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Study of Hybrid Cognitive Radio Networks Based On Access to the Frequency Spectrum and Their Ability to Succeed

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Abstract:

In this research, we will study the performance of the network and users in light of accessing the hybrid spectrum in the large (huge) cognitive radio network (CRN) so that we have primary users and secondary users when a primary user transmits on the same channel and at a uniform time (the same time) the user units are eclipsed Sub-state the channel through the sensing channel and draws the appropriate scheme for accessing the channel (it can be an overlay) for transmissions based on the results of the sensing channel. Controlled in order to produce less interference (the interference in the first network is less than the interference in the preceding), and when we don't have primary users, the secondary user units do it = a transmission process under the overlay channel and thus increase the flow based on random geometry.

Keywords:
Hybrid-spectrum-access, CRN, radio cognitive, network, spectrum.

Introduction:

The non-stop proliferation of Wi-Fi communications structures and offerings implies that the situation of spectrum administration and availability proceed to entice attention.

In fact, over 25 billion gadgets are predicted to be related on the net after 3 years, and a successful conversation amongst these gadgets requires appropriate coordination among users As for the existing materials, which are considered low on the spectrum,[2] and therefore it is very important to study the behaviors and how they work for users or operators in Wi-Fi networks [3].

Let us define at a quick glance what access to the hybrid spectrum is, as it is considered one of the most important models that have been able to coordinate and manage the mechanism of spectrum use is the (c-r-n) technology [3][4], i.e. the cognitive radio network that allows the presence of unlicensed devices known as sub-users (secondary) (sus),allowing them to By transmitting[4].

On private channels belonging to unlicensed users known as (Pus) a search that guarantees the continuity of transmission on these channels as long as it does not cause interference that harms or affects other transmissions in order to preserve quality and service quality (QoS) and at the same time work on improving productivity and optimizing the channel utilization by secondary users [5]. It is customary to use three popular models for managing the channel access process for the transmission process in (CRN) technology, which are (basic, overlapping, and hybrid models) depending on the access relationship for both primary and secondary users [5].

In our study this (hybrid spectrum access mechanism) this method allows special transmissions operations based on the overlay and substrate schemes, all of which depends on the condition of the channel, so that we will study for its importance and prove its ability[5][6], so that there must be a continuous process of detection and sensing the channel after that Each unit (SU) must choose a specific model (scheme) suitable for it to access the channel based on the result of the sensing (channel sensing) and in the case of the channel does not contain a primary user (typical)[7], the secondary units start the transmission process based on the overlay scheme and the process of switching to the original spectrum.

Network
Model

Assuming we have a pattern network (Sir-A-N) as in fig 1:

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The following figure shows the transmitters and receivers, where we have primary transmitters (P-TS) and secondary devices (STS), so that the term (CR-N) known as wide band or very large band is frequently used (Fig. 1). And this case when Sending the B-U and both the S-U at the same time and period of time on one channel here can have a negative impact on the work and performance of this network that we have, so that, as is known, the connection model consists of () in addition to a receiving device The target is[8], but any non-primary (secondary) connection model or model consists of (PT- xk p ∈Φ/p-) with a target device in order to ensure correct access and correct transmit and receive quality consists of (ST- xk s ∈Φ/s-) with a target device in order to ensure proper access and correct transmit and receive quality[8].

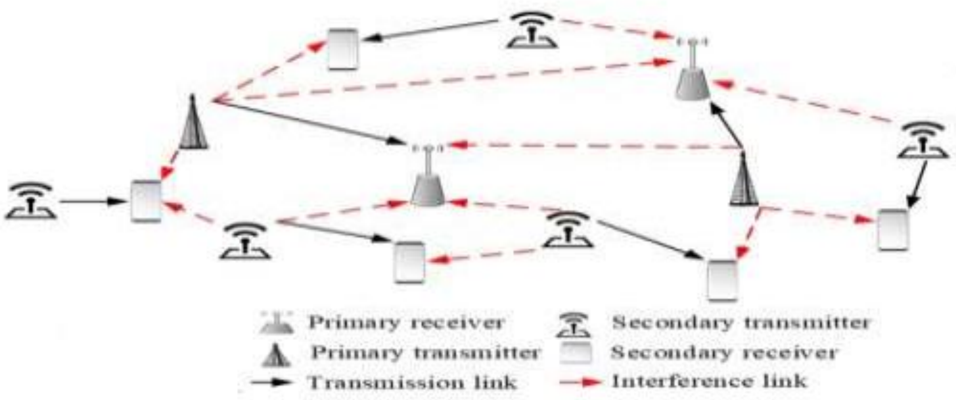

Fig 1: Users' distribution in massive CRN.

Here we will assume the following: As each (p-T) expresses the least of a certain distance is (D), in order to fulfill the condition of spacing between transmitters, which is symbolized by the symbol (p-U), and we note that the process of distributing the basic users here is not Applicable and compatible with reality[8], but it has been shown that it is possible to correctly provide a simulation close to reality for the (pTS-S) distributions where each has a region of a random distance (R) with an undefined random direction, the assumption that we follow here is that for each A transmitter there is a target associated with it (the closest target to it) and here the existing system is a separate system (time constrained) so that each ST unit is expected to carry out a process of sensing the channel that you want to use at each interval or time slot in order to know Is the channel occupied by the main user or not? And here, when the process of detecting the presence of a main user operating the channel and sending it (at least one user) [9], then it depends on the principle of transmission with a maximum power (full)[9].

In order to increase the production process to the last possible extent while adhering to the restrictions imposed by the quality of service (BTS), it is-expected that the process of saving energy in special devices (special units) because the process of continuing to sense the channel may cause an impact on the efficiency of each unit Secondary (SU) and the sensing process can take place with each gap in time (gap) [9].

As long as the interference received at any (RR) is lower than the previous specified, then the transmission (ATS) is allowed within the known base mode[10], so the transmission power of any typical ST unit, meaning that the (PUS) is subject to power control technology as 1

$$P_s^u = \begin{cases} P_s^{max}, & \text{if } h_{sp}\|sp\|^{-\alpha} \le \frac{I_d}{P_s^{max}} \\ \frac{I_d}{h_{sp}\|sp\| - \alpha} & \text{if } h_{sp\|sp\|}^{-\alpha} > \frac{I_d}{P_s^{max}} \end{cases} \qquad (1)$$

P_s^{max} It represents the maximum transmitting power

I_d It expresses the maximum possible interference at any P-U,

h_{sp} The fading coefficient is exponential in both cases, distributed from it and independent between each (ST / PR)

||sp|| Express the distance symbol (Euclidean) between each (ST / PR),

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α It expresses the causal loss of the path for each (PR yk- p) from a certain distance (R -B), which is supposed to be within the scope of its region and the rate of intervention / for a sign added to the noise S-I-N-R.

$$\mathrm{SINR}_{y^{p}_{k'}} = \frac{P_p \mathrm{h}_{\mathrm{x}^{\mathrm{p}}_{\mathrm{k}}} r_p^{-\alpha}}{\sigma^2 + \mathrm{I_{pp}} + I_{sp}{}'} \qquad (2)$$

P_p The fixed power of the transmission process for each p-T,
h_{ab} It is the gap that adopts the main distribution of the channel between a sender and a goal (A-B)
I_{pp} The symbol expresses an overlap from a basic user except (X -kp)
I_{sp} The overlap resulting from (S-T-S) at (yk -p)
σ^2 It is a signal that expresses the strength of thermal noise. As the previous of S-I-N-R

$$\mathrm{SINR}_{\mathrm{y}^{\mathrm{s}}_{\mathrm{k}'\mathrm{t}}} = \frac{\mathrm{P_s h}_{\mathrm{x}^{\mathrm{s}}_{\mathrm{k}}{}'\mathrm{y}^{\mathrm{s}_{\mathrm{s}}^{-\alpha}}_{\mathrm{k}}}}{\sigma^2 + \mathrm{I_{ss}} + \mathrm{I_{ps}}{}'} \qquad (3)$$

I_{ss} expresses the interferences of active subunits except for (XK) at Y-Sk
I_{ps} is the from active P-Ts at (y-s k.)

Analysis of Success Probability:
We will consider a model system in which each of our node generates packets and sends these packets to their intended destination after performing a special operation (Bernoli independent and distributed)[10][11] in the form:

]1 ,0[∈vTr,t

at each time interval T, so that

{Tr = p} for PT &{Tr = s} for S-T.

We will consider a separate time system in the study where the packets in the different nodes are independent as is the case within the normal so that packets can be modeled and created in the nodes according to Bernoulli [12], which means that each packet is sent as soon as it is created (at the same moment) and the iteration that does not work is done Returning it in the future until ensuring its success. The operation can be considered successful when the (SINR) received at the target receiver has a threshold greater than the previous threshold (SENR TR), and here it has been assumed that each receiver has the self-ability to Create an ACK for each effective-transmission and an {N-A-C} for every failed transmission.
1-We will assume that the network achievement is fixed and the locations of all the sending nodes and the target (receiving) remain constant at any moment, thus the probability of success at each independent time
The possibility of success with Hybrid and cognitive networks:
The success likelihood is given as a common shipping fee (or carrier completion rate) at any take a look at receiver [13]. Under the hybrid-spectrum get admission to mode, such an evaluation depends on the transmissions in each of the overlay and underlay modes
1-Analysis in the Primary Network:
In the case of a random selection of the primary transceiver in the hybrid CRN system, the probability of success is :

$$\mu_{\mathrm{p}}^{\mathrm{h}} = (1-\mathrm{p_m})[\varepsilon(1-\mathrm{p}^{\mathrm{o}}_{0'\mathrm{p}}) + (1-\varepsilon)(1-\mathrm{p}^{\mathrm{u}}_{0'\mathrm{p}})] + \mathrm{p}_{\mathrm{m}(1-\mathrm{p}^{\mathrm{OI}}_{0'\mathrm{p}})}, \quad (4)$$

p_m This symbol expresses the false detection of the signal generated by (pT) through (S-T). And that is between the modes of (overlay-base), and when the value is zero, the overlay is traditional here,
ε = 1 Here is the base mode, but here the value (zero)< ε<1 refers to the hybrid mode
$\mathrm{p}^{\mathrm{u}}_{0'\mathrm{p}}$ It expresses the discontinuation opportunity for each pU.,
$\mathrm{p}^{\mathrm{OI}}_{0'\mathrm{p}}$ It is the probability of a transmission interruption, similar to the overlay mode $\mathrm{p}^{\mathrm{o}}_{0'\mathrm{p}}$ It expresses the probability of outage in the continuous transmission and the error of the PU signal (which is the chance of the transmission being interrupted at the target node so that it is obtained from a common {PR yk -p}as indicated by the relationship(2)

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$$P_{outage}=P\left(SINR_{Y_K^p}\leq\theta_p\right)=1-\exp(-s\sigma^2)\mathcal{L}_{I_{pp}}(S)\mathcal{L}_{I_{sp}}(S),\quad(5)$$

L_I is the Laplace seriously change of combination is the amount of overlap in s = θP prα pp $\theta_p = 2\tau-1$, the place τ It is the standard value of the important transmission process from (4). The evaluation of the basic transmission and overlay (conventional) must first be obtained before the values for the hybrid.
1. Prototype: At least one PT so that the STS adapts to the active PTS as the basic mode but must be outside the Exclusion Zone (D) in any PT, after which it receives a potential outage (PU) in any (P) $PR_{Y_K^p}$ is received from (5) as :

$$P_{o,p}^{u}(y_k^p) = 1-\exp(-s\sigma^2)\mathcal{L}_{pp}(s)\mathcal{L}_{I_{sp}}(s).$$

In a simplified CRN, entirely a single PT xk p transmits on any channel, as a end result LIpp= 1. However, in a large or large scale CRN viewed in this paper, extra than one PTs can co-exist internal the equal channel, as a end result {2} expressed as

$$I_{pp} = \sum_{\in\emptyset_p x_i^p/x_k^p} P_p h_{k_i^p\,k^p}\|x_{ix}^p y_y^p\|^{-\alpha}[2].\ \mathcal{L}_{I_{pp}}\text{ is}$$

$$\mathcal{L}_{I_{pp}}(s) = E\left\{\exp\left(-s\sum_{x_i^p\in\emptyset_p/x_k^p} P_p h_{x_i^p y_k^p}\|x_i^p y_k^p\|^{-\alpha}\right)\right\},\quad(6)$$

||ab||It is the error in taking the correct path between a sender and a target (receiver),
The (H-A-B) must be able to correspond to the negative variables that change randomly and match the mean of the unit as follows (hab ∼ exp 1).

$$\mathcal{L}_{I_{pp}}(s) = \mathcal{L}(\lambda_p^I p P_p, s) = \exp\left\{-\lambda_p^I \upsilon_p \frac{\pi^2\delta}{\sin(\pi\delta)}\right\} P_p^\delta s^\delta\quad(7)$$

$\delta = 2\alpha$ and $\lambda_p^I = \lambda pPa$. The expression of Pa can be got Pa = exp(−λpπD2), Responsible for managing disharmony between active units of the P-T.

$$\mathcal{L}_{I_{sp}}(S)=\mathcal{L}(\lambda_s^I{}' P_s^u{}' S),$$

λIs = λsPb, understanding that an ST will solely transmit when its region is backyard the place of radius D of any energetic PTs. Hence
Pb = {exp(−λI pπD2)}. The ensuing factor technique in this case is higher represented as gap processes. However, to keep away from needless tricky analysis, here we have an approximation of the active unit distribution process from ST.

2-Overlay model (overlay): BTS is transferred in overlay mode when there is no STS, so the interference here in this case must be zero (provided that there is no interference between the channels used)&LIsp= 1

$$P_{0'p}^{O}(y_k^p) = 1-\exp(-s\sigma^2)\mathcal{L}(\lambda_p^I, P_p, s).\quad(8)$$

In case of false detection of (PTS) by (SUS), the (STS) is sent with a full sending card (PSO) that is larger than (PSU), so we have more interference in the first network

$$\mathcal{L}_{I_{sp}}(S)=\mathcal{L}(\lambda_s^I{}' P_s^o{}' S)'$$

$$P_{0.P}^{OI}(y_k^p) = 1-\exp(-s\sigma^2)\mathcal{L}(\lambda_p^I, P_p, s).\quad(9)$$

2-Analysis in the secondary Network:
We can obtain the probability of success in (SR) according to the penetration pattern of the hybrid spectrum at any ε

$$\mu_s^{OL} = p_q(1-p_f)(1-P_{os}) + (1-p_q)p_m(1-P_{os}^{h}) +$$

$$(1-\rho)\varepsilon[p_q p_f(1-P_{os}^{ul}) + (1-p_q)(1-p_m)(1-P_{os}^{u})],(10)$$

$P_{o,s}^{O}$ Expresses the chance of disconnection and disconnection in the (SU) in the overlay mode as long as there is no channel detection error condition,
$P_{o,s}^{u}$The probability of separation in units (SU) similar to the base setting
$P_{o,s}^{OI}$ The probability of separation in units (SU) but here in the superposition mode (overlay model) and in the case of at least one false detection

$P_{o,s}^{uI}$ The possibility of separation in units (SU) but here in the basic situation there is interference by units (pT)
p_f Incorrect false alarm
p_q The unavailability of any pT units results from continuous follow-up of the channel
The outage probability at any typical (SR ys k)is obtained from (3) as :

$$P_{outage} = P(SINR_{y_k^s} \le \theta_s) = 1 - \exp(-z\sigma^2)\mathcal{L}_{I_{ss}}(z)\mathcal{L}_{I_{ps}}(z), \quad (11)$$

Basic model: As in the normal basic mode, when there is at least one PT, the STS will coexist with the active PTS, and the probability of the SU outage

$$y_k^s at\ z = \frac{\theta_s r_s^\alpha}{P_s^u}$$

$$P_{o,s}^{uI}(y_k^s) = 1 - \exp(-z\sigma^2)\mathcal{L}_{I_{ss}}(z)\mathcal{L}_{I_{ps}}(z). \qquad (12)$$

We know that $\mathcal{L}_{I_{ss}}(z) = \mathcal{L}(,\lambda_s^I, P_s^u, z),$

$$\mathcal{L}_{I_{sp}}(z) = \mathcal{L}(\lambda_p^I, P_p, z).$$

When sending (STS) resulting if the base is wrong, there will be only one interference from another one like it , so :

$$P_{s,p}^I(y_k^s) = 1 - \exp(-z\sigma^2)\mathcal{L}(\lambda_s^u, P_o^u, z). \quad (13)$$

Overlay mode: In this situation, it can be assumed that the value of the interference from PTS is nil, in the event that there is no active PTS within the channel LIps= 1

$$P_{s,s}^I(y_k^s) = 1 - \exp(-z\sigma^2)\mathcal{L}\left(\lambda_s^O, P_o^O, sz = \frac{\theta_s r_s^\alpha}{P_s^o}\right). \quad (14)$$

Also, in the case of incorrect detection of the BTS signal, in this case, STS will be sent with a full transmitting power and capacity (POs > PsU), and then interference will be generated at (PR) and interferences resulting from (BTS) will be added to it.

$$P_{p,s}^I(y_k^s) = 1 - \exp(-sz\sigma^2)\mathcal{L}(\lambda_s, P^O, sz)\mathcal{L}(\lambda_p^O, P_q, sz). \quad (15)$$

Conditional success and its probability in the initial network:
$PR_{y_k^p}$ (Expressed as μ!ypk) is thus given as

$$\mu_{y_k^p}^! = P\left(SINR_{y_k^p} > \theta_p \backslash \emptyset, \forall \emptyset = \emptyset_p^I \cup \emptyset_s^I\right). \quad (16)$$

In normal base mode - probability of success

$$\mu_{y_k^p}^{!u} = \exp\left(\frac{\theta_p r_p \sigma^2}{P_p}\right) \prod_{x_i^p \in \emptyset_p^I \backslash X_k^P} \left(\frac{\upsilon_p}{1+\theta_p r_p^\alpha \|x_i^p\|^{-\alpha}} + 1 - \upsilon_s\right) \prod_{x_i^s \in \emptyset_s^I} \left(\frac{U_s}{1+\theta_p r_p^\alpha \|x_i^s\|^{-\alpha} \frac{P_s^u}{Ps}} + 1 - \upsilon_p\right). (17)$$

After analyzing (28-30) the second moment is $\mu_{y_k^p}^{!u}$ And by approximating the descriptive distribution by following the approach as in (30-31) with beta distributions

$$P\left[\mu_{y_k^p}^{!u} \le x\right] = I_x(\beta_1, \beta_2),$$

$$\beta_1 = \frac{M_1(M_1 - M_2)}{M_2 - M_1^2}$$

$$\beta_2 = \frac{(M_1 - M_2)(1 - M_1)}{M_2 - M_1^2}.$$

M1, and M2 are the first and second moments of $\mu_{y_k^p}^{!u}$

The probability for the conditional success of any ($PR_{y_k^p}$) in the mode (classical superposition) is as follows

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$$\mu^{!p}_{y_k} = \exp\left(\frac{\theta_p r^{\alpha}\sigma^2}{P_p}\right) \prod_{x^p_k \in \emptyset^I_p \setminus x^p_i} \left(\frac{\upsilon_p}{1+\emptyset_p r^{\alpha}_p \|x^p_i\|^{-\alpha}} + 1 - \upsilon_p\right)$$

σ2 → 0

$$M_{b,ouerlay} = \exp\left\{-\lambda_p \emptyset^k_p r_p \frac{\pi^2\delta}{\sin(\pi\delta)} \sum_{k=1}^{\infty} \binom{b}{k}\binom{\delta-1}{k-1} \upsilon^{\sigma\ 2}_p\right\}. \quad (20)$$

The probability of conditional success in the second network:
The probability in each ($SR_{y^s_k}$) is as follows:

$$\mu^{!}_{y^s_k} = P\left(SINR_{y^s_k} > \frac{\emptyset_s}{\theta}, \forall\emptyset = \emptyset^I_p \cup \emptyset^I_s\right). \quad (21)$$

σ2 → 0

$$\mu^{!u}_{y^s_k} = \prod_{x^s_i \in \theta^I_s / x^s_k} \left(\frac{\upsilon_s}{1 + \theta_s x^{\alpha}_s \|r^s_!\|^{-\alpha}} + 1 - \upsilon_s\right) \prod_{x^p_i \in \theta^I_p} \left(\frac{\upsilon_p}{1 + \theta_s r^{\alpha}_s \|x^p_!\|^{-\alpha} \frac{P_p}{P^u_s}} + 1 - \upsilon_s\right). \quad (22)$$

We get(b-th) (time) as follows

$$M_r = E_{y^s_k}\left(\mu^{!u}_{y^s_k}\right)^b = E_{b_s}\left[E \prod_{x^s_i \in \theta^I_s / x^s_k} \left(1 - \frac{E[\upsilon_s|\phi]}{1+}\right)^b E \prod_{x^p_i \in \phi^I_p} \left(1 - \frac{E[\upsilon_p|\phi]}{1 + \frac{\|x^p_!\|^{-\alpha}}{\theta_s r^{\alpha}_s} \frac{P_p}{P^u_s}}\right)^b\right]. (23)$$

From here we can get the approximate probability of conditional success in our second network for (classical basis and overlay) and the case that expresses false detection, then we reach the hybrid analysis directly from equation No-10 [14].

Analysis of the flow in the network and the analysis of the average life of the information in it:

We will study some network throughput analyzes and analysis A-O-I

1-network throughput:

Let us define the throughput of a network, which expresses the average number of packets and information that reach the destination (the target) successfully and within a specific area and range at any point in time [15]. The average network speed in the main (symbolized by it TN p) is given as follows :

$$T^p_N = \lambda^I_p \upsilon_p \log_2(1+\theta_p)\mu_{y^p_k}. \quad (24)$$

With the transport sign in our second network it can be derived similarly as follows

$$T^s_S = \lambda^I_N \upsilon_s \log_2(1+\theta_s)\mu_{y^s_k}. \quad (25)$$

2-Studying the average age of packages and information:

We rely on the metric that determines the newness of the data for the target contract, which is (A-O-I)
So that timing is important in this case for reliability because the failure occurs when the packet is delayed on its target [16], so that (A-O-I) expresses the difference between the current moment of observation (t) and the time of the basic creation of the studied packet (G(T)).

$\Delta(t) = t - G(t).$ (26)

A-O-I evolution

$$\Delta(t+1) = \begin{cases} \Delta(t)+1, & \text{transmission failure} \\ t+1-G(t), & \text{otherwise.} \end{cases} \quad (27)$$

The function of the meter is to capture the sum of the total waiting times of the packets in the waiting table and to add to it the wasted time for the service.

(XK) Number of intervals for successful delivery

(yk) is the sum of aoi

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$$X_k = \sum_{i=1}^{M} I_i, \qquad (28)$$

(M) Variable number of transmission attempts between each two packets

$$Y_k \sum_{k=t_k}^{t_k+1} \Delta(k). \qquad (29)$$

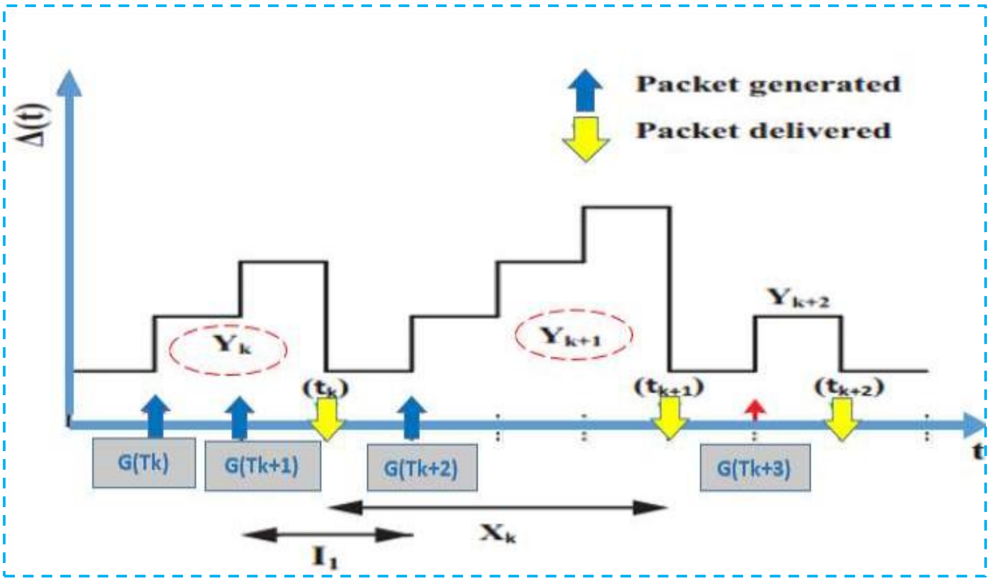

Fig 2: A-O-I values evolve
Fig. 2: (A-O-I) values evolve
The figure (2) shows how the (A-O-I) values evolve
(i) Denotes the time difference for arrival
(XK) The number of such intervals for two successful deliveries
(yk) sum (A-O-I) between
From the previous equations (33-15), it is possible to know the mean (A-O-I) where
(L) Number of packages
And average Δ(W) is as follows:

$$\Delta(W) = \frac{L}{W} \frac{1}{} \sum_{k=1}^{W} \Delta(k) = \frac{1}{W} \sum_{k=1}^{L} Y_K = \frac{1}{W} \frac{}{L} \sum_{k=1}^{L} Y_K. \qquad (30)$$

Below we will present some of the results of simulations carried out to illustrate how the work and performance of the units (PU-SUS)[17], and the probability of success of any device in transmitting is the delivery rate so that the target or receiving device does not experience any disconnection or disconnection resulting from the activities of the users.
Table 1 compared the performance of the hybrid spectrum access mode with overlaid, conventional and basic access systems.

Parameter	Definition	Value
λ_s	Distribution of secondary transmitter-receiver pairs	0.3
λ_p	Distribution of primary transmitter-receiver pairs	0.03
r_p	Distance between any tagged primary transmitter-receiver pair	0.5 m

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r_S	Distance between any tagged secondary transmitter-receiver	0.1 m
P_P	PT's transmission power signal	0 dB
P_S^O	ST's transmission power signal in the overlay mode	-32 dB
P_S^u	ST's transmission power signal in the underlay mode	-36 dB
α	Path-loss exponent	4

In order to ensure the implementation of the BUS conditions of service, a high delivery rate of packets must be ensured at the target [18], and in the absence of good coordination between channel sensing, errors and drop in transmission rate can occur as shown in Fig. 3-1

So that the higher the switch rate, the lower the service completion rate (PU) due to the excess activities of the special units in the known basic mode [19], and in the case of false detection, the more negative its impact on the delivery service, so it is important to coordinate between the special units in the channel sensing mechanism.

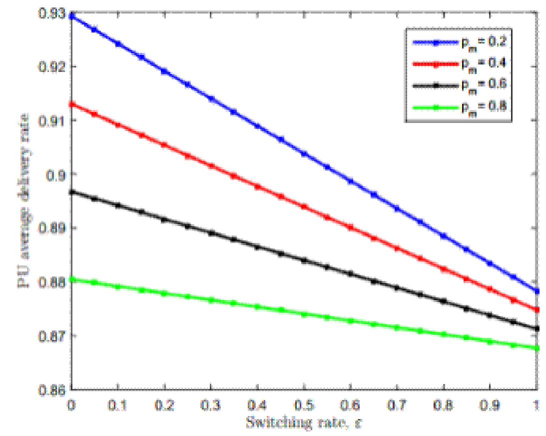

Fig 3-1: The success of the service in the first network according to the hybrid mode

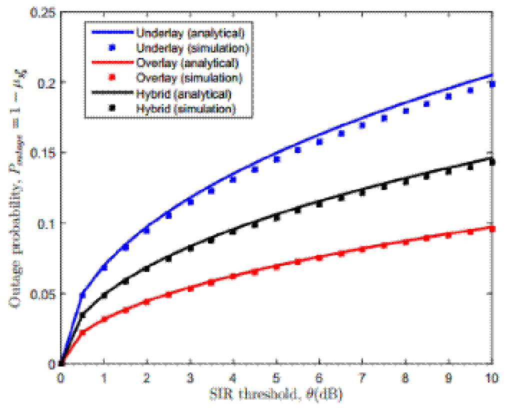

Fig 3-2: Increased transmission rate and probability of

It is obvious that with the increase in intensity and degree (SINR-θ-Tr,), the probability of disconnection (outage) will increase, so that the higher the rate of the first data link, the greater the probability of disconnection and disconnection in the first network, and thus a decrease in the BU rate with the increase of data, regardless of the method of access to the spectrum and this is explained in Fig. 3-2, so that in the (combined / superimposed) spectrum model, the probability of separation (disconnection) is less in the hybrid than it[20].

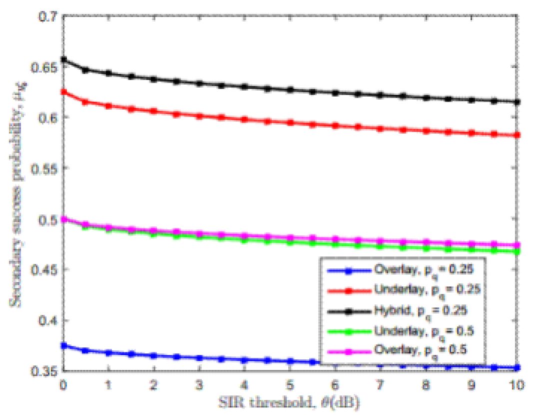

Fig 4-1: The rate of data access in our second network

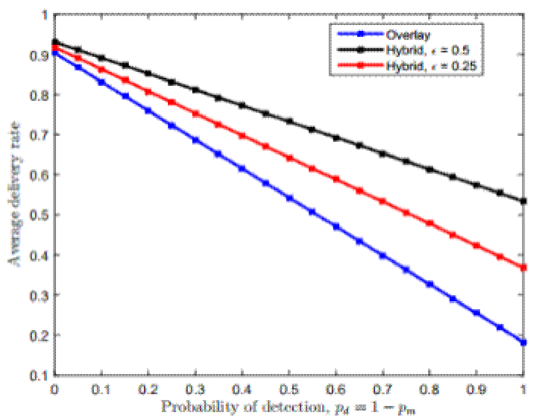

Fig 4-2: Success rate of SU access and impact of BU detection on it

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We have in the studied dual network, we will show the probability of completing the process successfully and the effect of the data rate on it. Every increase in data (average) is accompanied by a decrease in the probability of completing the process successfully, as the mixed model (hybrid) improves the success of the transfer process in the second receiving network, so that the units are Capable of transporting at maximum Capacity when there is no PU and improving success in the hybrid model, Fig. 4-1.
We can maintain the laws of (QoS) by improving the detection process of the signal, and because of the restrictions imposed on transmission when one or more of the (PU) is present, the average arrival and delivery decreases [21], here we notice the high performance of the developer of the (hybrid) model in increasing the rate of reaching the target (delivery for packages), Fig. 4-2.

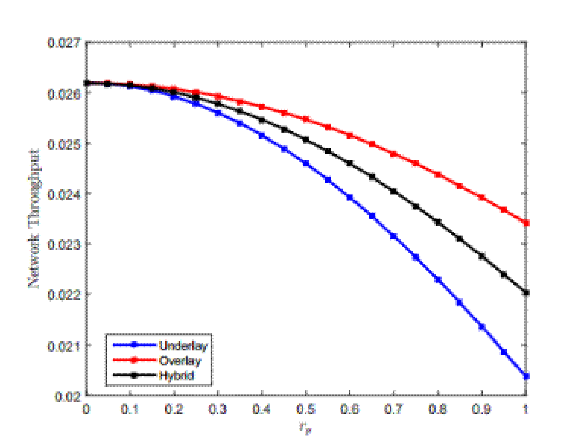

Fig. 5-1: A-o-I in the 1st network

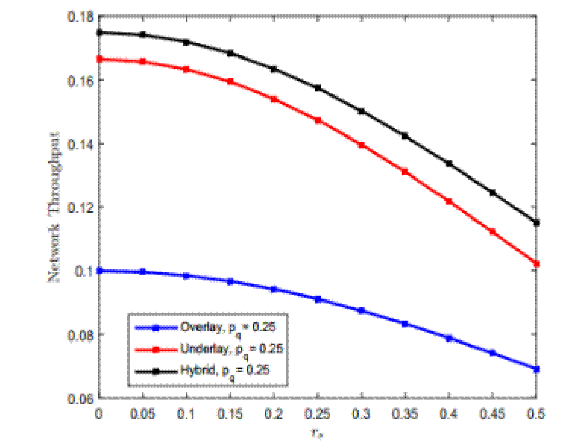

Fig. 5-2: A-o-I in the 2end network

The greater the distance between the sender and the target, the lower the transmission rate. One of the effects on the performance of the network is interference as well, especially in the studied hybrid mode [22], as shown by the scheme Fig. (5-1). the same happens to the second network, as is the case in the scheme Fig. (5-2) and we note that the units are more effective in the hybrid mode.

Conclusion:

The reason for this study is the need to improve the performance of the channels of the units, especially those in which some units use them, such as PU units, so it is essential in our study to know the performance of the hybrid type of spectrum and the access mechanism and how it is the result of a comparison with other patterns (overlay and basic). We discussed the ability of the hybrid spectrum (access model) and improving performance and access to the channel for sub-users while ensuring the highest quality for the primary users. Our results for the hybrid spectrum showed its ability to increase performance in accessing the channel while maintaining the constraints imposed on the quality of service (PUS); these results are helpful in the CRN models.

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