maintaining excellent spectral changes, the radio terminals operate in the best available frequency band spectrum by allowing the use of dynamic scope.

Spectrum sharing: cognitive radio and cognitive radio networks [8] allow users to share the bands of licensed-band spectrum users. However, the cognitive radio user's licensed-band interference caused users to define and transmit them to be kept below a certain threshold.

Sensing-based spectrum sharing: sensor-based spectrum sharing cognitive radio networks [9]. Cognitive radio users are licensed by the state to determine the allocation of spectrum licenses to users. Cognitive radio users are deciding their transmission technique. If users are not using the licensed bands, bands that cognitive radio users sending over. If users are using the licensed bands, cognitive radio users to transmit power through their licensed users, and share the spectrum bands.

IV. COGNITIVE RADIO CHARCTERISTICS

The dramatic increase of service quality and channel capacity in wireless networks is severely limited by the scarcity of energy and information measure that are two elementary resources for communications. Therefore, researchers are currently focusing their attention on new communications and networking paradigms that can intelligently and efficiently utilize these scarce resources.

Cognitive radio (CR) is one critical enabling technology for future communications and networking that can utilize the limited network resources in a more efficient and flexible way. It differs from traditional communication paradigms in that the radios/devices can adapt their operating parameters, like transmission power, frequency, modulation type, etc. to the variations of the surrounding radio environment [10]. Before CRs adjust their operating mode to environment variations, they must first gain necessary information from the radio environment.

This kind of characteristics is referred to as cognitive capability [11]. This enables CR devices to be aware of the transmitted waveform, radio frequency (RF) spectrum, communication network geographical information, type/protocol, services, user needs, security policy and locally available resources.

After CR devices gather their needed information from the radio environment, they can dynamically change their transmission parameters according to the sensed environment variations and achieve optimal performance, which is referred to as re-configurability.

V. COGNITIVE RADIO APPLICATIONS

1. Smart Grid Networks

Based Smart Grid from an architectural perspective, the three layers: high-level layers, power layer (production and distribution), network layer and application layer (such as advanced metering applications and services, demand Response and grid management). A smart grid power, generated delivered, consumed and transforms the way.

Adding newly networked intelligence throughout the grid, the demand will increase grid reliability improves handling and responsiveness, Efficiency, better linking increases and renewable / distributed energy sources, integrates, and potentially reduces costs The provider and the consumer[12].

2. Public Safety Networks

Wireless communications in detail, such as the police, fire and emergency medical services, such as emergency, used to prevent or respond to incidents and access to emergency services as soon as possible by the citizens. Public safety workers abound their ability, to improve the wireless laptops, handheld computers and are equipped with video cameras and mobile immediately central control, the ability to collaborate with co-workers.

In the wireless services the importance of CR is about the public protection from voice messaging, email, web browsing, database access, film transfer, video streaming and other extended broadband services. Video surveillance cameras and sensors are important tools to extend the eyes and ears of the public security agencies. Correspondingly, data rates, reliability and delay requirements vary from service to service.

3. Cellular Networks

Consumer expectations always use cellular networks, which is one of the undergoing dramatic changes in recent years, i.e., where and when connected. The introduction of smart phones, the popularity of social networks, such as emerging media platforms (Y. Hulu et al.,) the introduction of the e-reader devices, all you need to add to the already high and growing use custom data services such as email and web browsing, cellular networks. This trend, FCC identified forecasting national broadband project [13].

4. Wireless Medical Networks

In recent years, there's nowhere for monitoring vital signs of patients in hospitals is increasing interest in the implementation such as temperature, pressure, blood oxygen and (ECG) and so on. General health can be monitored on from monitored sensors that are connected by wires to a bed and then the monitor.

MBANs (Medical Body Area Networks) a promising solution to remove the wires reliably and inexpensively allows multiple sensors to collect and monitor data quality factors wireless pharmaceutical fast [14] that can respond.

VI. COGNITIVE RADIO FUNCTIONS

The representative duty cycle of CR, is illustrated in Fig. 1, which includes detecting, selecting the best frequency bands, spectrum white space, coordinating spectrum access with other users and then, vacating the frequency when a primary user appears. Following functions which support the cognitive cycle are:

- Spectrum sensing and analysis.
- Spectrum management and handoff.
- Spectrum allocation and sharing.

Through spectrum sensing and analysis, CR can detect the spectrum white space is depicted in Fig. 2, i.e., a portion of frequency band that is not being used by the primary users utilizes the spectrum, when primary users start using the licensed spectrum again, CR can detect their activity through sensing, which has where no harmful interference is generated due to secondary users' transmission.

Recognizing the spectrum white space by spectrum management, sensing, and hand off function of CR enables secondary users to choose the best frequency band and hop among multiple bands according to the time varying channel characteristics to meet various Quality of Service (QoS) requirements [15]. For instance, when a primary user reclaims frequency band, the secondary user that is using the licensed band can direct transmission based on the channel capacity determined by the noise and path loss, interference levels , holding time, channel error rate and etc to other available frequencies.

In dynamic spectrum access, a secondary user may share the spectrum resources with primary users and other secondary users, or both. A good spectrum allocation and sharing mechanism is critical to achieve high spectrum efficient resources. Since primary users own the spectrum rights but secondary users co-exist in a licensed band with primary users of spectrum.

The interference level due to secondary spectrum usage should be limited by a certain threshold can be calculated. When multiple secondary users share a frequency band and their access should be coordinated to alleviate collisions and interference.

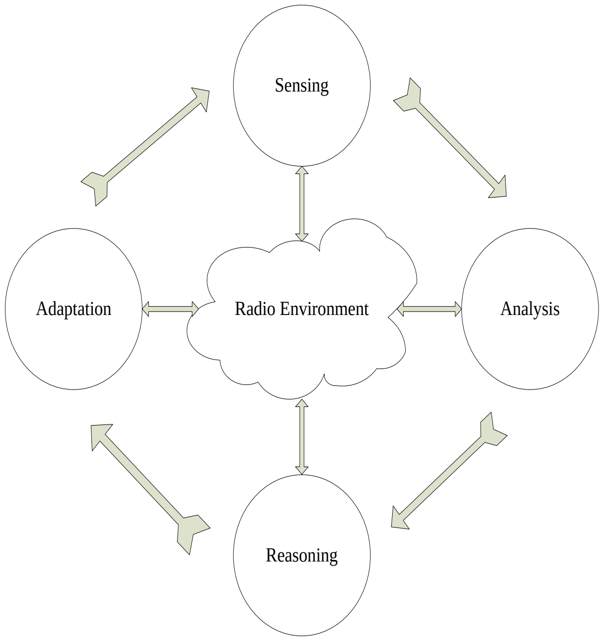

Fig.1.Cognitive cycle

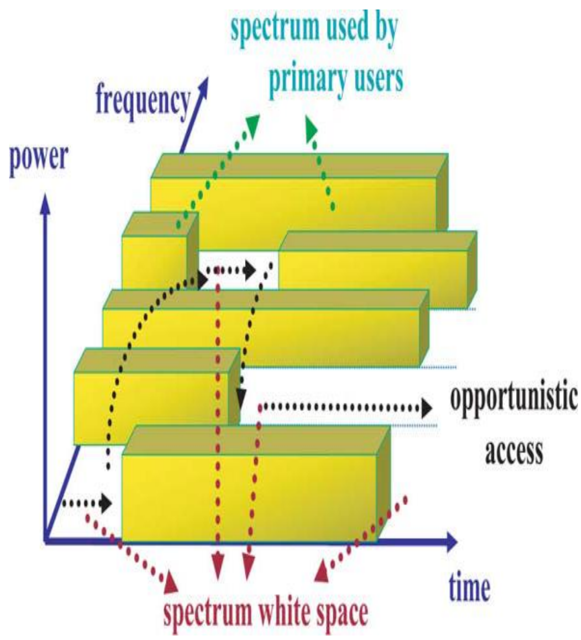

Fig.2.Illustration of spectrum white space

VII. COGNITIVE RADIO CONCEPT ARCHITECTURE

There are two major sub-systems of a cognitive radio the operating software provides a range of possible operating modes for various inputs and a flexible SDR unit that makes decisions based on a psychiatric unit. Spectrum sensing is a separate subsystem, more often in the presence of other services or the user to determine the signal to be measured in the context of a cognitive radio architecture included.

These sub-systems need not define a piece of equipment, but instead spread across a network is important to note that it will incorporate elements. As a result, cognitive radio is often referred to as a cognitive radio system or an intelligent network.

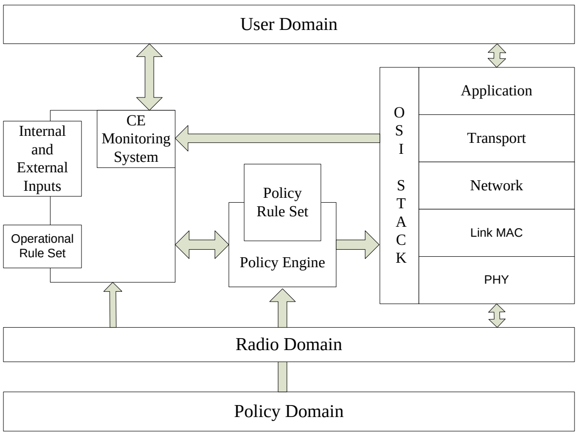

Fig. 3 cognitive radio concept architecture

Cognitive Radio and Dynamic Spectrum Access enables sub-structures cognitive enabling technologies for cognitive radio companion next radio and dynamic spectrum access and support for the implementation of the technologies that are required under the wireless innovation forum members information process design complex information systems and subsystems communicate with it from the perspective of a process to increase the understanding of how to determine the current status of and opportunities to interact with other systems[16].

Modeling Language: it is flexible and efficient communication protocols. Such as the vertical and horizontal mobility, spectrum awareness and dynamic adaptation of the spectrum, waveform optimization, feature exchanges and support for advanced applications of the advanced features of next generation radio systems and subsystem. The cases made extensive use of a modelling language and defining the signalling scheme, requirements, communication, technical analysis features and provides the foundation for improving the quality of support for these capabilities.

A modelling language or meta-language, expressed in a formal declarative language that is machine readable defines the communications infrastructure of the cognitive radio.

Radio Environment Map: Operation of the engine, a psychiatrist at a particular moment in time data and terminal operation Meta data is needed to define the spectrum environment.

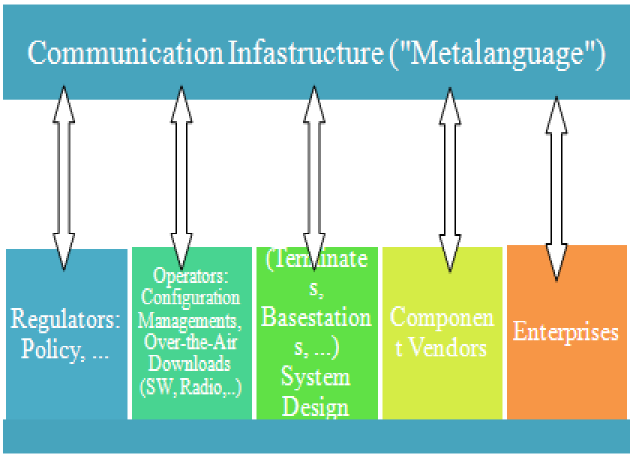

Fig 4: Enabling Architecture

This data is referenced to the map of the radio spectrum environment of economic transactions, dropouts, handovers, networks and information on the services can be added.

Data capturing and measurements contained in the map by synthesizing multiple radios, in part, derived and that can be accessed remotely through cognitive engine is stored in a database. Standardized information architecture, data structures and function, including enabling access of information system requirements, such as the movement of current and future cognitive radio spectrum usage, the spectrum of economic transactions, dropouts, to give up networks to accommodate the necessary flexibility to support should be limited for services.

Test and Measurement: Cognitive radio spectrum policy such as sensitivity, interference avoidance, database performance, and adherence to the unique test challenges as the key activities and performance levels.

Test methodologies to support the challenges of hardware platforms, protocols, and standards, use cases, and the need to consider a range of requirements developed by the stakeholder spectrum.

Functionality and performance test equipment, test interfaces and test methods should also be taken into account.

VIII. COGNITIVE RADIO PLATFORMS

Most of the sites will be required to populate the classes test beds. It includes the Base station i.e., no power controls but more powerful nodes.

1. Client nodes

The performance of the client nodes is commonly less efficient, more compact and less expensive.

2. Mobile platforms

The most challenging issues of cognitive radio are the clients, the size, weight and power required for mobile platforms.

3. **Platform flexibility**

A wide range of issues, including the ability to implement this package includes a variety of physical layers, various front ends support (eg, covering the various spectrum bands very wide band, the most important of the spectrum sensing (-115dBm), different quality / cost tradeoffs), and access to programming tools.

4. The software availability

Software radio platforms is the cost and time of developing software consuming, so the preference given to sites that come standard with a broad base (and preferably open source) software. In this context, the software includes all the elements of the code field, embedded cores, CPU's, and the host system including a large part of the can be shared across multiple platforms and the threshold to reduce the cost of new entry groups.

Developing structures that support the portability of the software and will be part of the API selected research agenda is feasible and reliable path to be sites of the program should not be considered unless the initial availability or development software, but the effort required improving and maintaining the software over time. In that sense, the availability of open source software (such as GNU Radio project [17]) is considered key to the success of the initiative in a community test bed effort.

5. The physical properties of the device:

It includes a broad range of issues including the used in many different environments, the ability of the element to withstand radiation. Exposure in the vicinity of the main bands of high degree of isolation is the use of the spectrum and its range of motion etc., It's much better than any of the sites available that are sure to create a new platform.

XI. COGNITIVE RADIO PLATFORMS

A notoriously scarce and an unlicensed wireless spectrum in the vicinity of the radio transmission device cannot run, because of the need for tighter regulation such as the FCC, 6 kHz and 300 GHz which will increase each year and require a license for frequencies in the range between about 8 orders of magnitude includes the frequency bands of the spectrum and license until divided [18].

The wireless spectrum increased due to deficit. The quality of the cell phone as they mature, their peak data rates uniformly require more and more bandwidth spectrum, increased. New York, San Francisco, and Washington DC were metropolitan areas, such that bandwidth is often not enough to go around. The middle-based distance control, measurements and a different image for a closer study of the wireless spectrum are the major resources. Bands have ever seen using multiple licenses or beyond the ability of other nearby bars which are crowded, while all together are empty. FCC's even more densely packed urban areas and 35% in the overall spectrum utilization rarely goes on to reveal that the simultaneous use of the spectrum [19].

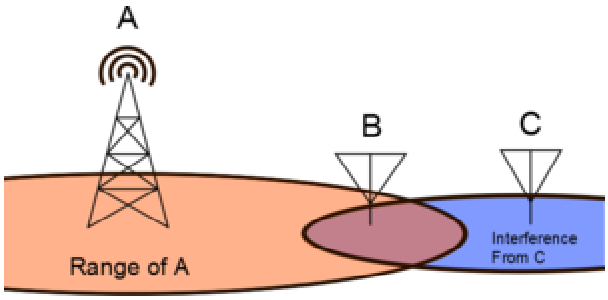

Fig. 5: An out-of-range secondary user C can interfere with primary spectrum users A and B.

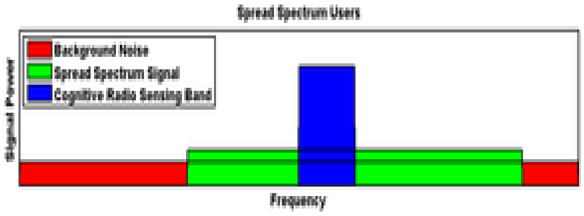

Fig. 6: It is often impossible to distinguish between background noise and a spread spectrum signal with wide bandwidth.

Cognitive radios from the current research crowded band users nearby empty hopes to improve the utilization of the spectrum by allowing a one-off blood. Cognitive radio is an ideal scenario for a spectrum of local spectrum usage, realizing its own radio parameters can be tailored accordingly. For example, a meeting of the New York City apartment complex is considered a personal Wi-Fi network. Personal, Wi-Fi devices which are designed to be easy to fill in the 2.4 GHz band currently co-located networks [18, 19].

In contrast, the upper band is used as an additional device, along with the provision of a cognitive radio, Wi-Fi spectrum usage and on the other that does not feel underutilization nearby spectrum blocks. Cognitive radio, so be sure to act free of the spectrum and the total available spectrum is more efficiently utilized [20, 21]. Empty broadcast television / radio stations, radio- astronomical systems, radio-navigation systems and many more examples of blocks of spectrum that are used. [19] The FCC is a high priority and 802.22 draft standard, which is still under review, the FCC's first foray into the cognitive radio and their commitment and demonstrates active interest in new technology [22].Despite the promise of cognitive radio technology and is ready to be implemented in a real-world situation; there are still hurdles to overcome before technicians. Interfere with the signals of the two is more insidious, leading to the mistaken conclusion that the spectrum block is empty, a cognitive radio, both of which lead to the primary users and primary users of spread spectrum, hidden among the many challenges that have yet to be resolved in the primary user [23].

The hidden root of the problem geometry is depicted in Fig. 5. Band C measures the energy to run the A and B for use licensed spectrum to use and background noise by setting a threshold that would compare the primary transmitter of a primary receiver B, and the second user C, considering the band is in use, if it is to decide.

The second C is the primary transmitter of the user in the event of a border to the conclusion that it is not in the immediate vicinity of the spectrum there is no primary user may associate. The second problem arises when the user starts to transmit C. Although far from the C, B, and its primary receiver may be near enough to receive the signal. However, in a manner that will prevent the use of licensed spectrum between C and B may hinder the transformation begins to transmit interference [23] Spread Spectrum Master can be an equally insidious problem.

Consider the use of the frequency plot depicted in which the user is the representative of a spread spectrum. As in Fig. 6 is a spread spectrum signal is very low power spread over a wider bandwidth user may be required. In the worst case scenario, a cognitive radio system is primarily used by the user is smaller than the wide bandwidth, the spectrum bands to be checked. Unfortunately, the primary user of low-power broadcasting, often designed to look like the background noise, and can tell you like it by the cognitive radio.

In fact, the only way to distinguish from the background of a spread spectrum transmission spectrum of the empty fake identity, leading to the full bandwidth of the cognitive radio may be impossible, is to sample [23].

X. FUTURE OF COGNITIVE RADIO

Mobiles and other wireless communication parts are try to make the ability to run more adaptable. In the future, it is convenient to install, use, and customer access to any nearby unused radio spectrum that combine cognitive radio technology allows wireless networking around.

XI. TOOLS

OMNeT++ (Objective Modular Network Test bed in C++) is an open supply, separate event machine tool written in C++. OMNET++ could be a general-purpose machine capable of simulating any system composed of devices interacting with one another. OMNeT++ supports wireless and mobile simulations within OMNeT++.

This support is alleged to be fairly incomplete. OMNeT++ is for academic and educational use. OMNeT++ [24] provides a hierarchical, component-based, standard and protrusive architecture. Components, or modules, square measure programmed in C++ and new ones are developed using the C++ class library which consists of the simulation kernel and utility classes for random statistics assortment, number generation, topology discovery etc.

QualNet communications simulation platform (QualNet) is a planning, testing and training tool that "mimics" the behaviour of a real time communications network. The Simulation could be a cost-effective methodology for deploying, developing and managing network-centric based systems throughout their entire lifecycle. Users will value the fundamental behaviour of a network system, and check the combinations of network options that are likely to work. QualNet provides a comprehensive atmosphere for making and animating network situations, designing protocols, and analyzing their performance [25].

NS-2 is a discrete event simulator which provides support for routing, multicast protocols over wired and wireless (local and satellite) networks and simulation of TCP. It is the foremost common network machine used by researchers and engineers. The network machine began as a variant of the REAL network simulator in 1989 and has evolved over the past years. NS-2 is written in C++ and is based on two languages: C++ which is used to extend the simulator (i.e. to outline protocol behaviours), and OTcl, an object-oriented extension of Tcl developed by David Weather all as part of the VU system project at Massachusetts Institute of Technology is used for scenario configuration, manipulation of existing C++ objects, periodic or triggered actions [26].

J-Sim has been developed entirely using JAVA Programming. This, coupled with the autonomous component architecture that makes J-Sim is very platform-neutral and reusable surroundings extensible. J-Sim additionally provides a J- script interface to allow integration with different script languages such as Perl, Tcl, or python [27]. In the current release have fully integrated J-Sim with a Java implementation of the Tcl interpreter (with the Tcl/Java extension) known as jacl. All the general public classes/methods/fields in Java can be accessed (naturally) in the Tcl environment. The Java based simulation and animation environments support web based simulation is a rapidly emerging area of simulation research and developed

XII. CONCLUSION

Cognitive Radio is a new type of network used to detect the communication channels and cutting edge technology from several research areas. This can provide the ability to monitor the operating environment and dynamically reconfigure its own characteristics. This paper presents and explains the Cognitive Radio Applications, Tools, Challenges, Platforms and Radio functions which are the distinguish background of a cognitive radio.

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