COGNITIVE RADIO

The Electromagnetic Radio Spectrum, a natural resource, is currently licensed by regulatory bodies for various applications. Presently there is a severe shortage of the spectrum for new applications and systems. However various studies have concluded that at any time and place, very little of the licensed spectrum is actually utilized.

The unutilized part of the spectrum results in 'Spectrum holes' or 'White Spaces'. Therefore, recently it has been proposed to allow utilization of the unused spectrum at a time to other users who do not hold the license. This will be possible by the Cognitive Radio technology being developed now. Cognitive Radios are defined as radio systems which perform Radio Environment analysis, identify the spectrum holes and then operate in those holes.

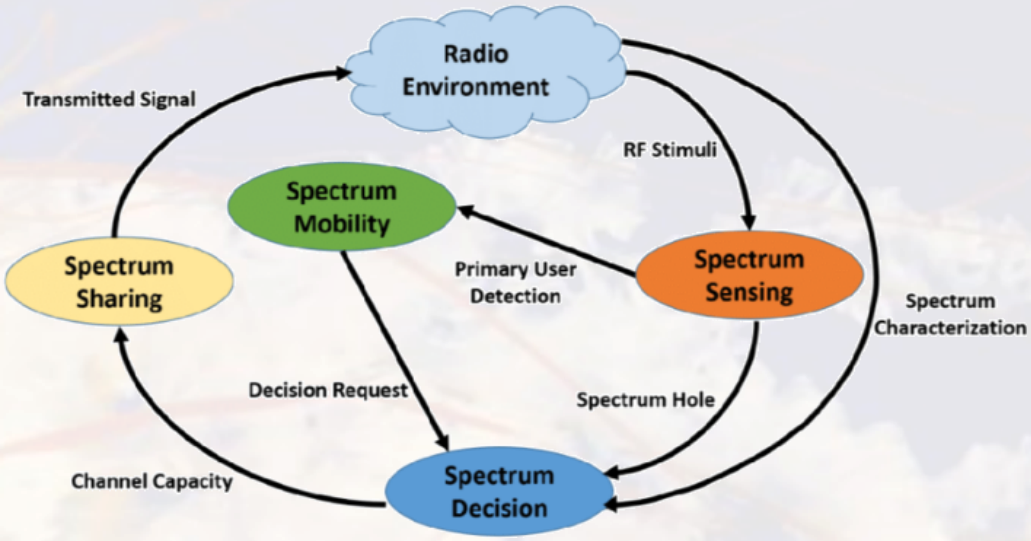


Fig: Cognitive Radio Modules

In cognitive radio terminology Primary user refers to a user who is allocated the rights to use the spectrum. Secondary user refers to the users who try to use the frequency bands allocated to primary user when the primary user is not using it.

Spectrum Sensing, an essential component of the Cognitive Radio technology involves, 1) identifying spectrum holes and 2) when an identified spectrum hole is being used by the secondary users, to quickly detect the onset of primary transmission. This needs to be done such that guaranteed interference levels to the primary are maintained and there is efficient use of spectrum by the secondary.

Spectrum utilization efficiency is not the only benefit of cognitive radio technology; however, it is one of the more high-profile possibilities, in part due to the economics of being able to sublease spectrum as needed. The supply of available radio frequency spectrum is often described as being in a state of shortage. Whereas demand for spectrum in the most useful frequencies exceeds supply, some statically allocated spectrum bands experience low utilization. A cognitive radio that is capable of exploiting unused or lightly used spectrum will have great value in improving efficiency of spectrum utilization. Based on the technology advancements of SDR, a cognitive radio could easily operate on multiple frequencies with a variety of power levels and modulation bandwidths; incorporate sophisticated control algorithms to prevent or reduce interference so more spectrum can be exploited; provide the capacity to move the regulators from a band-by-band set of rules to more mega-policies, enabling both new technologies and new entrants; and assist the regulator to serve the public interest by providing spectrum when and where it is needed by using technology to satisfy the ever-increasing spectrum demand and streamline the licensing process.

CHALLENGES:

1 Quality of service: Spectrum mobility should be carried out with negligible latency. To reduce delay and loss of information during spectrum handoff, new mobility methods is required to be designed. Due to spectrum handoff in CR network link state parameters are affected which leads to network instability problem - clogging or link error. Therefore, maintaining service quality for the complete cognitive operation is still an ongoing issue.

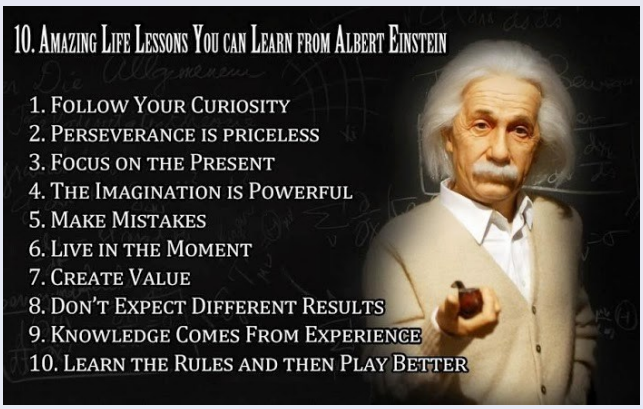
2 Spectrum sensing techniques: Spectrum sensing algorithm implemented till now is Energy detection, Match filter detection and Cyclostationary feature detection. In matched filter detection, primary user location has to be known in advance and also many assumptions are required, which is very difficult to implement practically. Also, these techniques give less accurate result which fails in certain conditions.

3 Complex Circuitry: For reliable detection of primary user transmission, a complex circuit is needed for analog to digital converter to sample wideband signal with large dynamic range. It becomes difficult to balance between high speed and high accuracy; therefore it is important to decrease the dynamic signal range before analog to digital conversion.

4 Security: Network security has become a major issue and also open challenge in Cognitive Radio network. There are various attacks in CRN. The major attack which affects spectrum sensing operation is Primary User Emulation (PUE) attack. A stationary as well as mobile primary user suffers from this attack. Stationary primary users are TV bands and cellular network whereas mobile primary users are wireless microphone. There are various techniques for detection of PUE attack for stationary primary users. But for mobile primary user, only two techniques are implemented. Thus, there is a need of a technique which can detect PUE attack for both stationary as well as mobile primary users.

5 Sensing period: Two periods exist in cognitive user transmission process: Sense and quiet period. Sensing cannot be performed while transmitting packets Hence CR users should stop transmitting while sensing which decreases spectrum efficiency. It becomes difficult to maintain a balance between sensing accuracy and spectrum efficiency.

6 Energy Consumption: Energy efficiency is major concern in wireless communication as it presents battery life. In Cognitive Radio lot of time is consumed for spectrum sensing Operation. To improve energy consumption without any compromise with the spectrum sensing operation, quality of service and seamless communication is a topic of interest.



Prof. Archana Ingle
H.O.D. EXTC