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A Short Preamble Cognitive MAC Protocol in Cognitive Radio Sensor Networks

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Abstract - *There are several difficulties in today's spectrum environment, but one of the most pressing is the lack of available spectrum. Cognitive radio is an ideal technology for this purpose since it can pinpoint the available bandwidth without disrupting the experience of key users. Cognitive radio capabilities makes sense in sensor networks, leading to a novel sensor networking paradigm known as cognitive radio wireless sensor networks (CR-WSNs). CR nodes may get access to the channel and make efficient use of white space thanks to MAC protocols. It also guarantees that the spectrum's dynamics aren't too intense, which in turn necessitates closer interaction across MAC protocols.*

***Key Words*: Cognitive radio, wireless sensor network, MAC protocol, CR-WSN**

1. INTRODUCTION

The noun "Cognition" is where the term "cognitive radio" originates. Knowing, learning, and comprehending are mental processes that constitute this. In order to boost the overall system capacity, researchers are now investing in various approaches of employing cognitive radio to utilise more locally underused spectrums. Smart and aware of its physical surroundings, cognitive radio is an intelligent wireless communication technology. The primary objective of a cognitive radio network is to make efficient use of the unallocated frequency spectrum without negatively impacting licenced users. Wireless sensor networks have several benefits. Cognitive radio and wireless sensor networks (CR-WSN) may be integrated into a single system. With so many nodes to coordinate, wireless sensor networks often need a wide deployment area. That's why when we combine them, we get better results and additional features. Self-organization and long-term operation of wireless sensor nodes are other key features.

We are aware of the existence of several levels, each serving a distinct function in the grand scheme of things. The seven levels of an operating system are as follows: Physical, Data Link, Network, Transport, Presentation, and Application. The Media Access Control (MAC) layer, part of the data connection stack, will be our focus. The data link layer's role is to establish communications between nodes inside the same network. The logically lower tier of the data link stack, which includes LLC and MAC. The COGMAC protocol is our exclusive attention to the mac protocol for cognitive radio.

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2. BRIEF OVERVIEW OF COGNITIVE RADIOTECHNOLOGY

By fusing radio with networking, the technology known as "cognitive radio" (CR) maximises the potential of available airwaves. CR is proposed as a way to efficiently repurpose licenced spectrum in order to address the problem of congested networks. There are two basic types of users in a cognitive radio network: primary users (PUs) and secondary users (SUs). PUs are free to utilise the channel for as long as they see appropriate. When PUs (also known as cognitive users or SUs) no longer have a need for their spectrum, they might lease it to other users. When SUs use the shared spectrum, it does not interfere with PUs' devices.

General Architecture of Cognitive Radio

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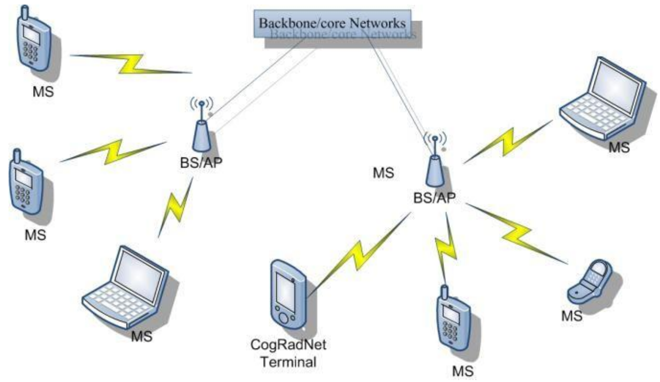

Fig -1: infrastructure architecture [4]

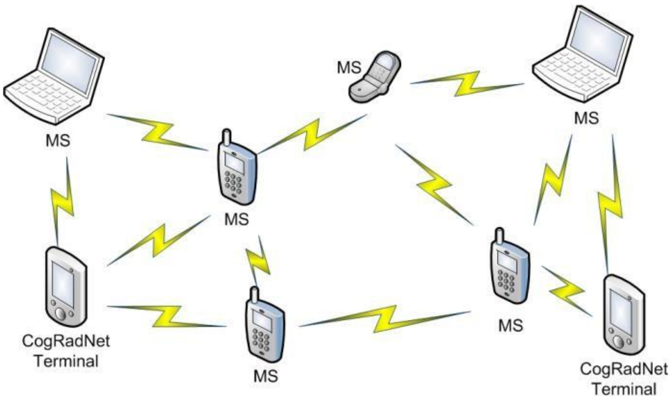

Fig -2: ad-hoc architecture [4]

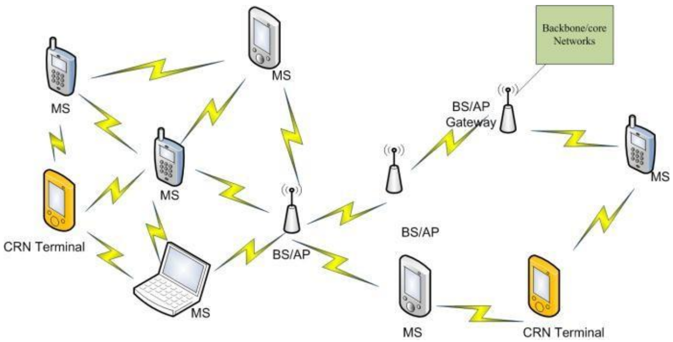

Fig -3: mesh architecture [4]

3. WIRELESS SENSOR NETWORK

The purpose of a Wireless Sensor Network (WSN) is to monitor our environment by linking together dispersed, autonomous sensors. The autonomous sensors are equipped with a radio transceiver to allow for wireless communication between multiple wireless sensor nodes. The WSN architecture is simple, as shown in Figure 4. A WSN is composed of hundreds of WS nodes dispersed throughout the sensor landscape. Most networks have nodes that are more than a few yards apart. The data from WS nodes may be gathered by the sink node/base station in a single-hop or multi-hop mode. The sink node then forwards the data to the consumers through a gateway, the internet, or routers.

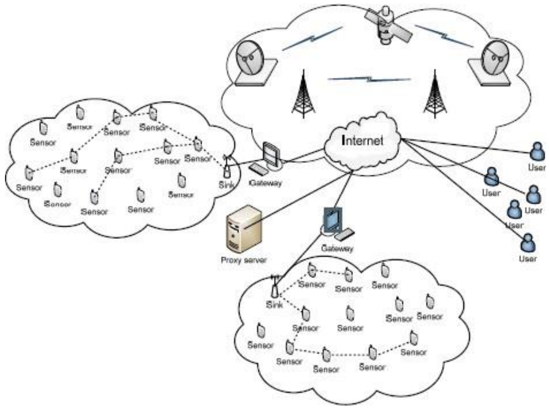

Fig -4: conventional wireless sensor network (6)

4. COGNITIVE RADIO WIRELESS SENSOR NETWORK

In a Cognitive Radio Wireless Sensor Network (CR-WSN), wireless sensor nodes dispersed throughout a network exchange data about an incoming event signal via multi-hop, dynamic communication utilising any of the accessible spectrum bands. Nodes in a CR-WSN will choose the best available channel as one becomes available, name it, and then make room for authorised users. Once an end-to-end connection has been established, CR-WSN is able to maximise spectrum utilisation and take care of fulfilment, both of which boost system performance.

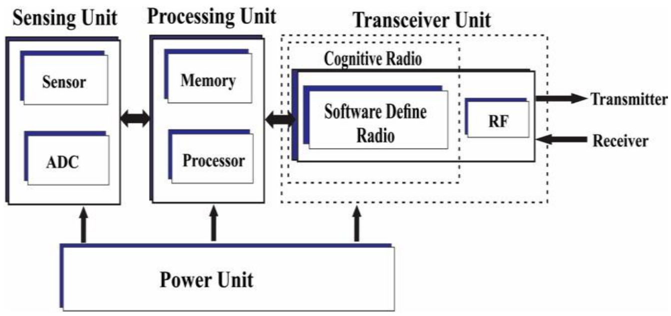

Fig -5: hardware structure of CR-WSN (6)

5. CLASSIFICATION OF CR MAC PROTOCOL

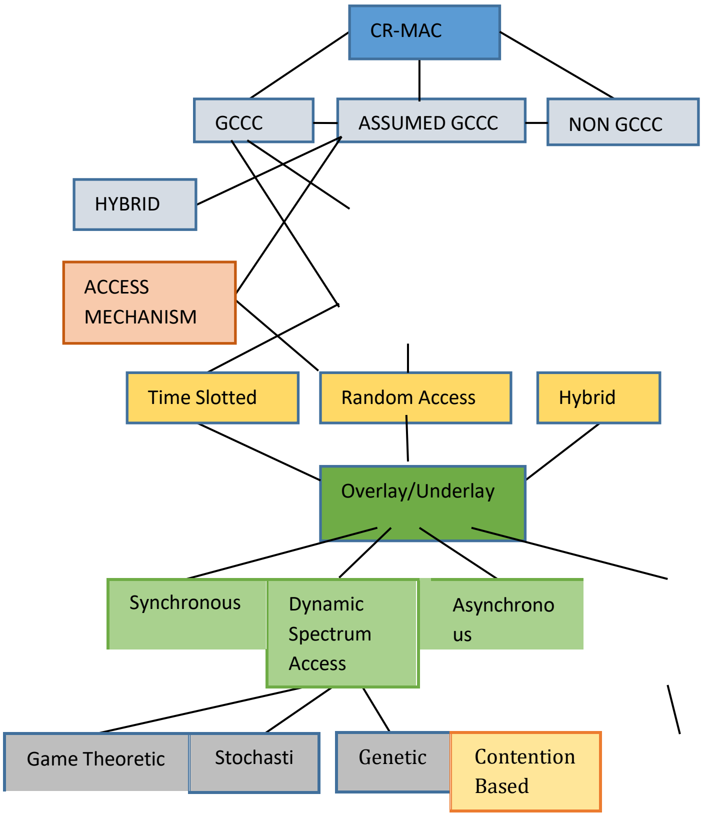

Fig -6: classification of CR-MAC protocol

6. INTRODUCTION of COGMAC PROTOCOL

COGMAC is an MPR-based, distributed cognitive mac protocol. It was developed to make the most of PU's inherent performance qualities. The obvious benefit of COGMAC is that it does not rely on a MAC protocol, while traditional MAC protocols do. COGMAC works effectively in both licenced and unlicensed bands.Decentralised MAC techniques are preferable when exact spectrum opportunities are difficult to forecast and cooperation from PU is doubtful. In the event that a PU has to free up a channel, our MAC solution will use machine learning to make a weighted decision on which alternative channel to use.

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6.1multichannel preamble reservation (MPR)

In order to avoid the rendezvous issue and ensure uninterrupted transmission, the MPR technique is used. To do so, it is necessary for the receiving node to constantly monitor all open channels in order to identify any possible broadcasts. A node's channel pool refers to its collection of accessible channels. This is why the process of feeling these channels one by one is known as pool sensing. In order for us to occupy the channel, the transmitting node must send numerous copies of the same frame in a row. In order for its transmission to be picked up by nodes during pool sensing. Repetitive frame transmission is the sending of the same frame many times. Both RX1 and RX2 pick up the signal and get a full picture, as seen in the image. However, the procedure is hampered by the fact that it takes too much time to finish. The COGMAC+ protocol is an alternative that potentially address this issue.

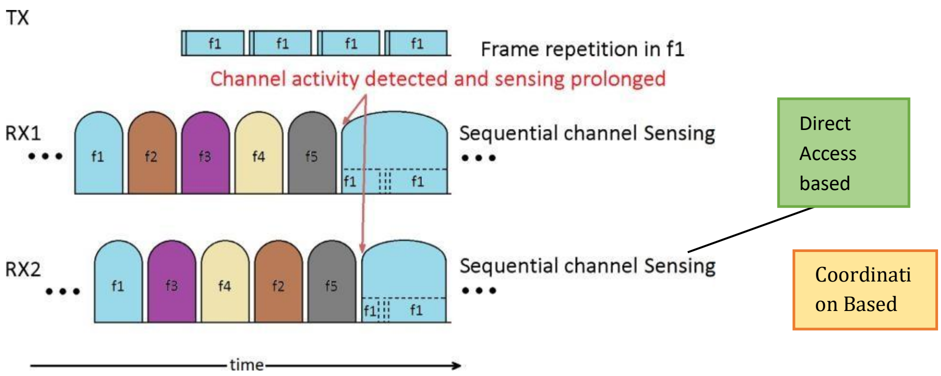

Fig -7: MPR scheme (7)

7. COGMAC+ PROTOCOL

Based on the current state of the carrier sensing, the false positive ratio, and the predicted noise level, the energy detection threshold is adaptively adjusted in COGMAC+. We must reduce frame repetition to efficiently accommodate increased data flow. COGMAC+'s aggregation transmission mode, which begins immediately after the reserving channel, involves the constant transmission of frames without any repletion.

multichannel multi-frame transmission (MMT)

MMT solves heavy data traffic. We limit the parameter and proceed. Frame-based analysis improves performance in this approach. We optimise protocol speed and Pus protection using multiple constraints. MMT scheme is MPR scheme improved.

Considering the minimal duration between twosuccessive frames inter_Fr, we have,

$$N_{PU} = \frac{t_{PU} - t_{RX\_mode} - t_{TX\_mode} + t_{inter\_FR}}{t_{Fr} + t_{inter\_FR}} \quad (1)$$ [7]

NPU is the maximum number of frames permitted in a PU permission period. CCA1 operation time must be constrained below to prevent missing recurrent frame transmission.

$$t_{CCA1} > t_{TX\_mode} + t_{RX_{mode}} + t_{CCA2} \quad (2)$$ [7]

CCA based random back-off scheme

Channel Collision Avoidance (CCA) prevents collisions, a major issue. Nodes wait randomly. Random back off scheme unit time is (CCA1 + channel switching period) in COGMAC+. It promotes protocol portability.

noise floor estimation

NFE is done during carrier sensing. It usually compares carrier power to a preset threshold.

Low detection thresholds allow low transmission power or long-range devices to interact.hence it produces high false positive frame detection ratio and extra delay. Unnecessary delay causes issues.

High detection thresholds reduce communication range, another drawback. Thus, every gadget needs a threshold. Fix detection threshold is ineffectual and immovable.

One approach is false positive detection ratio and range, while maintaining protocol stable at run-time. No noise or gearbox expertise is needed. Node may dynamically alter threshold depending on factors.

NFE and AEDTA are the two approaches. If channel is idle, NFE updates noise level during carrier sensing. AEDTA constantly lowers the threshold to enhance detection range. Both work during channel idleness.

8. SUMMARY

This study reviews cognitive radio network medium access protocols. Cognitive radio improves spectrum utilisation and communication quality via opportunistic spectrum access and channel adaptation. Resource-constrained sensor networks may use these quiet characteristics. Cognitive radio's various channel availability may also solve sensor network's dense deployment and busty communication issues.

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