COOPERATIVE SPECTRUM SENSING USING COGNITIVE RADIO

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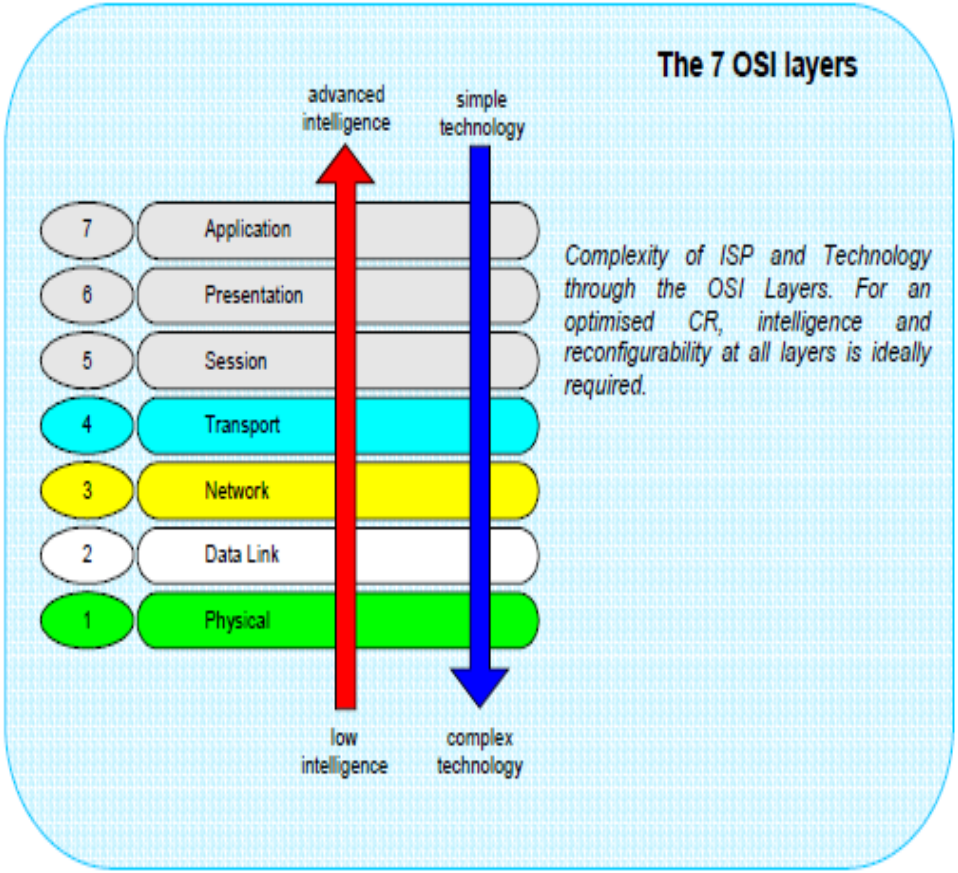
WHAT IS COGNITIVE RADIO?

CR can be defined as "…a radio that is aware of its surroundings and adapts intelligently".

- Intelligent Radio.
- Senses Environment and Spectrum(Cognitive capability).
- Analyzes it(Self-organized capability).
- Adapts to it(Reconfigurable capability).
- Learns from the results.

INTELLIGENCE AT ALL THE 7 LAYERS OF THE "OSI" MODEL.



CR uses intelligent signal processing (ISP) at the physical layer of a wireless system and is achieved by combining ISP with software defined radio (SDR)

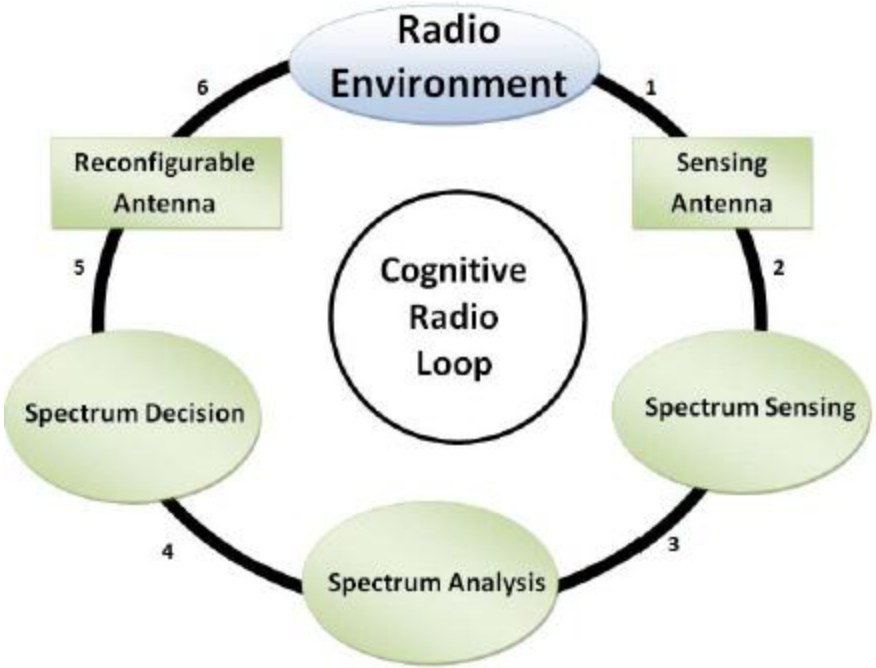
CR NETWORK MECHANISM

1. Sense -> Sensing antenna

2. Analyze

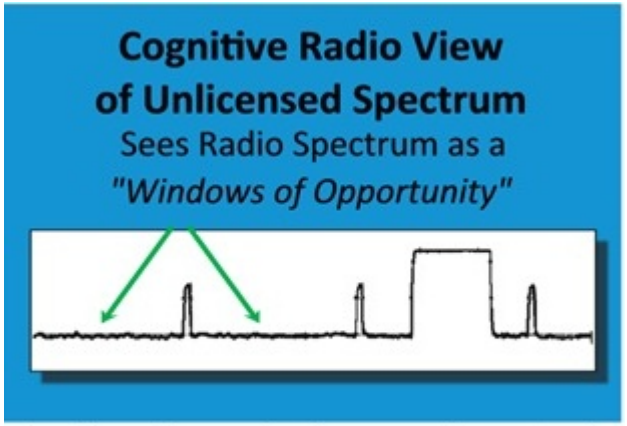
3. Decide

4. Tune in -> Reconfigurable antenna



COGNITIVE RADIO FEATURES

- function in **challenging conditions**
- quickly identify **unused "gaps"** in spectrum that are not being used
- find and **tune to other spectrum if interference** is detected on the frequencies being used (example - xMax samples, detects and determines if interference has reached unacceptable levels up to 33 times a second)

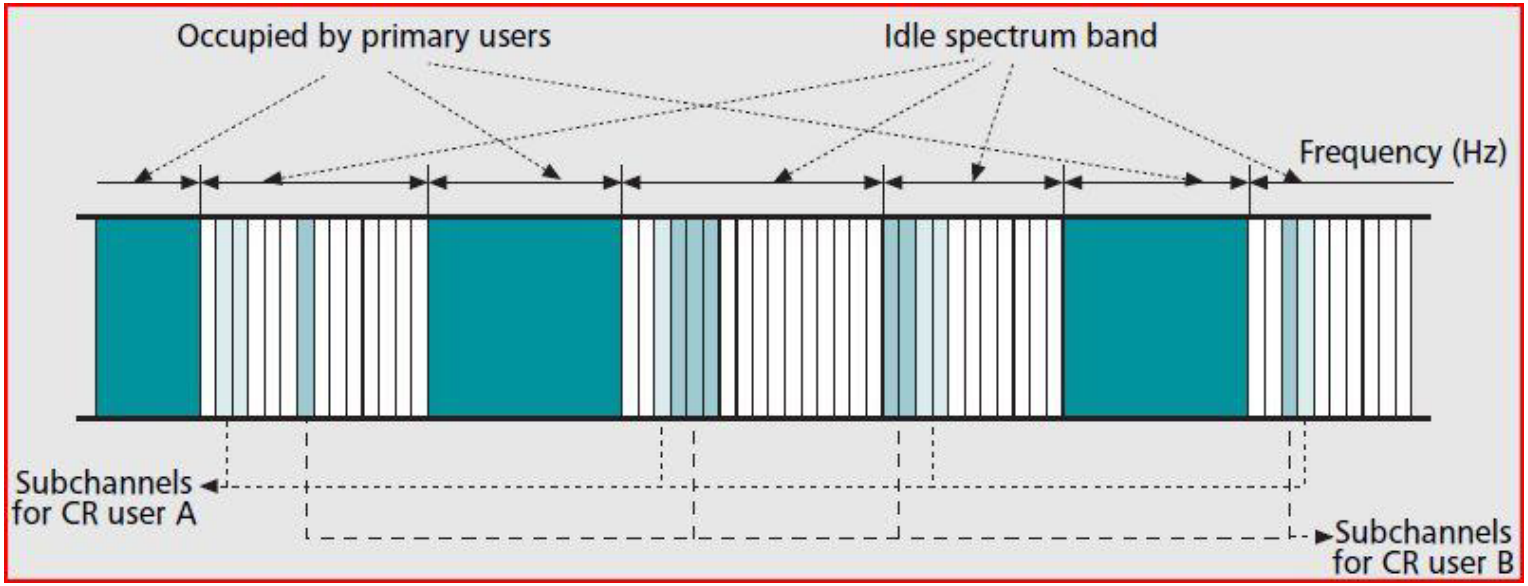


Cognitive radios can view the same radio spectrum in deeper detail, allowing them to identify unused gaps to transmit signals.

WORKING

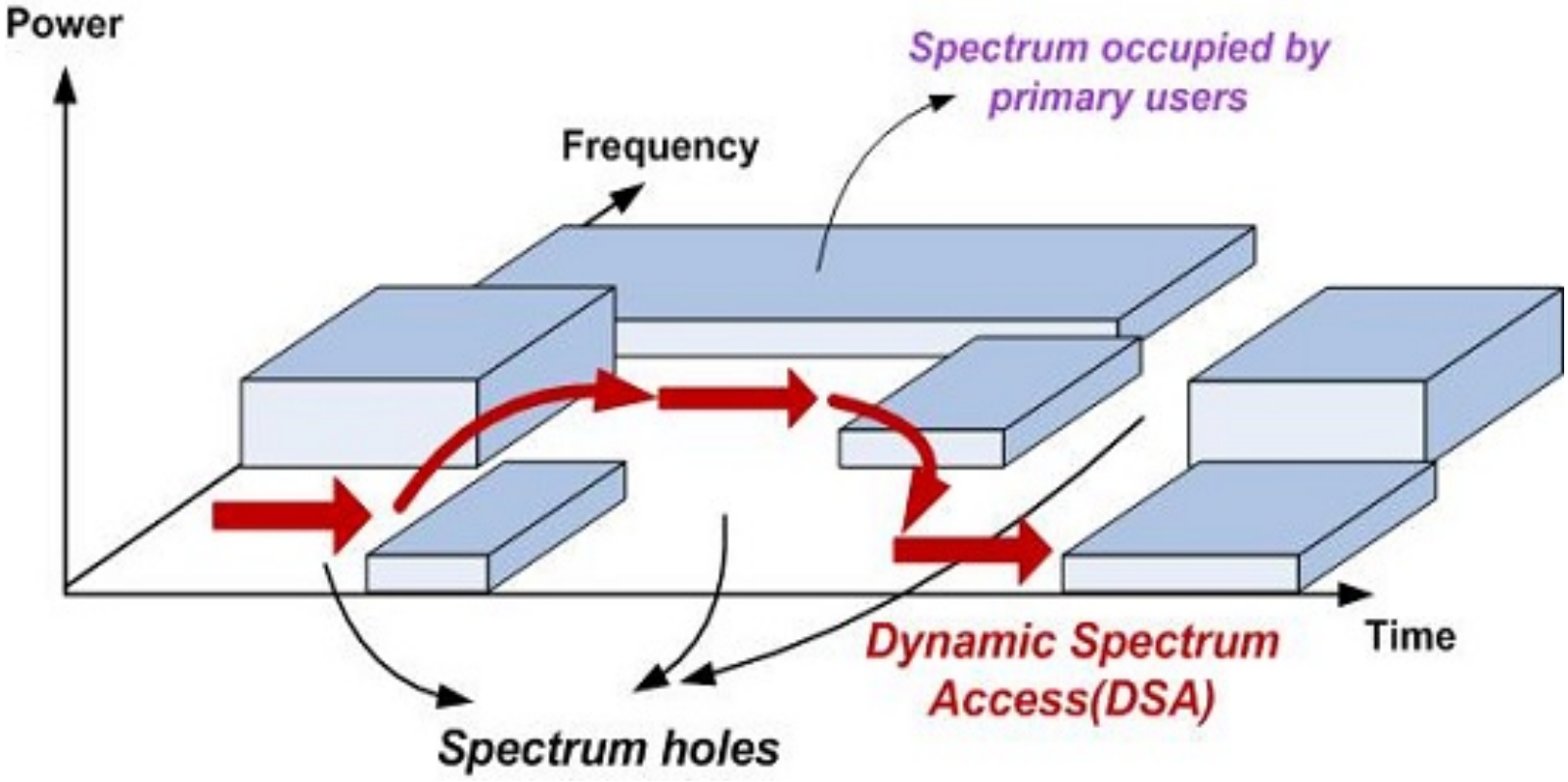
- Cognitive Radio exploits sparsity of the spectrum
- Licensed Users as Primary Users(PU)
- Cognitive Radios as Secondary Users(SU)

COGNITIVE RADIO SCENARIO



WORKING OF COGNITIVE RADIO

- These unused parts of the spectrum of primary users are known as **spectrum holes.**



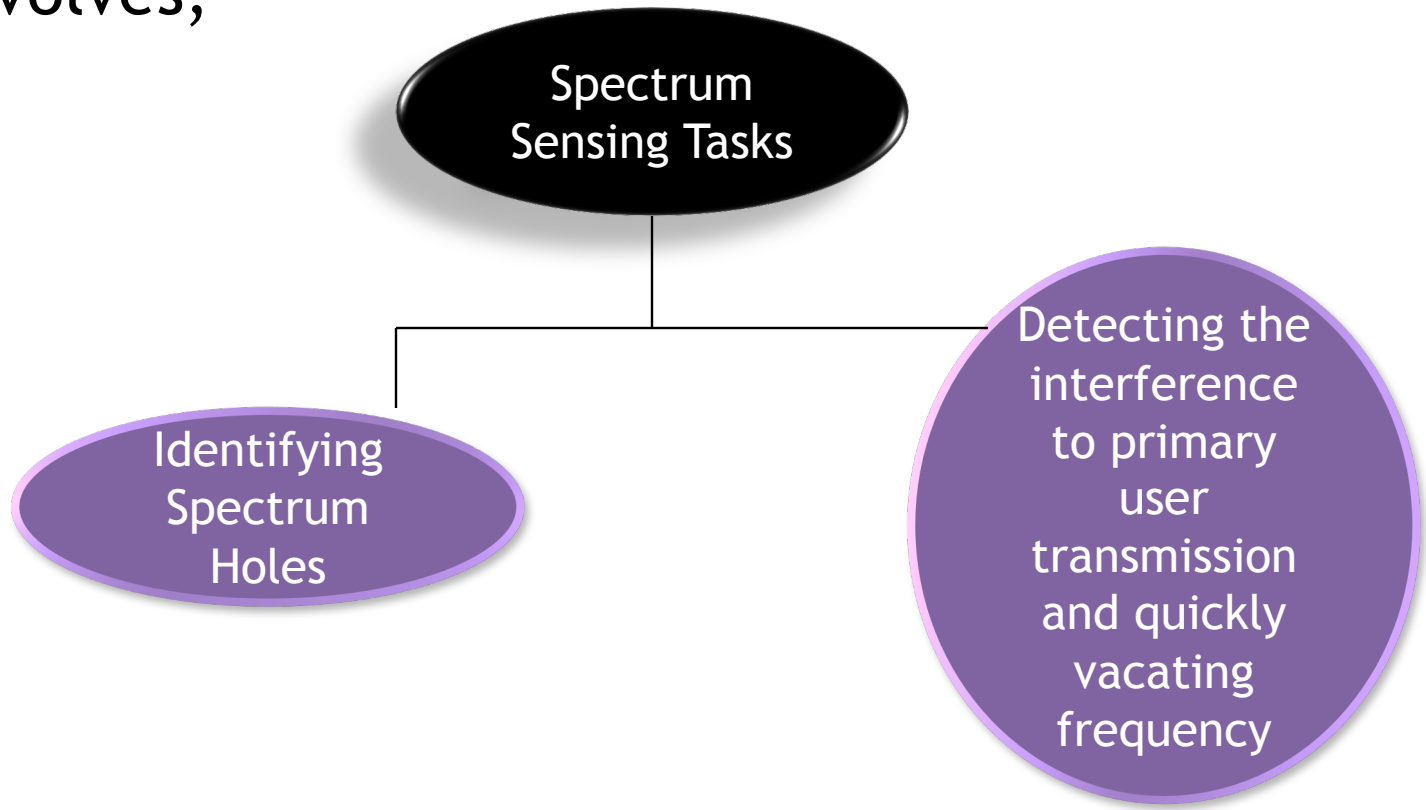
SPECTRUM MANAGEMENT

- Determine which portions of the spectrum are available: **Spectrum Sensing.**
- Select the best available channel: **Spectrum Decision.**
- Coordinate access to this channel with other users: **Spectrum Sharing.**
- Vacate the channel when a licensed user is detected: **Spectrum Mobility.**

In our project, we have simulated the spectrum sensing and spectrum hole decision making part

SPECTRUM SENSING

Spectrum sensing an essential component of the **Cognitive Radio** technology which involves,



SPECTRUM SENSING TECHNIQUES

Spectrum sensing can be done using the following methods :

1) Transmitter detection
2) Cooperative detection
3) Interference temperature detection under the transmitter detection
4) Matched filter detection
5) Energy Detection:Decision static follows chi-square distribution by false alarm and detection probability.
6) Cyclostationary detection methods

SPECTRUM SENSING METHODS

- **Standalone Sensing:** In standalone sensing, individual node senses the Power Spectral Density (in Energy Detection Technique) and decides upon the availability of spectrum for secondary user transmission.

- **Cooperative Sensing:** In cooperative sensing, a cognitive radio network is formed. They individually make a decision about the availability of spectrum and share their knowledge with each other. With the information from all the nodes, a central node then decides upon the availability of spectrum.

We simulated Cooperative Spectrum Sensing.

ADVANTAGES OF COOPERATIVE SENSING

- The hidden node problem can be addressed.
- Problem of worsening signal to noise ratios can be dealt with.
- Time required for the detection of the primary signal can be reduced .
- Reliability of sensing information is increased.

SOFTWARE USED FOR SIMULATION

- Network simulators like OPNET, MATLAB, NetSim and NS2 can be used to simulate a Cognitive radio network.

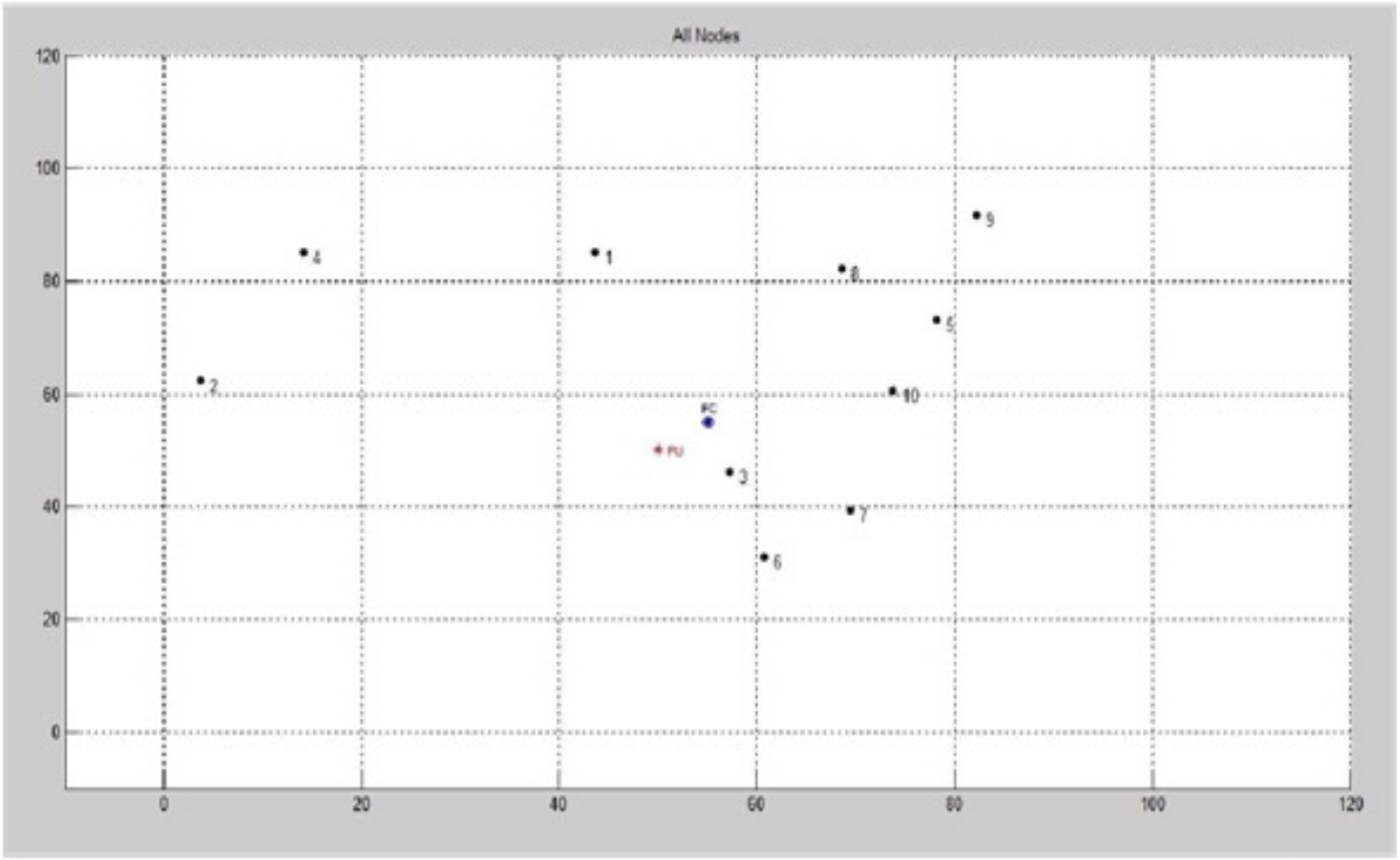
- We will be prefering **MATLAB** for simulation of the Cognitive Radio Network.

ENERGY DETECTION

- To simulate Cooperative Spectrum Sensing , the individual nodes use “Energy Detection” to come to a local decision about the presence of Primary User (PU).

- Based on the local decisions, **the Fusion Center(FC)** comes to a final decision about the presence of the primary user.

RANDOMLY GENERATED POSITIONS FOR NODES



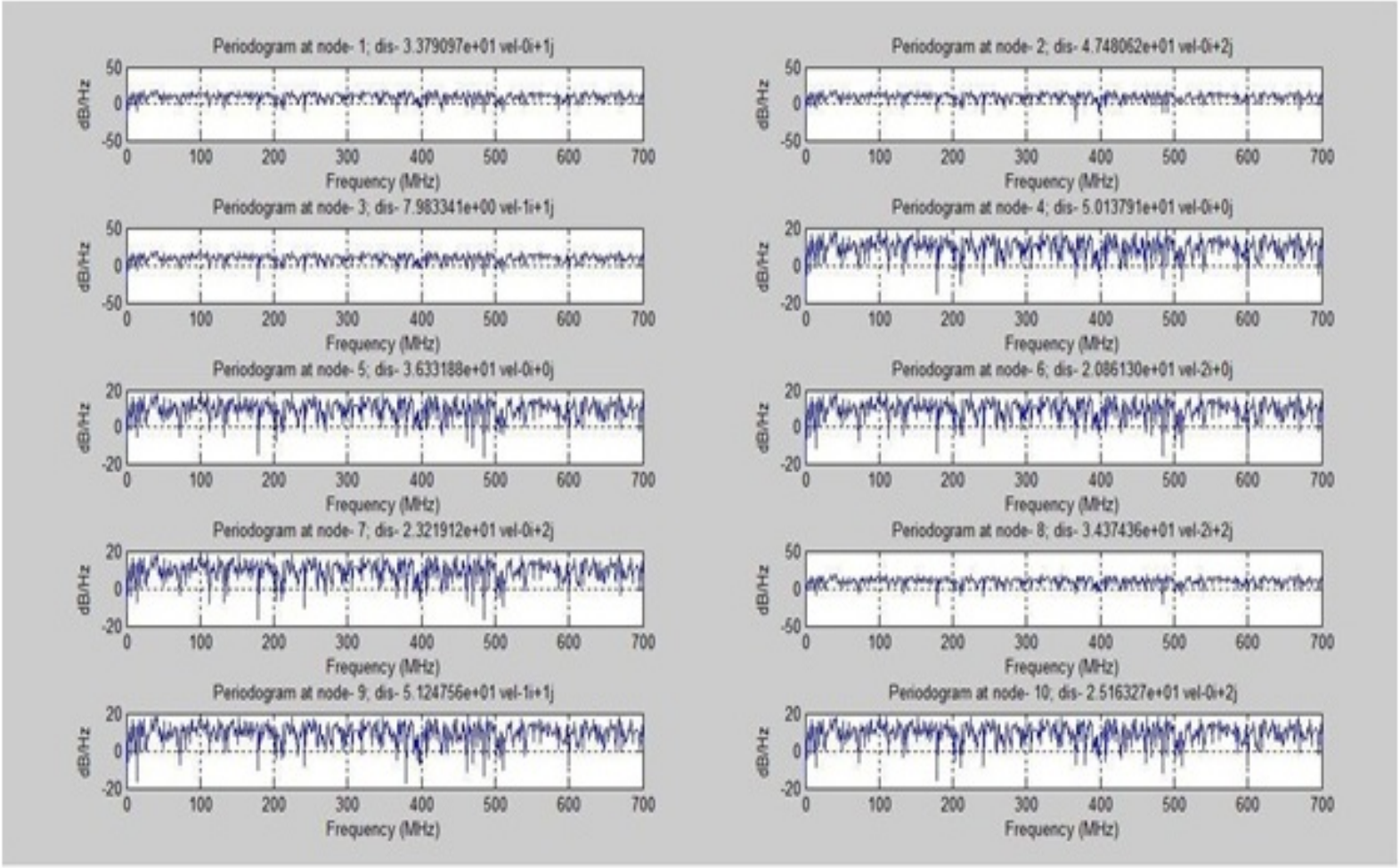
ENERGY DETECTION ALGORITHMS

1) Periodogram Generation :- It is an estimate of spectral density of the signal

2) Energy Detection:- Calculates threshold based on probabilities of detection and false alarm

3) Channel Availability

PERIODOGRAMS FOR SECONDARY USERS



FUSION CENTRE

Based upon a predefined algorithm utilizes the results from the individual secondary users and determines the available frequency bands

COOPERATIVE SPECTRUM CLASSIFICATION

- Based on how cooperating CR users that share the sensing data in the network:

1)Centralized

2)Distributed

3)Relay-assisted

WHY THIS PROJECT

- Evolution of numerous wireless applications.
- Limited Public Bandwidth or Spectrum
- Inefficient use of Licensed Spectrum
- What if one could use the licensed spectrum when no primary users are using it?

Thank you