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Energy Consummation in cognitive radio network using Different Methods

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Abstract*: *The cognitive radio and resource allocation techniques have been proposed for efficiently utilizing the radio resources. Cognitive radio is an emerging technology intended to enhance the utilization of the radio frequency spectrum and allocate the available resources correctly. The cooperative communication system, with the same total power and bandwidth of legacy wireless communication systems, can increase the data rate of the future wireless communication system. A combination of cognitive radio with resource allocation can further improve the future wireless network performance and reduces the energy consummation. Efficient resource allocation in cognitive radio network (CRN) is essential in order to meet the challenges of future wireless networks. In this Paper, we are going to discuss the different Localization Techniques, objectives and protocols used in the literature for resource allocation in CRN. This paper also highlights the use of power control, cooperation types, network configurations, and Energy consummation used in CRN. Finally, directions for future research are outlined of proposed algorithms for energy minimization.

Keywords* : *CRN, Cooperative communication, Resource allocation algorithms, Energy Consumption.

I. INTRODUCTION

Due to rapid deployment of new wireless devices and applications has spurred a growing demand for wireless radio spectrum and power resources. To Make spectrum access more flexible by allowing unlicensed (secondary) users to access the radio spectrum under certain restrictions, the cognitive radio (CR) paradigm adopts a dynamic spectrum management model as the spectrum licensing scheme. From the greening perspective, CRs enable spectrum sharing with smart operation and agile spectrum access. However, spectrum efficiency does not mean energy efficiency, as the Shannon capacity formula shows the tradeoff between the bandwidth and power. Cooperative relay network is a promising concept to optimize CR and provision green communications. The basic idea is to have multiple nodes in the network help each other's transmission to achieve diversity. Cooperative relay can reduce transmission power owing to the shorter transmission range and can potentially generate less interference and yield high signal to noise ratio (SNR).

In cooperative relay based CR networks, the primary system can engage appropriate secondary users to relay its transmission so as to improve primary transmission performance, e.g., enhancing achievable throughput/reliability and/or saving energy. Cognitive radio is an emerging technology intended to enhance the utilization of the radio frequency spectrum. Cooperative communication and multi-antenna systems, with the same total power and bandwidth of legacy wireless communication systems, can increase the data rate of the future wireless communication systems. A combination of cognitive radio with cooperative communication and/or multiple-antennae can further improve the future wireless systems performance. However, the combination of these techniques raises new issues in the wireless systems that need to be addressed.

Cognitive radio Formally, a cognitive radio is defined as a radio that changes its transmitter parameters based on the interaction with its environment [3], [12]. The cognitive radio has been mainly proposed to improve the spectrum utilization by allowing unlicensed (secondary) users to use under-utilized licensed frequency bands. In reality, unlicensed wireless devices (e.g., automatic garage doors, microwaves, cordless phones, TV remote controls etc.) are already in use [13], [14]. The IEEE 802.22 standard for wireless regional area network (WRAN) addresses the cognitive radio technology to access white spaces in the licensed TV band. In North America, the frequency range for the IEEE 802.22 standard will be 54- 862 MHz, while the 41-910 MHz band will be used in the international standard [1]. Table I shows the IEEE 802.22 system parameters [4].

Cognitive **R**adio (CR) is a reactive, adaptable radio network technology which can dynamically detect the available nodes in a wireless spectrum and change transmission parameters enabling more wireless communication channel that are available in network & improve the radio network operation. CONNITIVE radio is a promising technology aiming at better utilization of available channel resources by prescribing the coexistence of licensed (or primary) and unlicensed (secondary or cognitive) radio nodes on the same bandwidth [1]. One of the key challenges in the design of cognitive radio networks is the design of dynamic spectrum allocation algorithms, which enable the cognitive nodes to opportunistically access the available wireless spectrum, without interfering with existing primary nodes. Therefore, dynamic spectrum access techniques have received significant attention.

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In [2] and [3] the cognitive radio problem was investigated from an information theoretic standpoint. The cognitive transmitter is assumed to transmit at the same and on the same bandwidth of the primary link. Interference is mitigated through the use of complex preceding techniques that require perfect prior information about the primary signal. The concept of a time-spectrum block was introduced in [4] and protocols to allocate such blocks were proposed. In [5] the authors derived optimal and suboptimal distributed strategies for the secondary users to decide which channels to sense and access under a Partially Observable Markov Decision Process (POMDP) framework.

By adding to operation on CN it improve its frequency ,capability & other parameters so can get more outcomes, These parameters include delay , PFA ratio ,throughput & Energy consummation. This can be work as a autonomous environment that can be access according to his work to get more efficiently work from CR[4][5]. The CR observed his own in continuous manner with radio frequency that can be gain from other. Then this output can be use by CR for other work so can get safe communication in WMN and get maximum output in less time. So can it deliver the required data with good quality.

Types of cognitive radio:

Depending on transmission and reception parameters, there are two main types of cognitive radio:

- Full Cognitive Radio (Mitola radio), in which every possible parameter observable by a wireless node (or network) is considered.
- Spectrum-Sensing Cognitive Radio, in which only the radio-frequency spectrum is considered.

Other types are dependent on parts of the spectrum available for cognitive radio:

- Licensed-Band Cognitive Radio, capable of using bands assigned to licensed users (except for unlicensed bands, such as the U-NII band or the ISM band). The IEEE 802.22 working group is developing a standard for wireless regional area network (WRAN), which will operate on unused television channels, also known as TV white spaces.
- Unlicensed-Band Cognitive Radio, which can only utilize unlicensed parts of the radio frequency (RF) spectrum.[citation needed] One such system is described in the IEEE 802.15 Task Group 2 specifications, which focus on the coexistence of IEEE 802.11 and Bluetooth.[citation needed]
- Spectrum mobility: Process by which a cognitive-radio user changes its frequency of operation. Cognitive-radio networks aim to use the spectrum in a dynamic manner by allowing radio terminals to operate in the best available frequency band, maintaining seamless communication requirements during transitions to better spectrum.
- Spectrum sharing: Spectrum sharing cognitive radio networks allow cognitive radio users to share the spectrum bands of the licensed-band users. However, the cognitive radio users have to restrict their transmit power so that the interference caused to the licensed-band users is kept below a certain threshold.
- Sensing-based Spectrum sharing: In sensing-based spectrum sharing cognitive radio networks, cognitive radio users first listen to the spectrum allocated to the licensed users to detect the state of the licensed users [6]. Based on the detection results, cognitive radio users decide their transmission strategies. If the licensed users are not using the bands, cognitive radio users will transmit over those bands. If the licensed users are using the bands, cognitive radio users share the spectrum bands with the licensed users by restricting their transmit power [23].
- Database-enabled Spectrum Sharing, In this modality of spectrum sharing, cognitive radio users are required to access a white space database prior to be allowed, or denied, access to the shared spectrum. The white space database contain algorithms, mathematical models and local regulationsto predict the spectrum utilization in a geographical area and to infer on the risk of interference posed to incumbent services by a cognitive radio user accessing the shared spectrum. If the white space database judges that destructive interference to incumbents will happen, the cognitive radio user is denied access to the shared spectrum [24].

Functions of cognitive radios Network:

Power Control: it can be use for different type of spectrums sharing to get the maximum power in secondary interface so that we can help to primary user for getting throughput & protect Primary user.

Spectrum sensing: Finding the unused spectrum and dividing it with other without affecting secondary user. Due to it we are able to detect the unused spectrum & able to used as maximum as possible. Detecting primary user is not our work but detect the node those are not utilized & used it is the most important task.

Transmitter detection: CR is able to detect the transmission time so can use it regularly [25]. There are different method uses to find the transmission time.

Energy detection: In WMN energy detection used to show the Present or absences of energy in network just by observing the signal received & send in network. This detection method is simple method to detect the system energy.

Cyclostationary-feature detection: These type of method are more user friendly that can be use easily such as BPSK , QPSK , AM OFDM , etc. So can get maximum outcome [21]. However, noise signals (typically white noise) do not exhibit cyclostationary behaviour. Due to uncertainty in noise. Cyclostationary it can be use by single or mutlicycle structure.

Cooperative detection: it works on the basis of sharing information those node shares their information with other so can get maximum resource utilization.

Null-space based CR: In WMN the CR detect the blank space in two nodes and transmit the data through that network without interfacing with primary user.

Spectrum management: By finding the most available node in network that has good capacity for communication so can communicate with other without disturbing the primary user [6]. CR can find on the basis of good energy band so we are able to get good quality outcome in less time according the requirement. So node management system required to get efficient output.

Problems in current CR Network :

- High energy consumption is one of the main challenges faced in cognitive radio (CR) networks, which may limit their implementation especially in battery-powered devices [1].
- Resource allocation is also create the problem in network and used the maximum energy [2].
- Required more time to share the data so throughput is limited and reduces the packet delivery ratio.
- Uses Unstructured Network.
- Its also have the consistency problem as network not stable due to large energy consummation.

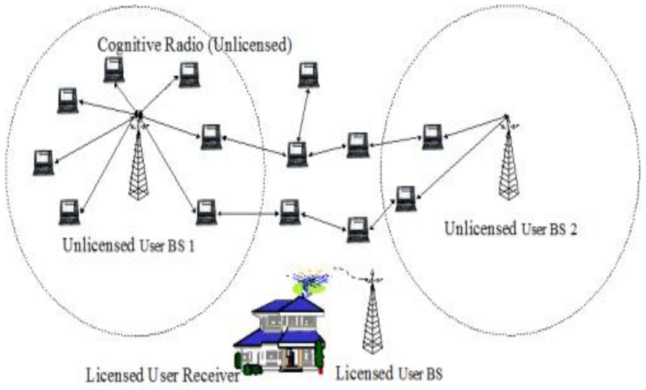

Figure 01: A Cognitive Radio Network Architecture with Licensed and Unlicensed based user

Why You Need Effective Resource Allocation

- Flexible for all size.
- Save money.
- Boost productivity.
- Improve time management.
- Strategic planning.
- Managing workload.
- Eliminate risk.

II. LITERATURE REVIEW

The cognitive radio (CR) technology is treated as one of the key technologies in the future of wireless communication systems. Especially, in the customization of the fifth generation (5G) communication network architecture, CR is considered to be the indispensable approach to tackle the problem of spectrum shortage that impedes the sustainable development of wireless communications. In CR networks (CRNs), based on the spectrum sensing results, secondary user (SU) can dynamically access the underutilized frequency spectrums, also named as the spectrum holes which belong to the licensed spectrum of primary user (PU). According to different access schemes (i.e., overlay, underlay and interactive), CRNs can improve spectrum utilization while protecting the communications of PU according to the interference temperature (IT) limit. In addition, the cooperative communication technologies contribute to the development of CRNs for increasing the capacity and expanding the communications range [3]. According to different cooperative approaches, cooperative-based CRNs can be divided into two categories: cognitive cooperative networks without relays and cognitive relay networks [4]. There are not actual relays or base stations(BSs) to cooperate communications in cognitive cooperative networks in which users collaborate with each other. The special cooperative methods might be that the same category users collaborate with each other, or SUs collaborate with PUs. Cognitive relay networks literally include actual nodes or BSs which play a role of relay to increase communication coverage area. Under the following three main forward protocols: amplify-and-forward (AF), decode-and-forward (DF) and coded cooperation (CC), the study context of cognitive relay networks mainly focus on the following aspects: spectrum sensing, dynamic spectrum access and power allocation (PA).

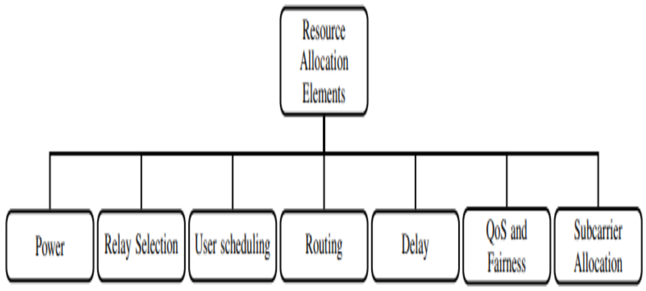

Figure 02: CRN Resource Allocation

Anchor Free Vs Anchor Based Nodes

To localize any system in a global coordinate system Anchor Nodes which are also known as Beacon nodes or seed nodes are playing a crucial role. Any normal sensor node can be a anchor node whose location coordinate are pre known and many other node can estimate their location by receiving the messages from anchor nodes [5].

This anchor nodes can be equipped with some additional hardware which help to locate the exact position like a Global positioning System(GPS).Then anchor free nodes can also be a without GPS where they can found the exact position by using location of other nodes in proximity. GPS enabled anchor nodes simply locate the position of any nodes in coordinate system. But this GPS also has some limitation i.e. it will not work in dense environment or in indoor systems where many obstacles are there and also its power hungry.

Elements of Resource Allocation

The main functions of cognitive radios are,

Power Control: it can be use for different type of spectrums sharing to get the maximum power in secondary interface so that we can help to primary user for getting throughput & protect Primary user.

Spectrum sensing: Finding the unused spectrum and dividing it with other without affecting secondary user. Due to it we are able to detect the unused spectrum & able to used as maximum as possible. Detecting primary user is not our work but detect the node those are not utilized & used it is the most important task.

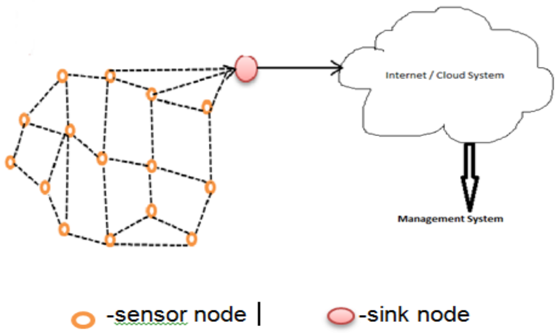

Figure 03: WSN Scenario Diagram

Transmitter detection: CR is able to detect the transmission time so can use it regularly. There are different method uses to find the transmission time.

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In Paper [1], The data and spectrum exchange, the concept of energy and spectrum exchange has attracted much attention since energy harvesting (EH) is introduced into wireless communication networks. Energy harvesters take fuel from readily available ambient sources, including wind, solar, biomass, hydro, geothermal, tides, and even radio frequency (RF) signals [9], [10]. To overcome the dynamics and uncertainties of the green energy sources, three strategies are adopted in existing approaches. The first one is energy storage provisioning, which will facilitate the time domain energy management so that energy can be saved for future use [11]. The second one involes a backup non-renewable energy source, such as the on-grid energy that will guarantee the smooth operation of the system in case the harvested energy is insufficient [12], [13]. The third one is radio resource exchange among neighboring nodes, such as the energy cooperation scheme that can share one system's excessive energy with the other [14].To minimize the impact of dynamics of green energy sources on the network performance, the modernized electricity grid has allowed the distributed harvested green energy to be contributed back to the smart grid in exchange for on-grid energy credit [17], [18]. Consequently, in the green energy powered wireless access networks, the smart grid is an "unlimited energy storage device" with back up ongrid power supply. Moreover, energy trading between BSscan facilitates the radio resource exchange between the grid connected wireless access nodes [19], [20].

In [2], The cognitive radio concept is desirable for a wireless mesh network (WMN) in which a large volume of traffic is expected to be delivered since it is able to utilize spectrum resources more efficiently. Therefore, it improves network capacity significantly. However, the dynamic nature of the radio spectrum calls for the development of novel spectrum-aware routing algorithms. In fact, spectrum occupancy is location dependent, therefore in a multi-hop path available spectrum bands may be different at each node. Hence, controlling the interaction between the routing and the spectrum management functionalities is of fundamental importance. While crosslayer design principles have been extensively studied by the wireless networking research community, the availability of cognitive and frequency agile devices motivates research on new algorithms and models to study cross-layer interactions that involve spectrum management-related functionalities.

In [3], An energy efficiency and average throughput maximization for CRNs is studied in, which also analyzes the tradeoff between energy ef_ciency and average throughput under the imperfect sensing decisions and different PU traf-cs. Chu and Zepernick [19] propose two optimal PA strategies for the hybrid interweave-underlay cognitive cooperative radio networks with the imperfect spectrum sensing to maximize channel capacity and minimize outage probability. In [20], under the spectrum sensing uncertainties, an interference-limited resource allocation algorithm including subcarrier allocation and PA in cognitive heterogeneous networks is investigated to reduce the interference to macrocell users and satisfy the requirement of femtocell users. A new objective function of spectrum utilization is formulated in [21], where a joint optimization of sensing threshold and sensing duration is realized for better spectrum utilization.As mentioned above, PA in CRNs with the imperfect sensing has been a interesting and challenging research topic in wireless communications. In consideration of both EH and the imperfect spectrum sensing, it is meaningful to take EH and the spectrum sensing uncertainties into the PA problem in cognitive relay networks for their real application.

In [4], Recent studies demonstrated that it is feasible to improve transmission reliability with redundancy coding and retransmission in WSNs, especially to the case of a bit loss within a packet that can be recovered by utilizing some form of coding schemes [4]. One of these schemes, network coding, can be employed to increase the reliability of the whole network [5]. The nodes not only send their own information but also send a parity information related to neighbors. This kind of communication technology takes advantage of the broadcast characteristic and has some similar merits with the multipleinput multiple-output technology. It is quite resultful to fight with the channel effects of fading and shadowing [6]. Previously, many excellent schemes based on joint source channel coding were introduced to improve the transmission reliability and energy efficiency of WSNs. One of the schemes, the distributed joint source-channel coding with the Copula function- based correlation modeling [7], was proposed for temperature measuring. In this scheme, the Copula-function based modeling approach is employed to express the correlation amongst the temperature data from sensing nodes, and the redundant data transmission can be minimized, which increases the network energy efficiency. Another among the schemes, the joint source-channel-network coding [24], employs compressed sensing to project the data vectors to a lower dimension to reduce the amount of data to be transmitted. In this scheme, the spatial pre-coding is employed to decrease transmission power further.

Technique	Merits	Problem
Fuzzy logic and ACO based OD-PPRP routing	OD-PRRP has better network lifetime, less transmission delay, high packet delivery ratio and decrease in overhead than other routing protocols like EARQ, EEABR and EAODV.	It is applicable only on WSN network, so can be applied to MANET or wireless network.
Route Construction Method	Can construct effective communication routes in terms of both power consumption and the quality of communication.	Some metrics other than the packet delivery ratio seem to be needed to further improve the quality of communication.
A cross-Layer Channel Access and Routing Protocol	The proposed protocol can more efficiently support QoS packets, even the network is highly loaded.	Need to investigate more detailed QoS requirements of medical information systems.
Integration platform based on WBAN	Optimized the WBAN and the TCP as a sampling rate control.	Usage of Zigbee protocols because it has a slower power consumption rate.
Milestone-based predictive routing	The proposed routing protocol reduces energy consumption and packet delivery ratios in comparison to previous routing protocols such as ALURP and Elastic.	Improve the predictive protocol by managing QoS in sink mobility WSNs.

Table 01: Survey on Different routing Scheme

III. CLASSIFICATION OF RESOURCE ALLOCATION & LOCALIZATION TECHNIQUES.

To find the correct Resource and localization of sensor nodes different Resource allocation and localization techniques have been used [3]. It comes in different ranging such as AOA, TOA, TDOA, RSSI etc. While estimating the Resource allocation and location of sensor nodes the way to distribute computation and how to choose algorithm for Resource allocation and localization there are different prospects. The Resource allocation and localization techniques can be largely categorized into centralized and distributed techniques [4].Where the distributed techniques can be again divided as Range Free Techniques and Range Based Techniques.

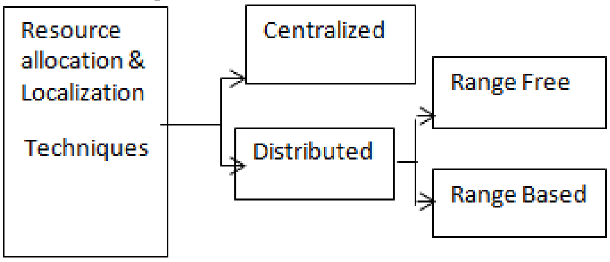

Figure 4: Classification of Resource allocation & Localization Techniques

There are Different Resource allocation and Localization Algorithm some of it as follow,

*A)*DV-Hop Resource allocation & Localization Algorithm

DV-hop is identical range-free localization algorithm which was proposed by Niculescu D. et al [5]. The key concept of a DV-Hop algorithm is node transfer information with its neighboring nodes. Every anchor node broadcasts a beacon message which contains the location of anchors with hop count values. Every receipting node keeps the minimum value in hop count field, which it receives and discard the higher values in hop count field. Classical distance vector routing method is also work in same manner. All nodes are receiving other nodes information of WSN; keep the minimum value of the distance and removes higher values.

The hop count value keeps increasing at every intermediate node till it reaches to anchor node. By taking the product of average per-hop distance and the shortest way among the sensor nodes, the distance between unknown node and anchor node can be estimated

The overall single hop /distance can be calculated as a

Hop Size i (1)

Where j is an anchor node with (x_j, y_j) coordinates and distance between node i to anchor j is a hj. For this algorithm in two planes (2D) minimum 3 anchors are needed where as in three plane (3D) minimum 4 anchors needed. In DV-Hop algorithm after the hop count forwarded by neighbor nodes to reach this to anchor node after adding 1 to the current hop count till it reaches to anchor node. But in improved algorithm using anchor position re-estimation, above step is repeated to minimize the ALE (Average location error of anchor) by modifying the hop size value.

This way, the optimal Hop Size improvement is obtained.

Approximate Point in Triangle (APIT)

In this range free localization algorithm[4], the main principles of APIT is triangle method, assuming that there are n anchor nodes which able to communicate with the unknown node, the algorithm will traverse number of different triangles, and calculate the centroid of the overlap area of the triangles as the expected location of the unknown node.

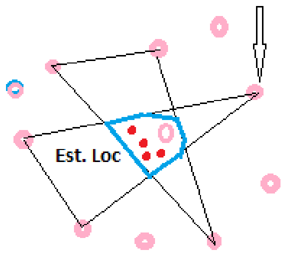

Figure 5:APIT Algorithm Scenario These APIT algorithms mainly work in four steps:

The unknown node hears the information of the all near anchors.

Every three neighbouring anchor forms triangle by connecting to each other.

Test the all unknown node whether node is within the any triangle or not.

Finally by computing the center of gravity (COG) of the intersection area of all of the overlap triangles in which the unknown node resides whose position needs to be estimate.

This algorithm is suitable for the unknown nodes are perfectly resides inside the triangle with its anchor but there is deviation in results when node is on the edge or near the edge from inside of a triangle and when it is perfectly outside but neighboring anchors are inside the triangle. To give the remedy to problem Fang Z. et.al [6] proposed an improved version of an APIT algorithm to address an issue. Due to Inside to out error and Outside to in error of the unknown node the major basis of error of procedure is edge effect. Wang solved this edge problem by using backtracking algorithm and also introduced area test to reduce the percentage of error occurrences. An Improved APIT algorithm achieves best while high Node density with less packet loss rate as compare to previous basic APIT algorithms.

MultiHop

In Multi Hop technique in large sensor Network able to compute connectivity graph [4]. The multi-dimensional scaling (MDS) by using the connectivity information assuming that all nodes are within the vicinity of communication range.

It has three steps as follows:

1] Estimate the distance between each pair of nodes.

2] MDS is used for the position estimation and fit the estimated distance.

3] The optimization is done in last step by using of the known locations.

However in practice present multi-hop localization methods experiences a number of difficulties, such as high computational complexity, less adaptable to irregular topology, less accuracy in positioning, etc. Such issues must be address in localization, so Guo propose a novel approach of improved Multi-hop Localization algorithm.

Guo x. et.al[7][8] is stated presented improved version of multi-hop algorithm for curtailing influence of specious estimated distances by multi hop on node localization. Where improved multi-hop has a greater computational complexity. This improved Multi hop Localization works in three steps:

1] To filter out incorrect estimated distances superior bound restraints are used to filter out and the expected position is determined to the intersection constrained by the accurate distances.

2] To fit the correct distance measurement the appropriate distance is used by arrangement of anchor nodes

3] In the coordinate calculation in node localization can be optimized by using least square (LS),and multilateration, Taylor LS, Weighted Taylor (WLS) and Constrained total least square (CTLS).These methods give guaranteed performance under some constraints and may expose some problems which covers a deficiency of local and global coordinate view of WSN, To process fairly every reference information of nodes in a same manner is needed to improve the accuracy of localization, When high computational overhead the complexity will be more and easy to get caught at local optimum.

Centroid

The centroid algorithm originally proposed by Bulusu N. et al.[9]. In this algorithm all sensor node receives location coordinates from all anchors along with communication range. Every unknown node in network listen for some predefined interval t and collects the information receives from messages they received from various nodes. The locations of all unknown nodes calculate using centroid determination from all known positions of anchors is in communication range.

In this localization technique neighboring anchor node positions (x_i, y_i) acquainted to estimate the location of the sensor node [24]. Here anchor node broadcast beacon message consist their location information using this information sensor node performs computation for their location as the centroid of all anchors nodes connected to the sensor node. Where (x_{exp}, y_{exp}) gives the expected positions of the sensor nodes and N is the no of anchor connected adjacently to the sensor node. This method is very simple and low cost solution but also has some large gap of error in din location estimation of the sensor nodes and it is intolerable in real time applications or critical applications requiring correct localization of sensor nodes.

$$(x_{exp}, y_{exp}) = \frac{(x_1 + x_2 + \dots x_n)}{n}, \frac{(}{} \quad (2)$$

Weighted centroid method is an enhanced form of centroid algorithm. The weights of the edges of anchor nodes which are connected to nodes are used to calculate the location of all nodes and every sensor nodes seeking for location computation that can be done as follows:

$$(x_{exp}, y_{exp}) = \frac{(w_1 x_1 + w_2 x_2 + \dots w_n x_n)}{\sum_i^n w_i}, \frac{(w_1 y_1 + w_2 y_2 + \dots w}{\sum_i^n w_i} \quad (3)$$

Where the weight of edge of anchor nodes connected to the other nodes. Based on the edge weight the proximity of the anchor node to sensor node decides. Algorithms perform better if the weighted edges are highly optimized.

Table 3: Performance Analysis of Different

Parameters	DV-Hop	Monto-carlo	Centroid
Packet Delivery Ratio	>9.9	>9.75	>9.4
Throughput	Good	Good	Average
End to end Delay	>.015	>.016	>.021
Energy Consumption	Less	Average	Good
Cost	Medium	High	Low
Overhead	Average	Large	Little

Resource Allocation By using different Parameters Schemes

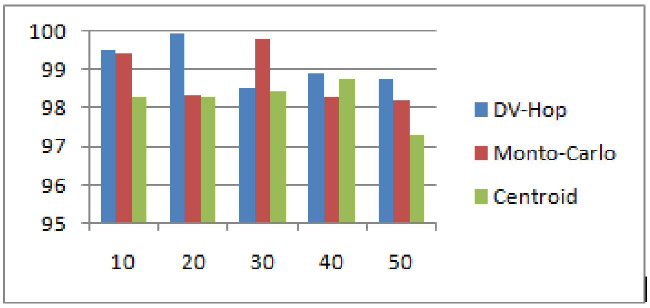

Figure 09: Packet Delivery Ratio

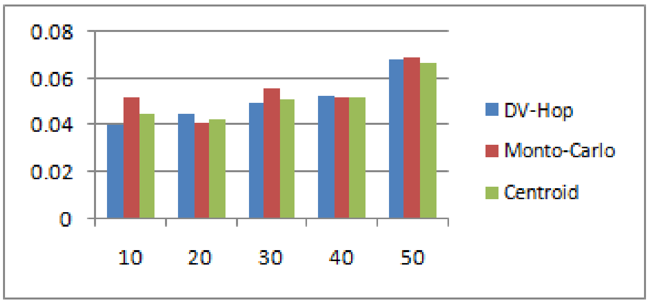

Figure 10: End to End Delay

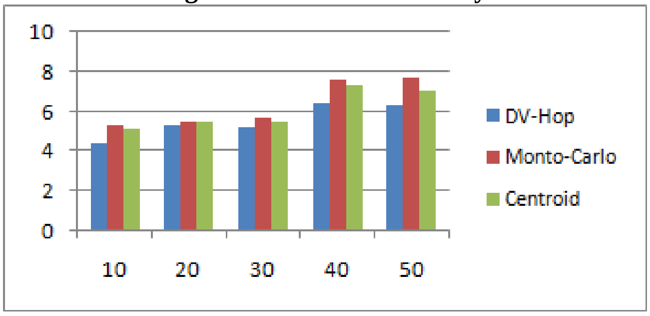

Figure 11: Energy Consummation

IV. CONCLUSION

In summary, research on radio resource allocation in cooperative CRN is quite broad and challenging. It is important to address these issues for better utilization of radio resources by using share resource allocation with shortest path & proposed method. In this work, we have discussed the different method currently used by CR to reduce the energy consummation. While research is steadily growing in resource allocation in CRN, we work on to minimize the energy consummation with other parameters. So using different localization algorithem we have seen that we need to focused on some new system to reduce the more energy used by system apply the proper resource allocation methods. In future we can work on more different parameter with Proposed method to reduce the energy consumed Network

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