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LOCATION AWARENESS SERVICES IN TERRESTRIAL REGION USING COGNITIVE RADIO TECHNIQUE

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Abstract *– Existing wireless network technology has many shortcomings such as network traffic, unavailability of channels. The bandwidth available for cellular system is always limited. Cognitive radio technique is a contemplate to solve the problem in wireless traffic resulting from limited available channels. At the same time terrestrial area is poor in network coverage. So here the terrestrial area is sensed and an efficient mobile service with proper handover is made using cognitive radio technique. Cognitive radio technique adapts the channels dynamically. An android mobile application is developed that provides the location aware services for those in terrestrial region using the cognitive radio technique. Supervised learning method called as Particle Swarm Optimization (PSO) is used for predicting the unused channels of the region, since it makes prediction based upon uncertainty.*

Keywords*— Cognitive Radio Technique, Geographic Information System, Terrestrial Area, Location Aware Services, Mobile Application.*

I. INTRODUCTION

Existing wireless network has a major problem of channel allocation, only the primary users are benefitted in this the current system and so many unused channels are being left unutilized optimally. Because of an ascent sought after of range imaginative applications there has been an expanding enthusiasm for thinking of element range access arranges that empower unapproved clients to get to a radio recurrence range once not being used by approved clients. This innovation is named intellectual radio or Cognitive radio (CR).

1.1 Cognitive radio

Cognitive radio technique is a novel approach for solving the problem in wireless network resulting from the limited available channel. Cognitive Radio (CR) is an adaptive, intelligent radio and network technology that can automatically detect available channels in a wireless spectrum and change the transmission parameters enabling more communications to run concurrently and also improve the radio operating behaviour. Cognitive radio technique can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones. A CR client is permitted to utilize exclusively unused range by accurately assessing situations to stop any obstruction or impact with the essential clients. The cognitive client system indirectly to a remote system that is upheld CR innovation it is important to consider the administration and coordination of correspondence over remote channels. As an after effect of the procurement of /inundation of heterogeneous range ,thinking of a Medium Access Administration (MAC) convention that gives keen coordination among optional clients Secondary User (SUs) isn't a straight forward errand . By using the Geographic Information System the location services for a particular specified location is provided.[1]

1.2 Satellite communication in terrestrial area

A communication satellite is an artificial satellite that relays and amplifies radio telecommunication signals via a transponder. Wireless communication uses electromagnetic waves to carry signals. The purpose of communication satellite is to relay the signals around the curve of earth allowing communication between widely separated. Communication satellites use a wide range of radio and microwave frequencies. Communications by satellite is not a replacement for the existing terrestrial system but rather an extension of wireless communication. Satellite communication has many advantages like coverage, high bandwidth, low cost, wireless communication, immunity, and broadcast/multicast. A communication satellite is a Radio frequency repeater.

1.3 Location aware computing

Location aware computing refers to system that can sense the current location of a user or device and has the ability to change the behaviour based on the location. The best known example is GPS (Global positing system) navigation device. GPS has the capacity to give direction to the user for how to

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get to a new location, and it can update this direction continuously as the direction moves. Most commonly a location aware system will determine its location through any of the below indicated methods:

- *Mobile phone triangulation*
- *Wi-Fi triangulation*
- *GPS*
- *Radio Frequency Identification(RFID)*

Location aware computing (or) context aware computing describes the special capability of information infrastructure to recognize and react to the real world context. Context in this sense includes any number of factors including user identity, current physical location, weather condition, time of day, date, or season, and whether the user is asleep or awake, driving or walking. The most critical aspects of context are location identity. Location aware computing system responds to a users location, either spontaneously like warning of a nearby hazard for example Is it going to rain in the next hour . The Global Positioning System (GPS) is the most widely known location- sensing system today.GPS uses an absolute coordinate system. Fig.1 represents the convergence of four independent technologies [1].

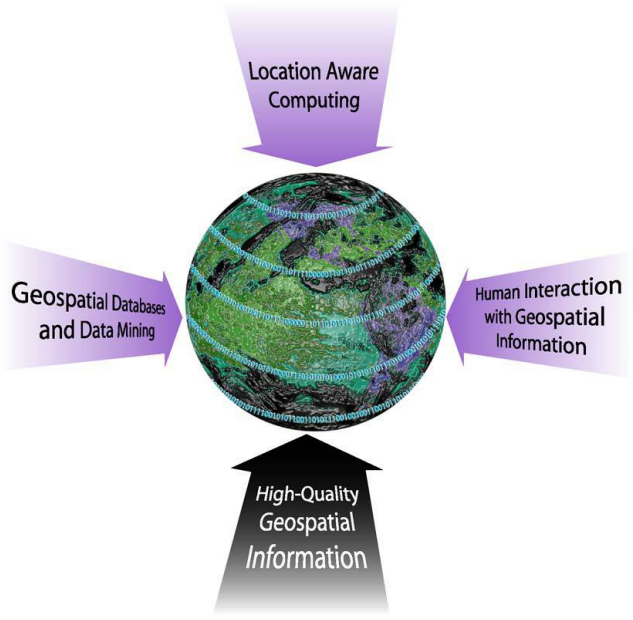

Fig 1 : Convergence of four Independent technologies.

II. LITERATURE SURVEY

Many factors lead to the development of cognitive radio technique, one of the major reasons is the steady increase in the requirement for the radio spectrum along with the drive for improved communication and speed. One example that exemplified the need for flexible communication occurred in the Netherland in 2000 when the fireworks factory exploded killing 23 people, destroyed much of the town and injuring more than the thousand people. While dealing with this catastrophe, the emergency services (fire, medical, police, etc,.) experienced real communication difficulties because they all have different communication system and were unable to communicate with the other service. Another major emergency was the 9-11 terrorist attack in the USA.

2.1 Performance analysis of cognitive radio spectrum

The unlicensed users are allocated with channels based upon their priority (High and Low).The Dynamic Spectrum Access (DSA) scheme is used for sensing the priority of the unlicensed users. In a centralized CRN, a central entity will be there which controls spectrum allocation and spectrum access, and also it is used to gather information about the radio environment. In distributed cognitive radio there will no main central control to gather data about the radio environment. In a centralized CRN function such as spectrum allocation and spectrum sensing become tougher then the number of cognitive radio devices increases. Furthermore in DCRNs, available channel are discontinuous generally may present may where in the total spectrum. The availability of these channels may vary with time .Therefore SUs should have the capability to cope with the dynamic environment, because the availability of channels with SUs at any moment and location depends on PU activity [2].

Spectrum sensing methodologies for cognitive radio techniques Spectrum sensing is an important functional unit of cognitive radio networks .spectrum sensing can be set to be the process of performing measurement on a part of the spectrum and making a decision related to spectrum usage based upon measured data. The growing demand for wireless application has put a lot of strain on the usage of available spectrum. To achieve the goal of cognitive radio technique, it is a compulsory requirement that a cognitive user perform spectrum sensing to detect the presence of primary user signal. In the context of cognitive radio, the primary users can be defined as the user who has higher priority or right in the usage of a specific part of a spectrum. The secondary users on the other hand are the users who have lower priority or lower rights; they use the spectrum in such a way that they do not cause harmful interference to the primary users. However secondary users need to have cognitive radio capabilities, such as sensing spectrum efficiently to ascertain if it is being occupied by a primary user and also change their radio parameters exploit the unused part of the spectrum. The three popularly used methods for spectrum sensing are: Energy detection, Matched filtering and Cyclostationary detection [3].

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2.2 Resource allocation in Cognitive Radio

Cognitive radio network is growing worldwide which leads such networks are suffering from the challenges of efficient spectrum or resource allocation as well as lack of spectrum. For increasing the employment of the restricted radio information measure currently days the cognitive radio has emerged as a promising technology whereas in wireless networks for services and applications accommodating the increasing quantity. To the dynamic radio environment, cognitive radio transceiver is ready to adapt and for the restricted radio resources the network parameters to maximize the employment whereas providing flexibility in wireless access. Spectrum a lot of dynamically is allocates by dynamic spectrum access and for analysis and it's a vigorous space. Radio nodes collaborating to noise ratio condition with continuing warning rate at terribly tiny signal. Simulation results indicate that each polynomial and linear classifiers offers high detection rate of primary users. In sequence from short channel usage time to decrease channel handoffs ensuing, for the channel allocation a usage threshold time is about. Once in an exceedingly single hop channel handoff cannot be enforced, to stay the communication the multi hop routing is going to be established. To handle the difficulty with dynamic channel allocation slotted decision admission management methodology is integrated. Many resource allocation techniques such as cognitive radio, polynomial classifiers, linear classifiers .Cooperative spectrum sensing, spectrum sharing, spectrum heterogeneity, multi hop routing, spectrum handoff, cooperative sensing, support detection, low rank property, matrix rank maximization, energy detector, GNU radio, EDD, slotted call admission control method integrated with dynamic channel allocation, collaborative sensing, link maintenance, reservation, admission control, Real time systems[4].

2.3 Routing protocols for cognitive radio network

Traditional routing metrics for link state or distance vector paradigms are not well suited to be applied to Cognitive Radio Network (CRN). The main reason is that there are frequent dynamic changes in the CRN that may trigger a large number of updates and lead to rapidly changing routing tables. These dynamic changes inherit the wireless mobile network characteristic including: nodes mobility, nodes limited power and the network life time, the wireless medium properties, channel scarcity, and conflict with other ISM –based devices; and have the added constraints imposed by the primary users. One of the main tasks of cognitive radio is to determine whether the spectrum band width is available or not. This includes analyzing the spectrum in its vicinity and analyzing the transmission to know the type of transmitter. A good routing metric for CRNs has to assign different weights to different spectrum ranges based on their availability and probability that a transmission will be interrupted due to the PUs activity and/or other SUs activity. It can also estimate the future activity of the PU to minimize the route interruption time and maintainable cost [5].

Following table I represent the survey of various cognitive radio techniques .It explains about definition of problem, Algorithm and limitation. In order to provide the location services in terrestrial region using cognitive radio to make the user to access the dynamic spectrum in critical regions. So that the efficient spectrum access will be provided by using machine learning algorithm.

Table I Represent the Survey of Various Cognitive Radio Techniques

Title of the paper	Problem definition	Algorithm	Limitation
Location-Aware Cognitive Communication Systems for Public Safety	Usage of cognitive radio to ensure human safety in case of emergency situation(ex: natural (or) manmade disaster)	Adaptive positioning algorithm	Reliability
Spectrum sensing methodologies for cognitive radio system.	Spectrum sensing technique form cognitive radio perspective	1)Optimal LRT based sensing. 2)Matched filter 3) Cyclosta tionary based sensing.	Multiple trade off in cooperative sensing delay
Performance analysis of cognitive radio spectrum access	Assignment of channels for the unlicensed users based upon their priority	DSA(Dynamic spectrum access)	Optimal number of channels and sub-channels allocation
Challenges in Location-Aware Computing	Methods for achieving accurate location aware service	----	GPS does not work efficiently for indoors
Location-Aware Computing	History and implementation challenges	----	hidden node problem

III. SYSTEM ARCHITECTURE& IMPLEMENTATION

A typical Cognitive Radio Network (CRN) environment consists of a number of Primary Radio Networks (PRNs) that coexist within the same geographical area. A primary network is an existing network that is licensed to operate in a certain spectrum band. Hence, a primary network is also referred as licensed network. A primary network can be either centralized infrastructure or distributed ad-hoc in nature. Primary users have priority with respect to the spectrum access and operate as they are the sole users of the licensed spectrum. Hence, primary users do not provide any type of cooperation to the

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secondary users. Therefore the primary network defines the upper bounds on the CRN activities in their licensed bands, typically in terms of maximum power levels, to guarantee the promised performance level to their legitimate users.

3.1 Centralized Cognitive radio network

Centralized Cognitive Radio Network (CRN) are infrastructure based network in which cognitive radio base station control and coordinate the activities of secondary users. It is represented in the below Fig.2

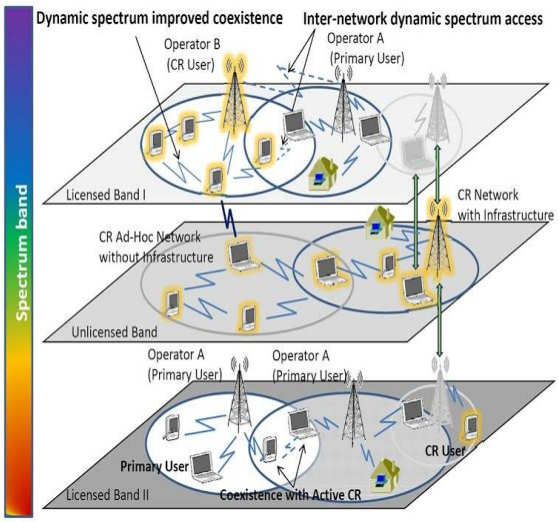

Fig 2: Centralized Cognitive Network

The cognitive radio base stations control the secondary transmission over both the licensed and unlicensed bands by collecting the entire spectrum –related information from the cognitive radio users. The IEEE 802.22 is the first world-wide standard for CRN. The IEEE 802.22 defines the specification of point-to-multipoint communication scheme over the used television bands in which a base station manages the cognitive radio users over the 33 km radius using the centralized spectrum database.

3.2 Distributed cognitive radio network

Cognitive Radio Network (CRN) also have the cognitive nodes communicating with each other via ad-hoc point-to-point connections over either the licensed or the unlicensed bands. This is represented in fig 3. While alleviating the infrastructure cost, such infrastructures less CRNs have increased networking complexity. In the absence of a controlling centralized entity, cognitive radio nodes in a distributed CRN jointly coordinate their spectrum access decisions to share the available spectral opportunities. Thus, global mechanism such as network-wide synchronization might be needed for spectrum access coordination. In addition distributed cooperative decision and communication techniques are used to improve the overall network performance.

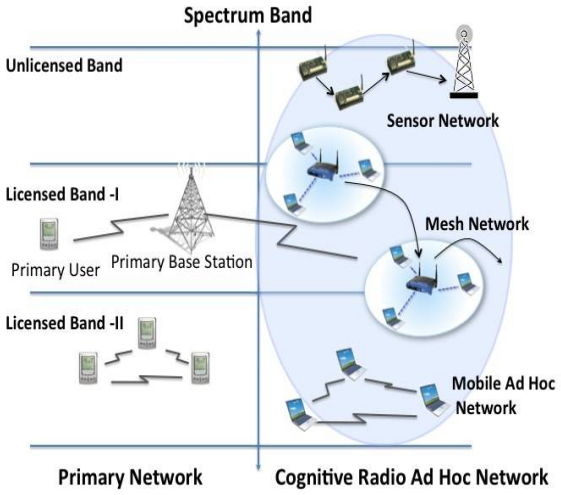

Fig .3 Distributed System Infrastructures

3.3 Implementation

Fig 3.represents the user in the terrestrial region requesting for the location aware services (temperature, wing, humidity, rain) about the region where the user resides. As soon as the service is requested it checks whether the requested user is a Primary User (licensed user) or Secondary User (unlicensed user).If the user is a Primary User (PU) user then it immediately provides the requested services to the user. If the user is the Secondary User (SU) user then the cognitive radio searches for the available channels in the SU Network of the unlicensed band. After finding the available channel in the unlicensed band it directs the channel to database [7].

From the database the details are transferred for processing them, here the PSO (Particle Swarm Optimization) algorithm is used for predicting and analysing the available channels for the SU (Secondary Users) in the unlicensed band [8]. PSO algorithm was developed for solving optimization problems. From the set of predicted and analysed channels, PSO algorithm optimizes the accurate channel needed for the SU (Secondary User) and redirects the results.

Here the particle represents the number of users of the region and the terrestrial region is taken as the search space. Initially the particle is initialized with the available best channel and this best channel is assigned as pbest(particle best). From this pbest, the more accurate channels are searched iteratively and assigned as f(p). This f(p) is compared with pbest, if the f(p) is greater than pbest then it is chosen as gbest(global best). This gbest is assigned to the user.

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Table 2. PSO Algorithm

Pseudo code:

[x*] = PSO()
P = Particle_Initialization();
For *i*=1 to *it_max*
For each particle *p* in *P* do
fp = f(*p*);
If *fp* is better than f(*pBest*)
pBest = *p*;
end
end
gBest = best *p* in *P*;
For each particle *p* in *P* do
v = *v* + *c1*rand**(*pBest* – *p*) + *c2*rand**(*gBest* – *p*);
p=p+v;
end
end

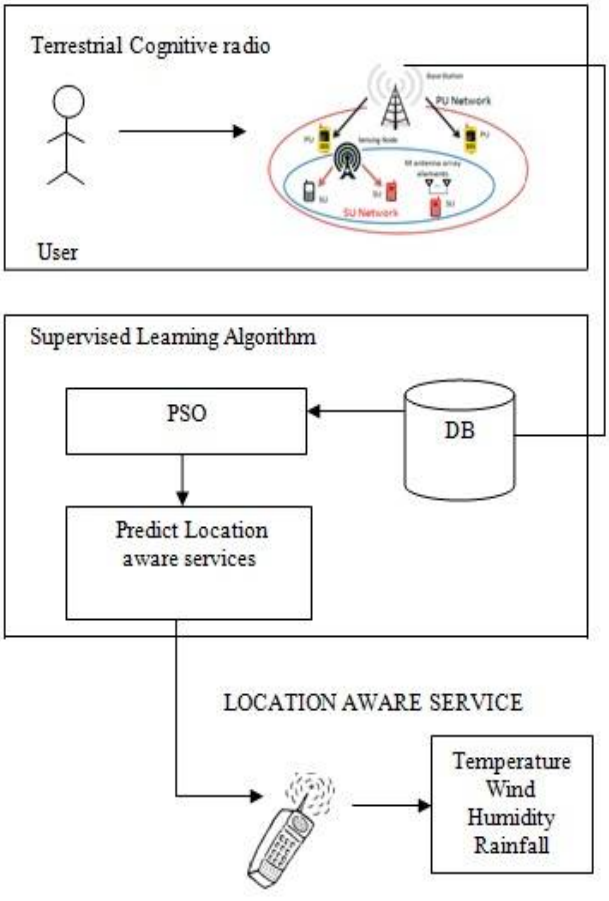

Fig 4 : System Architecture

The GPS (Global positioning System) is used for sensing the location details of the particular region. Accurate sensing of the spectrum is one of the prime requirements for efficient functioning of cognitive radio systems. Accurate sensing is achieved by using collaborative sensing techniques [6]. In this work cognitive radio is combined with Global Positioning System (GPS) to provide locations aware service of the region.

3.4 Cognitive Radio Efficiency

The efficiency of the cognitive radio is sensed and analysed by using supervised learning algorithm. In supervised learning algorithm, the predictions are made based upon the uncertainty. During the learning process, the supervised learning methods can be used to exploit prior information available to cognitive radio. A Cognitive radio is assumed to use the methodology of understanding-by-building and achieve two objectives namely permanent reliable communication and efficient utilization of spectrum resources.

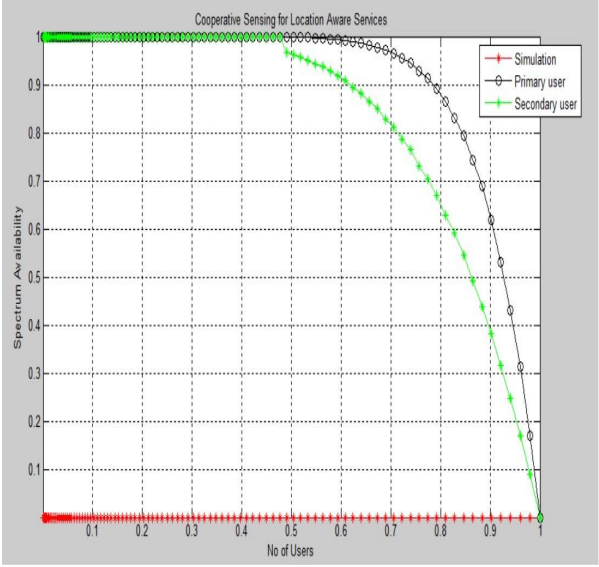

Fig 5: Efficiency of CR in Location aware service

The above graph represents no of users, spectrum availability and cooperative sensing .Red line represents the simulation, black represents the primary user and green represents the secondary user.

VI. CONCLUSION

In this work, location aware services in terrestrial region are provided to the user by using cognitive radio technique. The CR technique is implemented using supervised learning method, which uses particle swarm optimization (PSO) algorithm. PSO algorithm predicts and analyses the available

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channels of the region and GPS predicts the location aware services of that region (wind, temperature, humidity, etc,) are provided to the user without any delay in the network. The cognitive radio technique allocates the available free channels to demand channels in the unlicensed band. The location services details of a particular location is predicted, analysed and provided to the user without any traffic of network. Since all the users are provided with their required channels there would be no traffic in the network and no queuing of the users.

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