IMPLEMENTATION OF DYNAMIC SPECTRUM ACCESS IN COGNITIVE RADIO NETWORKS

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ABSTRACT

Spectrum inefficient utilization and growing in demand of wireless services is one of the challenges facing the wireless communication systems as the spectrum is a finite resource. There is a need of better and smarter exploitation of the limited spectrum which will enables the usage and to allowing sharing of temporally unused spectrum allocated to the television broadcast service in non interfering basis, to bring broadband access to hard –to-reach low population density areas. Cognitive radio is employed as a technique in the managements and sharing of the white space (unused spectrum).

1.0 BACKGROUND

A cognitive radio network is required to adapt its transmission parameters according to the changing in its environment and therefore it must be able to determine the status of the spectrum and as well as the activity of the primary user. The network should also be capable of dynamically accessing the white space. To achieve this goal, a spectrum sensing technique is required to determine the availability of the unused spectrum portion of the primary user. Due to the rapid in demand of the spectrum and aimed to meet the demand, there was request to the communication commission to create flexibility in the spectrum management policy in order to improve both technical and economic efficient spectrum utilization

3. PROBLEM STATE

IEEE 802.22 standard is a standard that describe a physical and media access layer of a WRAN (Wireless regional Area Networks) that aimed to make use of an unused TV spectrum band also known as spectrum hole (white space) in a non interfering basis in order to bring broadband access to hard –to-reach low population density areas. IEEE 802.22 specifies that the networks should operate in a point-to- multipoint basis. A base station which is a professionally installed entity will manage its own cell in which the number of consumer premise equipments (CPE) operates. Hence, there will be another infrastructure put in place to help the unlicensed users also termed as secondary or cognitive users to make use of the TV unused portion of the spectrum band also known as the white space. All CPE in the IEEE 802.22 system must have the ability to perform spectrum sensing i.e. ability to detect signals: Digital TV signals with receiver sensitivity of -116dBm, for analogue TV the sensitivity is -

94dBm and wireless microphone signals that are as low as -107dBm. To do all entities described above, the networks must have cognitive capabilities i.e. it is a cognitive radio networks. Cognitive radio techniques will be used to allow the sharing of geographically unused spectrum holes in a non interfering basis. This problem can be solved by considering the TV spectrum licensed user as the primary user and the customer premises equipments as the unlicensed or cognitive or secondary users. A channel access mechanism is designed for this cognitive system.

4.0 CHANNEL ALLOCATION AND ACCESS

The deployment of cognitive radio networks is aiming to reuse the radio spectrum allocated to TV service in non interfering basis. Three unique opportunities have been examined. First the cognitive users can opportunistically use the TV band when there is no TV user near by, secondly when a TV station is not broadcasting and lastly there exist TV user but the cognitive user is not within the *no-talk zone* of the TV user. In this work, TV station, TV users, cognitive base station (BS) and cognitive users are referring to as primary transmitter, primary receivers, access point (AP) and secondary users respectively. A centralized dynamic spectrum access is used whereby all secondary users transmit data through the access point (AP). The access point uses information about the activity of the primary receiver to compute the appropriate transmission parameters such as transmits power on the data channel. The AP uses two radio interfaces, one for the control channel and the other for data channel. The AP transmit and receives data from both channels simultaneously while the secondary users has only one interface which can transmit and receives in either control or data channel one at a time not simultaneously

5.0 CONNECTION MANAGEMENT, ADMISSION CONTROL AND POWER ALLOCATION FOR DYNAMIC SPECTRUM ACCESS

Both BS and cognitive users performs periodic channel sensing. The sensing results from cognitive users are sent back to the BS to construct a spectrum occupancy/availability map for each geographical location. To initiate connection with the BS, the cognitive user performs spectrum sensing and identifies the available white space. Based on this white space, the cognitive user then scans for synchronization channel (SCH) transmitted from the BS, this is a beacon broadcasted from the AP to all secondary users within the cell for time synchronisation and resource allocation information. After the SCH is received, the cognitive user initiates a connection by sending the request to the BS. Based on the sensing results, the BS performs admission control test. In the presence of primary receiver, the BS determines if the secondary transmitter is within the no-*talk region* of the primary receiver. Once it's not within the *no-talk region*, the BS computes the appropriate transmission parameters such as maximum transmit power for the secondary user to maintain the target SIR at the primary receiver and these information is sent back with a clear to send to the secondary user. While if the secondary user is within the *no-talk region* of the primary receiver, the request to send of the user would be drop.

6.0 CLUSTER-BASED COGNITIVE RADIO NETWORKS AS A MEANS OF UTILIZING THE WHITE SPACE

The technique described above can only utilized the white space within the transmission range of the AP and based on the analysis, the maximum cell radius of the AP is 1.2km. To improve white space utilization efficiency and reduce congestion in channel access, a cluster-based cognitive radio network have been proposed [1][2][3]. In figure 6.1 a cluster can be formed among secondary users with an access point acting as cluster head.

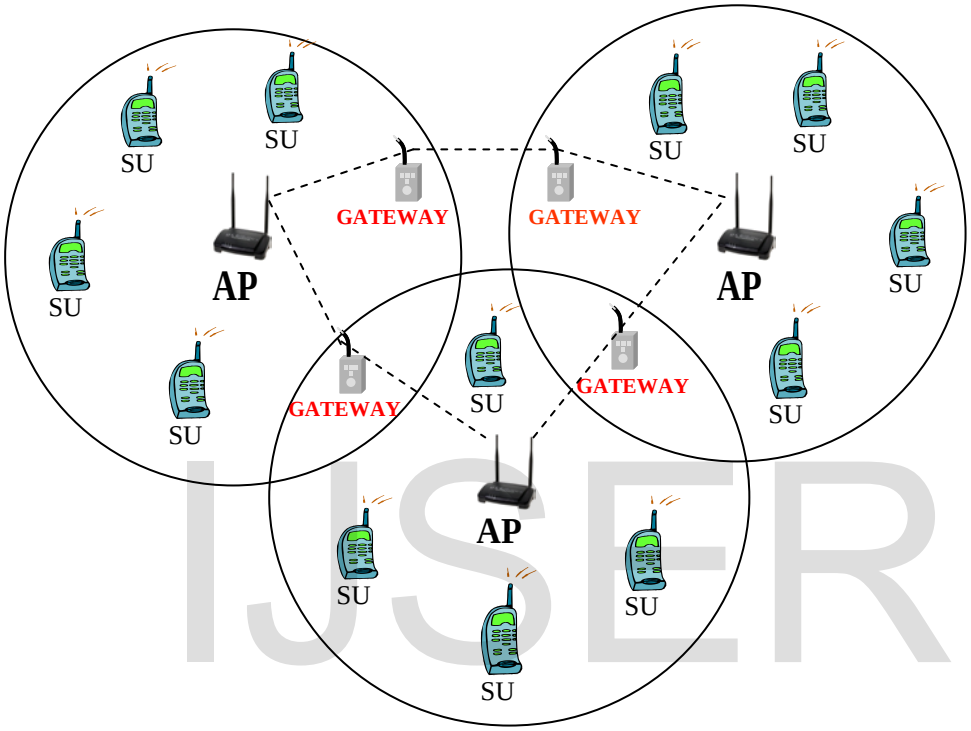


Fig 6.1 Custer-based cognitive radio networks

The clusters may be overlapping or non-overlapping. In overlapping case, there is one gateway which can communicate with the AP. In non-overlapping case, two gateways can communicate with each other, but not to directly the AP. Communications within the clusters is controlled by the AP. The AP provides supports for the secondary users to join and leave the network based on spectrum availability. Inter cluster traffic can be transmitted through the gateway.

7.0DETECTING LOCAL OSCILLATOR (LO) LEAKAGE POWER OF PRIMARY RECEIVERS VIA DISTRIBUTED NETWORK SENSORS TO SUPPORT OPPORTUNISTIC SPECTRUM ACCESS IN COGNITIVE RADIO NETWORKS

A cognitive radio network is required to adapt its transmission parameters according to the changing in its environment and therefore it must be able to determine the status of the spectrum and as well as the activity of the primary user. The network should also be capable of dynamically accessing the white space. Transmitter energy detection spectrum sensing technique have been used to design a transmit power control and ranging that will enable the coexistence of secondary users without causing harmful interference to primary users. However, transmitter detection techniques rely on receives signals from the primary transmitters. Hence, transmitter detection techniques alone cannot avoid causing interference to primary receivers and moreover, the AP must know about the presence of primary receivers and their locations since the interference occur at the primary receiver. The primary receiver usually emits local oscillator (LO) leakage power from its antenna terminal when it receives signals from the primary transmitter [4]. In order to reliably determine the location of the primary receiver, a primary receiver detection method would be used to exploits the LO leakage power instead of relying only on the signal from the primary transmitter and detects the presence of the primary receiver directly. Such an approach may be feasible when further hardware such as a supporting sensor network is deployed in the area with the primary receivers as shown in fig 6.2 below.

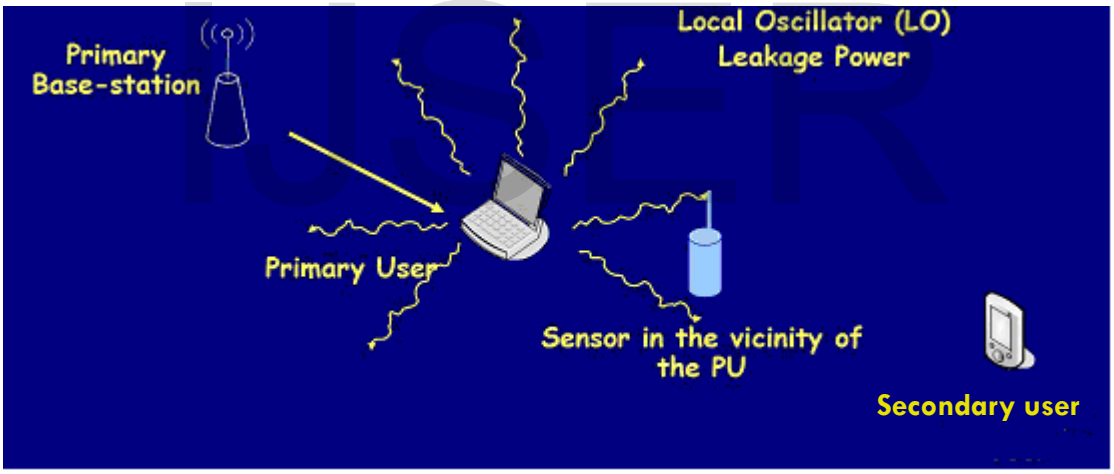


Fig 6.2 Sensor network support for cognitive radio system

Fig 6.2 above shows primary receiver emitting leakage power from its terminal as the results of signal receives from the primary transmitter and sensor measuring the leakage power. This leads to possibility of reliably locating the positions of the primary receivers or TV users and using this information gathered the cognitive network will guarantee that the secondary users will not cause severe interference that would degrade the SIR at the primary receivers.

8.0 SYSTEM ARCHITECTURE

Figure 6.2 illustrates proposed way of detecting the primary receivers. In [4], tiny low cost network sensors that would be mounted in the vicinity of the primary receivers were proposed. The networks sensors have the ability to detect low signal of local oscillator leakage power emitted from primary receiver antenna. It would then relay this information to the AP as shown in figure 6.3 below.

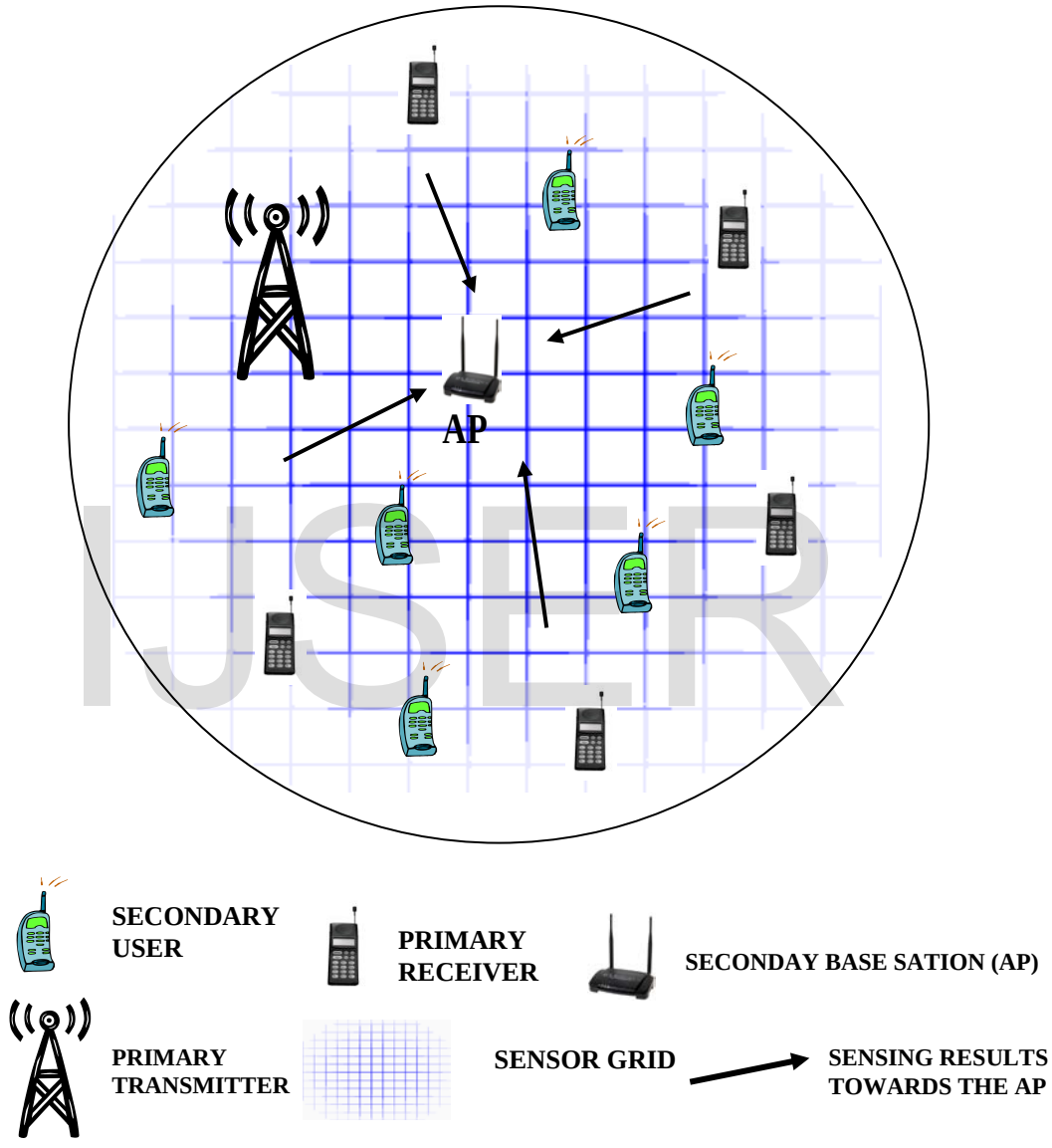
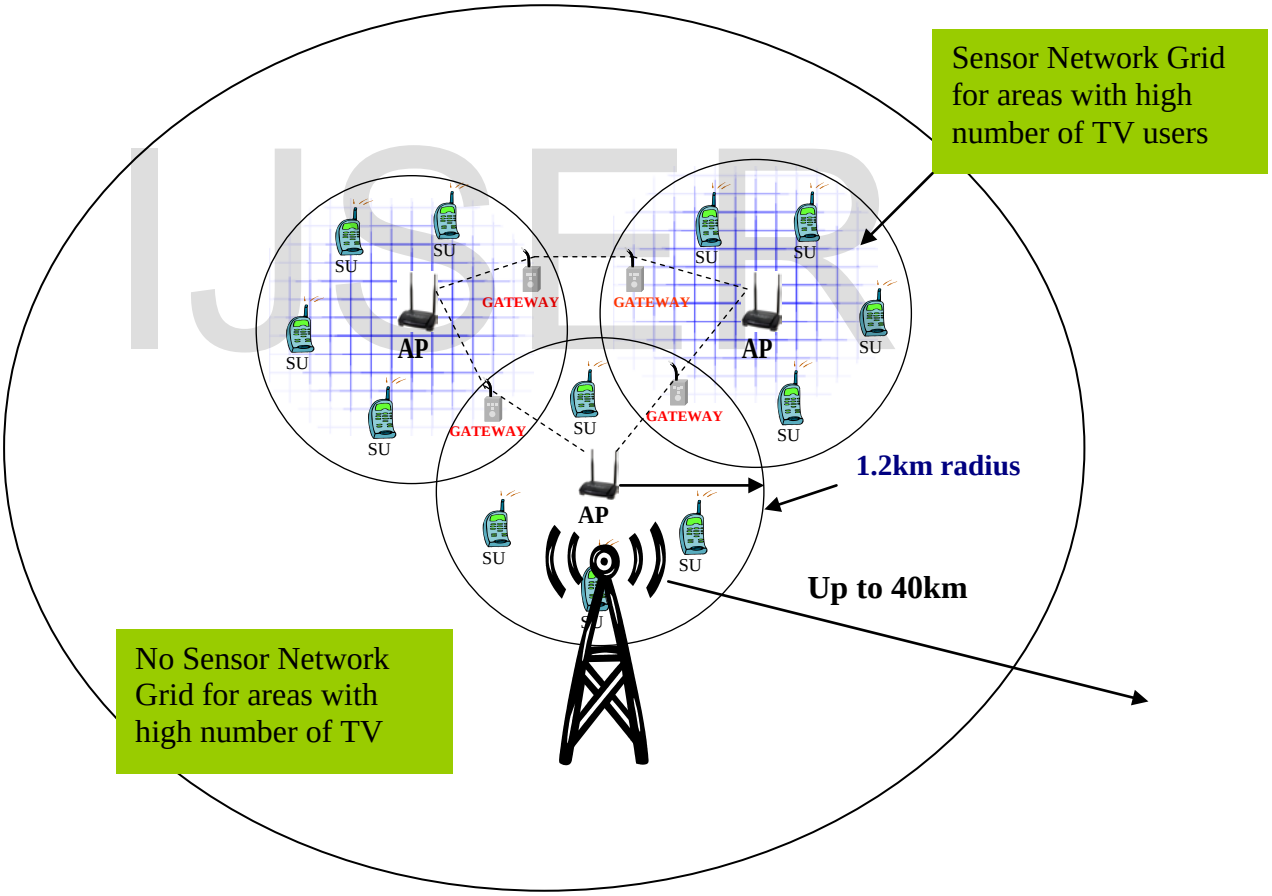


Fig 6.3: Detailed description of sensor network architecture. The primary and secondary system coexist, the sensor network is a fixed square grid.

The access point use this information for admission control by computing the relative position of the secondary transmitter to the primary receiver, and compare it with the

maximum permissible allowable transmission distance of the secondary user to maintain target SIR at the primary receiver. Since the locations of the TV users (primary receivers) may be known, the sensor network has to cover the whole area and therefore, a sensor grid is required for each cell where there is high number of TV users and where there are no TV users (primary receivers), sensor network is not required and therefore, the secondary users can access the spectrum via transmitter detection.

DEPLOYMENTS SCENARIO



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