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Energy Efficient Clustering Protocols in Cognitive Network for Better CR Performances

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***Abstract*— In modern wireless communications the spectrum is allocated to fixed licensed users and on the other side the number of wireless devices is increasing rapidly that has lead to spectrum crunch. As the spectrum is precious it has to be utilized efficiently. The solution to mitigate this problem is "Spectrum Sharing". One of the innovative approaches to recognize and access the spectrum holes present in the licensed spectrum is 'Cognitive Radio (CR)'. Spectrum sensing or sharing is a base for the performance of all functions performed by the Cognitive Radio (CR). Issues related to single CR detection are overcome by cooperative detection algorithms. Each CR user carries out sensing using ED in the sensing step to make a local decision. All local decisions are reported to Fusion Center (FC) via a band manager. Throughput problem in CSS and considered the influence of sensing and reporting duration. In extreme channel fading, channel impairments multipath shadowing or fading, spectrum sensing quality easily suffers which result in hidden terminal issue.**

***Index Terms*— Cognitive radio (CR), Spectrum sensing, LEACH, WSN, DSAC, Maximize throughput, Cluster head (CHs), Dynamic spectrum allocation (DSA)**

I. COGNITIVE RADIO (CR)

The cognitive radio is an intelligent wireless communication system that is aware about its surrounding physical environment and under a certain methodology is able to use available spectrum momentarily without interfering with the primary user who paid to be served in that area. A cognitive radio is a system that senses its operational electromagnetic environment and can dynamically and autonomously adjust its radio operating parameters to modify system operation, such as maximize throughput, mitigate interference, facilitate interoperability, access secondary markets"

The spectrum awareness is defined as multi-dimensional and mainly measures signal's presence in the frequency spectrum at a time at locations. Although other dimensions could be involved as coding or angle dimensions [7]. Spread spectrum signals or frequency hopping could allow vacant possibilities while angle dimension is made possible to account since the inclusion of smart antennas capable of detecting the arrival direction. This knowledge and awareness requires a high grade of flexibility and sensing capabilities in the radio architecture that just a software defined radio (SDR) would be able to support. The CR system has to support a dynamic spectrum allocation (DSA). This capability is a matter that involves technology, standardization and spectrum policy and requires changes in the business model. Measurements over spectrum at many different geographical locations show that the average occupancy is less than 6%. Some regions of the spectrum are more interesting than others due to technical reasons CR is moved by these commercial interests and the scarcity of the spectrum. Using intelligent systems DSA could be achieved digital technology like digital signal processing and faster processors available. Digital communication systems are more flexible and provide better bandwidth and energy efficiency than the analog counterparts. Multimedia services require voice, data and even video transfer nowadays and digital radios are suitable for this purpose.

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II. TYPES OF COGNITIVE RADIO NETWORKS

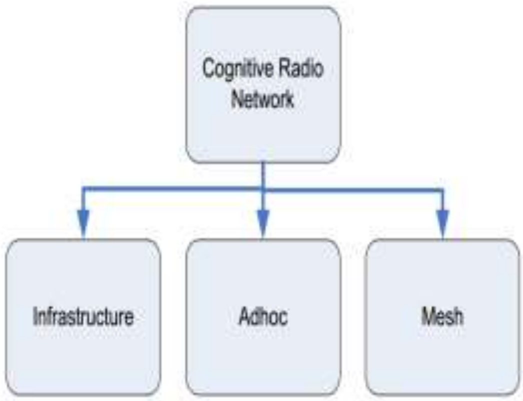


Figure 1.1: Types of cognitive radio

III. INFRASTRUCTURE ARCHITECTURE

In the Infrastructure architecture mode a CR base station is responsible for communication among the CR users of different network on hop. Different base stations are connected through backbone called Spectrum broker.

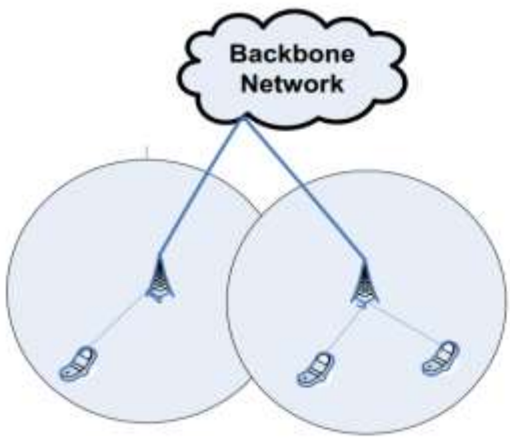


Figure 1.2: Infrastructure Networks [2]

A. AD-HOC ARCHITECTURE

This architecture is known as infrastructure less mode. In this mode CR users communicate with each other by exchanging control information in order to share the spectrum sensed through spectrum sensing process.

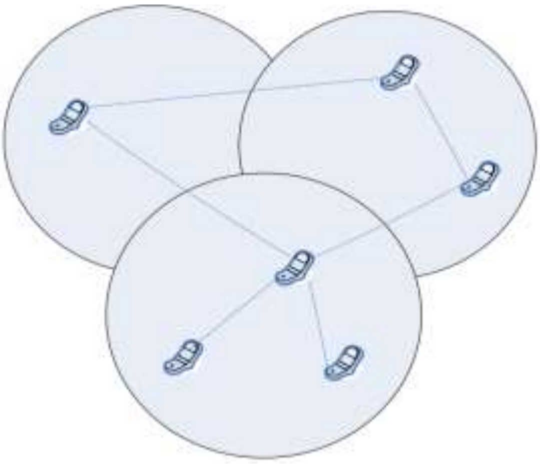


Figure 1.3: Ad-hoc Network

IV. LITERATURE SURVEY

B. LOW-ENERGY ADAPTIVE CLUSTERING

This is another step towards throughput maximization in cognitive radio, increasing the end-to-end probability of message delivery. We identity all parameters and all research has been done until we arrive at the final results which will be presented later in this report. Low-energy adaptive clustering hierarchy (LEACH) [20] is regarded as the most representative traditional algorithms. However, it can be only suitable for WSN Operating in the unlicensed spectrum band, and thus, it cannot operate with energy efficiency in CRSN. The literature [14] proposed a distributed spectrum-aware clustering (DSAC) algorithm based on the traditional K-means clustering algorithm with group-wise constraint. The algorithm initially takes each node as CHs and then merges CHs iteration until the number of CHs reaches a theoretically optimal number. However, a large number of information is intensively exchanged between nodes and CHs, which lead to the great waste of the energy in the nodes. The main objective of the LEACH is to improve the lifetime of the WSN's by trying to evenly distribute the energy consumption among all the nodes of the network & to reduce the energy consumption in the network nodes, by performing data aggregation & thus reducing the number of communication messages. LEACH selects the cluster head based on a predetermined probability & does not follow any energy efficient mechanism while choosing T(n). This approach does not take into account the distance & the residual energy of the sensor nodes to be elected as CH node. LEACH is a hierarchical, probabilistic, distributed, one-hop protocol. It is probably the first dynamic clustering protocol which addressed specifically the WSNs needs, using homogeneous stationary sensor nodes which are randomly deployed. This protocol still serves as the basis for the other improved clustering protocols for WSN. LEACH obtains energy efficiency by partitioning the nodes into clusters. The LEACH operates on rounds where each round is comprised of setup phase & steady state phase. During the setup phase the sensor nodes will select a random number between 0 & 1. If this random number is below the threshold value T(n). Then the corresponding sensor node will acts as a cluster head during the given period, called a round. LEACH distributes the role of cluster head among the member nodes in the cluster based on threshold value, which is calculated by the following formula;

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)} & if\, n \in G \\ 0, & otherwise \end{cases}$$

In LEACH-C (centralized) algorithm for the selection of CH, the same steady state phase as in LEACH protocol is used [6]. In LEACH-C, authors made an improvement over LEACH protocol such that during the rounds of the CH selection process the BS should know the residual energy level of all the nodes & location. The promising & emerging field of wireless sensor networks combines sensing, computation & communication into a single tiny device called sensor node. Through advanced & highly developed mesh networking protocols, these devices form a sea of connectivity that extends the reach of cyberspace out into the physical world. As water flows to fill every room of a submerged ship, the mesh networking connectivity will seek out & exploit any possible communication path by hopping data from node to node in search of its destination. At the same time as the capabilities of any single device are minimal, the composition of hundreds of devices offers radical new technological possibilities.

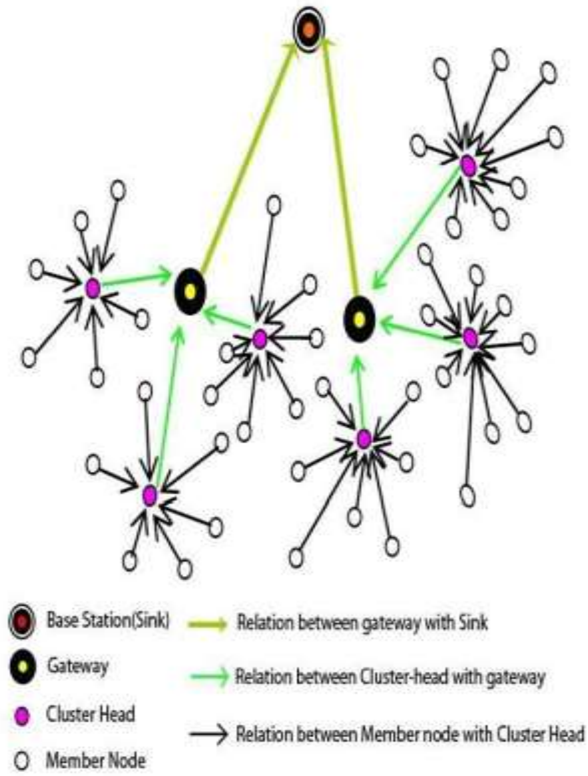


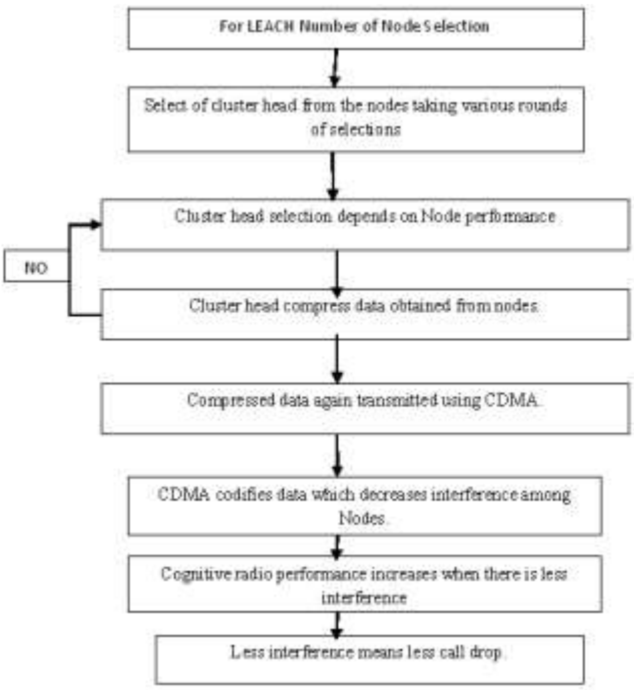
Figure 2.1 Gateway clustering concept of WSNs

Sensor node name	Micro controller	Transceiver	Program+ Data Memory	External Memory	Program	Remarks
Dot	ATMEGA 163	RFM TR1000 R	1K RAM	8-16K Flash	weC	GPRS, Blue tooth, GPS modules, sensor boards
Mica	ATmega 103.4 MHz, 8 bit	RFM TR1000 R,50 Kbit/s	128+4k RAM	512K Flash	nesC	Tiny OS support
Tiny node	Texas MSP430	Semtec SX1211	8K RAM	512K Flash	C	Tiny OS support
Rene	ATMEL 8535	916MHz radio BW 10Kbits/s	512 bytes RAM	8K Flash	C	Tiny OS support

Table 2.1 List of available prototype commercial sensor nodes

In wireless sensor networks the available power lies in the ability to deploy large number of tiny sensor nodes that assemble and configure themselves. The usages applications for these sensor node devices range from real time tracking to monitoring the ecological conditions, to omnipresent computing environments, to still monitoring of the health of structures or equipment's [10]. It can also control actuators that extend control from cyberspace into the physical world [9]

FLOW CHART FOR THE PROPOSED RESEARCH



V. CONCLUSION:

We described LEACH, a clustering-based routing protocol that minimizes global energy usage by distributing the load to all the nodes at different points in time. LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station. LEACH is completely distributed, requiring no control information from the base station, and the nodes do not re-quire knowledge of the global network in order for LEACH to operate.

VI. SCOPE OF FUTURE WORK

Performance analysis of two stage spectrum sensing technique based on timing can be carried out. CMME can be used to estimate the noise variance and fed it back to ED to enhance the performance of first stage in two stage spectrum sensing technique.. Real-time measured data can be used to check the detection performance.ˆ Under Optimal Cooperative Spectrum Sensing, the weights can be optimized by using evolutionary optimization techniques like Particle Swarm Optimization (PSO), Infeasibility Driven Evolutionary Algorithm (IDEA) etc to obtain better Probability of detection (*Pd*) Arising from a logical evolution of the control processes of a software radio, cognitive radio presents the possibility of numerous revolutionary applications, foremost of which is opportunistic spectrum utilization Cognitive Radio Technologies (CRT).

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