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An Overview of Radio-based Cognitive Wireless Sensor Networks a New Sensor Network Paradigm

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Abstract:- In the Last two decades Research related to WSN has tremendous increase . There are many area where the Wireless Sensor network used like Military Navigation System, Monitoring of health care, Exploration in Oil field, Monitoring of Nuclear Power Plant, Surveillance of under Water Activities and Geo informatics. There is over crowding of band due to which increased demand of Communication Channels with in this band as well as there is increase development of Wireless sensor network using the unlicensed spectrum band i.e. ISM - industrial scientific and Medical. There is the main issue in sensor network is to minimize Consumption of Energy without undermining the QoS (Quality of Service) provisioning of Network. It is fact that the problem with Scared Spectrum in unlicensed band and WSN application of Short Network lifetime rocking can be mitigated in the Unlicensed band with the paradigm shift in Wireless Comm. towards CR Technology. We present in this paper A radio based cognitive Wireless Sensor networks, A design Concept is proposed for this new sensor network paradigm. We highlight the some possible prospects and development and deployment challenges of paradigm in sensor network. We believe that this will give the direction for the next generation application in Sensor network.

Keywords**:** *Channels, CR-WSN, Spectrum, Next-generation, Communication, Energy Sensing*

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I. INTRODUCTION

In the modern word the Human life is more dependent on Communication Network. There are various Application like Security networks, Social networking, Educational research, Commerce and trade and development network. In Wireless communication there are some leading areas for development and research are mechanism and techniques to implement the cost effective and efficient utilization of spectrum of radio frequency and energy. It is consider that the radio frequency spectrum is more expensive and scare resources among all recourses of Wireless Network, It is more concern about energy consumption, the sensor devices of battery powered, especially in low energy [2]. It is observed that security issue with frequency spectrum is mainly due to static spectrum assignment policy adoption – that policy gives RoU (Right of Use) to User having licensed of Licensed Spectrum. This right exclusive led the scarcity of spectrum in band of licensed Spectrum, while there is a over clouding of network operators in unlicensed band because number of user increased in this band.

Wireless Sensor Network (WSN), consists of sensor nodes, which primarily performs the function of monitoring physical quantities in a given environment within which they are deployed [15][2].There are sensor nodes WSN (Wireless Sensor Network), these node monitoring the physical quantity of that environment in which they are placed. [16,01]described It is ad hoc network as self organized, compare no. of sensor nodes randomly or uniformly distributed in a given area. According to [11] , WSN operates in the unlicensed overcrowded radio frequency spectrum band. The 2.4 Ghz band availed for unlicensed user. Wi-fi, wireless microphone, Bluetooth and microwave oven used the same band. this is the proof of that band is overcrowded and it is showing negative impact on WSN general Performance in this band. Effectively in high density populated area where traffic density of communication is high.

However in Spectrum Access in new paradigm and the advent of Cognitive Radio Technology used in Licensed Band brought. In [4] Haykin explain Cognitive Radio as radio which is capable of its of being aware of its learning, Surrounding and adaptively changing its operating parameters in real time efficient communication to providing reliable ubiquitous spectrally by the object. The main 3 features of cognitive radio are Re Configurability, self awareness and smart adaptive behavior. These three features static spectrum utilization and allocation have give the path to a dynamic spectrums efficient utilization and access. Access of dynamic spectrum allows all unlicensed users (SU- Secondary User) the licensed band optimization belong to Primary user (PU) while the availability of primary user is not in currently scenario. In [14], cognitive radio utilize the recourses of under utilized spectrum along time and provide efficient dynamic spectrum access and frequency.

In Cognitive radio Technology there is the advantages of the Optimistic Access of Spectrum, WSN have the potential of working at lower licensed band of spectrum. Due to range extension efficient spectrum use at high energy efficiency in TV band[1]. A CR WSN (cognitive radio based wireless sensor network) or CRSN (cognitive radio-based sensor network) is a multichannel wireless network in which the sensor nodes dynamically adapt themselves to the available communication channel [5].

II. OVERVIEW OF TRADITIONAL WIRELESS SENSOR NETWORKS

At global Concern WSN are becoming popular area as second, after the internet. There are low cost electronics device known as sensor node having autonomous behavior

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and low cost used by wireless sensor network. The sensor node are capable for sensing remotely, processing and communicating in ad-hoc manner. These sensor node can sense quantities of physical worlds like pressure differentials, light intensity, moment of object, level of noise, change in temperature, sound intensity.[1] In a practical WSN the sensor need not to be uniformly distributed over the region but, they made a multihop network that communicate through Mesh Networking in order to complete a particular set of objective. There is no particular limit count of sensor node that should make sensor network while the nodes are few in number. In a particular geographical region the count of sensor node could be hundreds of thousands to sense a certain ambient condition by a given WSN. Although the Concept of WSN has been around for some time, it is still now recognize as developing technologies where more development and research area is open.

According to [3] in earlier technology of sensor network as SOSUS (Sound Surveillance System). The soviet unions submarine used this system acoustically during the Cold War era[3]. The wide range of application with increased processing capabilities Wireless Sensor Network have this time.

According to [8] WSN fields with capabilities of prolonging network lifetime. in [13] Operation mode selection scheme was proposed for the purpose of energy efficiency. As described earlier, Wireless Sensor Network is a self organizing ad-hoc network with sensor nodes disperse in a sensor location that is called sensor field. Each of the nodes reporting to the coordinating center, which could be a sink node or base station and collect data from the environment. The sink node can be used to sent for external device, the information provided by sensor node. It performs function as node organization, data aggregation , status assignment which are function of local network management. A typical wireless network architecture is described by Figure - 1.Because of better quality provided by the network and consumption of minimum energy this architecture is mostly adopted for Wireless Sensor network, due to which the network life will increase. The Unique features of an Ad-hoc Network of WSN are summarized in Table-1

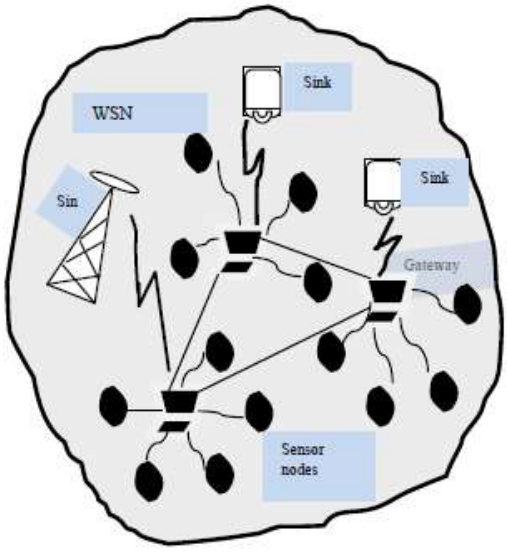

Fig 1: A Model of Simple Wireless Sensor Network

Table 1:Unique features of Wireless Sensor Networks

Characteristics	Explanation
Traffic Distribution	Depending on the type of application and the location pattern of communication traffic in sensor network is differs.
Node Mobility	Generally, no mobility or sensor nodes are designed for limited.
Data Fusion	As a result of power constraint and limited bandwidth, it becomes necessary to aggregate packets into one before relaying it to the monitoring node. This operation reduces media access delay bandwidth and consumption resulting from multiple packet transmission.
Deployment Density and Network size	Terminal density in a sensor network depends on application area and the region of deployment. The number of terminals in a sensor network ranges from three to several thousands.
Power constraints	This is a very stringent constraint in Wireless Sensor Network because sensor nodes operates in a remote location with minimum or no human intervention. It is important to develop energy efficient protocols which will guarantee a longer battery life of the sensor terminals.

III. TECHNOLOGY USING COGNITIVE RADIO

The concept of CR (Cognitive Radio) was first introduced by Mitola in [6]. Cognitive radio Technology use recourses of Wireless Network communication System more efficiently. Cognitive radio allows opportunistic use of the licensed spectrum band by an unlicensed user with minimum allowable interference to the licensed user and without compromising on the desired quality of service required by the unlicensed user. Following characteristics are showing at the heart of CR development;

- Agility and Flexibility: This is the ability to change the waveform and other radio operational parameters while on the move.
- Sensing: This is the ability to measure and observe the state of the radio environment and spectral occupancy. For the device to change its operation based on the current knowledge of the RF environment, sensing is very necessary.
- Adaptability and Learning : This is the ability to analyze sensory input, to recognize

With these characteristic features, Cognitive Radio has the capability to determine vacant band and sense the spectrum [5]. And by changing its operating parameters, Cognitive Radio can make use of the available sensed band in an opportunistic manner. This makes it possible for Cognitive Radio to operate both in the licensed and unlicensed bands of the radio spectrum. Figure 2. shows the simplified CC

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(Cognition Cycle). Cognition Cycle is an important concepts used in CR technology. The CC depicts how the CR responds to external boost within its radio environment. The CR senses and observes its operating environment in the observe state. It then orients itself in accordance with the sensing outcome. Depending on whether the outcome of the sensing requires immediate priority, urgency or normal transition, the orient state can transit to Act, plan and decide states respectively. In the plan state, most boost are dealt with deliberatively rather than reactively. An incoming network message would normally be dealt with by generating a plan, which is the normal path. The Plan phase should also include reasoning over time. Normally, deliberate responses are preplanned, while reactive responses are learned by being preprogrammed or informed. In the decide state, the radio decides on one of the various plans. The outcome of the decision leads to an action such as resources allocation in the act state. In the act state, a particular chosen action is executed, while the consequence of the chosen is learnt in the learn state. Learning is a function of the other states of the cognition cycle. Initial learning is controlled by the observe stage in which all sensory perceptions are continuously compared with all prior experiences to continually evaluate occurrences and to remember time since last occurrence of the stimuli from primitives to aggregates.

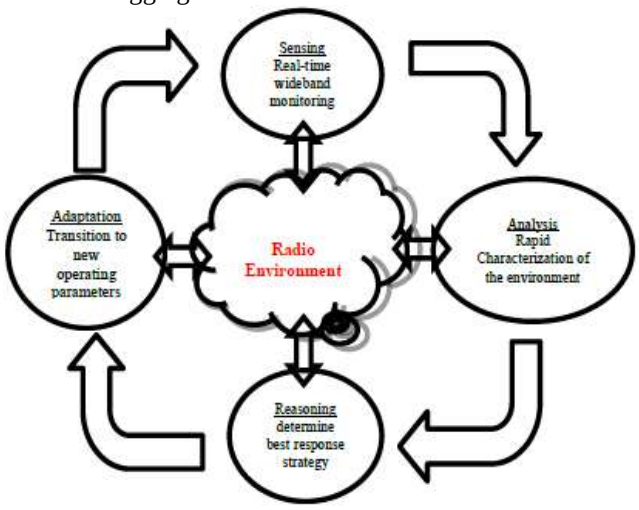

Figure 2 : - Cognition Cycle

IV. CONCEPTUAL DESIGN OF COGNITIVE RADIO WSN

4.1 Cognitive Radio Network Architecture

As stated in figure 3, Cognitive Radio Sensor Network model consists of unlicensed secondary user trying to use the licensed band when the primary user is not available and a licensed primary user operating within a licensed band. CRWSN (Cognitive Radio Wireless Sensor Network) is a distributed network of wireless cognitive radio sensor nodes, which sense an event signal and collaboratively communicate their readings dynamically over available spectrum channel in a multi-hop manner, ultimately to satisfy the application-specific requirements [1]. This is the next generation sensor network paradigm. Most Wireless Sensor Networks applications operate under IEEE 802.15.4 standard and operates under unlicensed band. The generally used unlicensed band for Wireless Sensor Network operations is the 2.4GHz band. This is due to low cost operating and flexibility within this band. However, in recent time, the unlicensed band has become over crowded with other wireless networks such as WLANs, Wi-MAX and WBANs operating within this band. This leads to the building of CRWSN in order to solve the problems related to coexistence of multiple networks in the unlicensed spectrum band. The low spectrum utilization in the licensed spectrum leaves a large amount of resources for Wireless Sensor Networks to serve traffic with strict quality of service requirements. Without having to access dedicated licensed spectrum, it is possible to build Wireless Sensor Networks with a minimum cost. There is little restriction on the air interfaces, coverage area and network topology. Medium Accesses Control protocol and resource allocation can be designed based on specific application requirements and network conditions in order to meet various Quality of Service requirements.

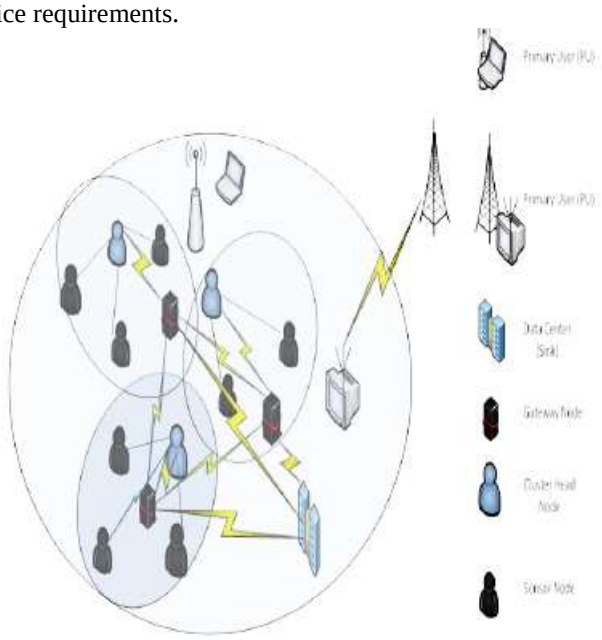

Figure 3 - Network Modal of CRWSN

4.2 Hardware Structure of Cognitive Radio

The CR based sensor network hardware is composed of the processing unit, the cognitive radio power unit, sensing unit platform and the RF unit. As shown in figure 4. For application specific network, there could be present mobilize unit and location finding unit. CRSN is different from the traditional wireless sensor node basically with the presence of the RF unit of the cognitive radio sensor nodes. The cognitive engine enables the CR sensor nodes to dynamically adapt their communication parameters. As promising as this hardware architecture is in terms of dynamic spectrum access for sensor nodes, there are noticeable challenges posed to a resource-constrained wireless sensor networks. WSN are constrained by resources such as Low Complexity Processing device , power, memory and communication. As a result of these limitations, the cognitive radio capability is also affected.

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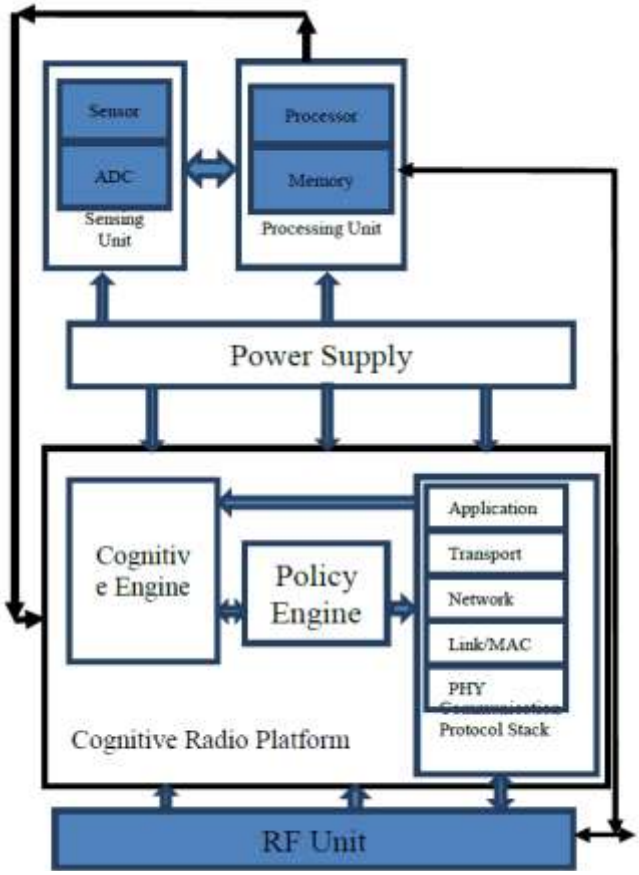

Fig 4: Hardware Architecture of a Cognitive Radio WSN

For instance, it will be necessary to consider low energy consumption spectrum sensing design and energy saving protocols in order to prolong the network lifetime. That's why , we suggest that for a better system architecture for Cognitive Radio WSN, there should be adaptive, dynamic Medium Accesses Control protocol using reinforcement learning technique. Also, there should be cross-layer energy management protocol integrating the physical layer and the MAC layer.

4.3 Cognitive Radio-based Sensor Network Topologies

CR based sensor networks are application dependent. Therefore, depending on the application requirements, different network topologies are being proposed. As shown in figure 3., Clustered Topology - a cluster-based topology is appropriate for effective operation dynamic spectrum management in Cognitive Radio WSN. Normally, it is important to dedicate a special channel to exchange various data like spectrum allocation data, spectrum sensing results, licensed user control and discovery information. In certain area of application, it may not be possible to find such a specific channel throughout the network. However, it has been shown that finding a specific channel in certain restricted application area is possible by using space correlation of channel availability. In cluster-based topology, some sensor nodes are elected as cluster head, i.e. the leader of the cluster. The cluster head may be assigned other responsibilities such as local bargaining of spectrum and spectrum sensing. Therefore, a new cluster head and cluster selection algorithm should be developed for cognitive radio sensor network taking cognizance of the resource constraint nature of the network. Hierarchical heterogeneous Topology: It is possible to introduce hierarchy into the network, whereby special nodes equipped high power source capable of longer transmission range. These terminals may be used as relay nodes such as available in mesh networks. This gives rise to a hierarchical topology and heterogeneous consisting of ordinary Cognitive Radio Sensor Network nodes, high-power relay nodes and the sink. The introduction of the heterogeneity brings about additional challenge in the face of the efficient dynamic spectrum access benefits brought about by the special nodes in the network. Problems i.e., increased communication overhead, special sensor and deployment of sensor needs be resolved in this topology. Ad-Hoc topology: This is an infrastructure less topology. The terminals communicate directly with the sink in a multi hop ad-hoc fashion. Spectrum sensing may be performed by each node individually or cooperatively in a distributed manner. Although, with this type of topology, communication overhead is no problem. However, hidden terminal is a challenge that needs be overcome as it leads to error eventual performance degradation of the primary user network and in primary user detection.

V. POTENTIALS AND PROSPECTS OF CRWSN

There are lots of prospect and potentials derivable from deploying Cognitive Radio WSN. Wireless Sensor Network with cognitive radio node will have the follow potential benefits attributable to the its dynamic spectrum access features;

• Dynamic Spectrum Access: With Cognitive Radio WSN, network performance can be maximized by means of dynamic spectrum access. Sensor terminals can dynamically and or unlicensed and opportunistically access licensed bands.

• Opportunistic Channel usage for bursty traffic: Sensor terminals with CR capability may opportunistically access multiple channels to solve the problem of collision during packet transmission in a densely deployed sensor network.

• Power Consumption Reduction using Adaptability: Energy consumption in time-varying wireless communication channels is due to retransmission and packet losses . With the adaptability feature of Cognitive Radio WSN, sensor nodes are able to change their operating parameters to adapt to the channel conditions. This will enhance the transmission efficiency, and thereby reduce power used for transmission and reception.

• Overlapping of Multiple Concurrent Sensor Networks: With dynamic spectrum management capability of CRWSN, multiple overlapping sensor networks can co-habit the same area serving different application purpose.

VI. CONCLUSION

With the advances in science, there was an growing curiosity in the usage of WSNs. Protection is a imperative challenge in WSNs. CR based wireless sensor network is a

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new approach for the next generation WSN. There are lots of potentials attributable and prospect to this new research field in sensor networks. In this paper, we have x-rayed cognitive radio-based wireless sensor network. We presented a design concept for the network models, considered possible architectures . We also analyze hardware architecture for resources-constrained cognitive radio sensor network. Based on possible models highlighted, we pointed out open research challenges associated with this new research field, and we suggested possible solution pathways to mitigate these challenges. We also described prospects of deploying WSN with Cognitive Radio features. Main features of these prospects is improved spectrum utilization in a multichannel sensor network that is resource-constrained. We believe our work will serve as a motivation for the research community to explore this promising research area.

REFERENCES

[1] K. A. Yau, P. Komisarczuk, and P. D. Teal, "CognitiveRadio-based Wireless Sensor Networks: Conceptual Design and Open Issues," Second IEEE Workshop on Wireless and Internet Services (WISe 2009), 2009.

[2] M. T. Masonta, N. Ntlatlapa, and M. Mzyece, "Energy and Spectrum Efficiency in Rural Areas based on Cognitive Radio Technology,"Southern Africa Telecommunication Networks and Applications Conference (SATNAC),2009.

[3] C. Chong, and S. Kumar,"Sensor Networks: Evolution, opportunities, and challenges,"Proc. IEEE 91:1247-56, 2003.

[4] S. Haykin, "Cognitive Radio: Brain-empowered wireless communications," IEEE Journal on Selected Areas in Communications,Vol. 23, pp. 201-220, 2005.

[5] O. Akan, O.Karli, and O. Ergul, "Cognitive radio sensor network," Network IEEE, Vol. 23 (4) pp. 34-40, August, 2009.

[6] J. Mitolla III and G.Q. Maguire, "Cognitive radio: Making software radios more personal", in IEEE Personal Communications, August 1999.

[7] A. M. Wyglinski, N. Maziar, and Y. H. Thomas, "Cognitive Radio Communications and Networks: Principles and Practice", Academic Press MA, USA, 2010.

[8] R. A. Rashid, W. M. A. W. Embong, and N.Fisal, "Computational model for energy aware TDMA-based MAC protocol for wireless sensor networks systems," 6th international conference on circuits and systems, electronics, control and signal processing, 2007.

[9] Y. Xu, Y. Sun, Y. Li Y. Zhao, and H. Zou, "Joint Sensing period and transmission time optimization for energy-constrained cognitive radios," EURASIP Journal on wireless communications and networking, Vol.2, p.16, accepted July 2010.

[10] S. M.Kamruzzaman, M.Hamid, and M.Wadud,"An Energy-Efficient MAC Protocol for QoS Provisioning in Cognitive Radio Ad Hoc Networks" Journal of Radio Engineering, Vol 19, No. 4, 2010.

[11] J. Jia, Z. He, J. Kuang, and H. Wang, "Analysis of Key Technologies for Cognitive Radio Wireless Sensor Networks", 6th International conference on Wireless Communications Networking and Mobile Computing, China,2010.

[12] D. Cavalcanti, S. Das, W. Jianfeng, and K. Challapali, "Cognitive Radio Based Wireless Sensor Networks," Proceedings of 17th International Conference on Computer Vol.

[13] Wang, W., V. Srinivasan and K.C. Chua,Using mobile relays to prolong the lifetime of wireless sensor networks, proc. ACM Mobicom, 2005.

[14] Rappaport, T.S., 1996. Wireless Communications,sensor networks, proc. ACM Mobicom. Principles and Practice, Englewood cliffs, NJ, Prentice-Hall.

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