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# Optimization of Resource Allocation in Wireless Systems Based on Game Theory

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***Abstract:*** The power allocation has for long been considered a major problem for communication between many users who share common resources. With the emergence of new paradigms such as ad hoc networks, unregulated frequency bands and cognitive radio, the study of power allocation distributed protocols becomes particularly relevant. In fact in such networks, terminals can freely choose their power allocation strategy without following the rules imposed by a central node. The terminals are considered to be independent actors and it is reasonable to consider that they are rational, that is to say, by regulating their transmission power levels, terminals wish to maximize their communication quality. In this context, it is natural to study the problem of power allocation of each terminal as part of game theory, considering the terminal as each players looking to maximize their own utility function by controlling their power emission. Game theory allows particularly to study the existence and multiplicity of balancing power allocation strategies that terminal has no interest to deviate unilaterally .In a multiple access channel, the signal from a terminal received by the other terminals as interference to their own signals. Each terminal of the transmission quality depends directly of the transmission power level of other terminals.

***Keywords:*** Game Theory, Fairness Optimization, Access Methods, Resource Allocation, Power.

## 1-Introduction:

The essence of game theory is the study of interactions between several decision makers whose decisions are interdependent: what a decision maker or player gets depends not only on what it does but also what the other players are doing. In wireless communication, transmitters may be seen as decision-makers who must choose their settings. These may typically include the power level of the transmission signal, the portions of the spectrum used, the emission periods, the type of modulation used, etc. [1]. When several transmitters use a common part of the spectrum simultaneously and in the same geographical area, performance related to a communication between a transmitter provided with its receivers of interest generally depend on both of the transmitter emitting strategy itself, for example the power level of the transmission signal but also the strategies of other transmitters. So the fact that common resources are shared, this generates interference or not, decisions transmitters are naturally interdependent. It is therefore not surprising that the game theory plays an increasingly important part in the area of wireless communication.

The evolution of the telecommunications world to mobile multimedia resulting from technological advances have shown that providing network access is not enough. The need for users moving towards the access to value-added multimedia services in their own nominal environment regardless of how they access systems. Multimedia services require high transfer rates and the quality of service requirements. They must coexist with real-time requirements to services such as voice service that does not tolerate variation in the time between sending and receiving packets [2]. The warranty of these services by the operator becomes much more difficult in technologies that take into account user mobility. The total accessibility on the move to service more and more consumers and network resources in real-time and interactive treatment, require solutions and technological support for managing multiple modes of access, transport and controls specific to each service or application, such as real-time service and reliable transport data, video conference or transfer of real-time video stream, transactional behavior, payment, etc.

New mechanisms will be needed to differentiate services and provide the quality of service required. These mechanisms include admission control, resource reservation protocols and packet scheduling policies. The challenge for next generation networks is to maintain high data rates and quality of service on the radio links (up and down) which are unreliable for transmissions. CDMA is the most advanced multiplexing technique, to be used especially on mobile networks of third generation. While previous frequency multiplexing techniques (FDMA) and time division multiplexing (TDMA) mainly consisted of dividing a physical quantity (a frequency bandwidth or time elapsing) into individual slots [3], CDMA does not set advance static allocation of these resources and is similar to the packet data transmission technology.

The communication between two mobiles is not established by a direct electrical connection or a wireless system centralizes around a central control unit managing different mobiles. The geometric area to cover is divided into cells, each having a base station. The communication is then provided by the links between the base station and the various mobiles. It is provided by allocating a channel to each mobile [4]. A channel usually employs two transmission frequencies: one is used to communicate information from the base station to the mobile and is called downlink communication; the other is used to communicate information to the mobile station base and is called uplink.

The terminals are assumed able to detect and reuse in an effective and an opportunistically way the unused spectrum by other systems. In this context, the objective of our work is to understand how terminals interact when they allocate power among several orthogonal frequency bands on which you can find relay nodes. This scenario is modeled by a set of channels with a parallel interference. The natural paradigm, used to explore transmitters, which is independent and selfish, is the theory of non-cooperative games. Each transmitter is supposed to be a selfish rational decision-maker and it chooses its strategy, the power allocation that maximizes its own transmission rate. The power allocation that maximizes the terminal rates for the channel with a selective frequency interference. Also the dual problem of power allocation that minimizes the power consumption which ensures a minimum rate between different pairs of terminals.

In this work, we consider the source-destination links and relay that is available on each band can be used by issuers. The transmitters decide on their own political power allocation between bands and not those of the relay nodes are common.

The rest of the paper is organized as follows: in Part 2 we explain the formalism of game theory, Part 3 we detail the multiple access techniques and methods of allowances, Part 4 we explain our theoretical approach, Part 5 is reserved to simulations and analysis of results, and conclusions are given in part 6 .

## 2-Game theory in wireless systems:

To meet growth bandwidth demands of internet users on mobile, different network access technologies knew a beginning of deployment by operators. A major challenge in a heterogeneous wireless environment is to allow network selection mechanisms to keep the mobile network users always connected anywhere and anytime [1]. For this, game theory techniques were analyzed and adopted to model and understand the competitive and cooperative scenarios between network operators and users.

This theory is based on a set of tools to analyze situations in which what is optimal to do to an agent depends on expectations that it forms on that one or more other agents will do. The aim of game theory is to model these situations to determine an optimum strategy for each agent [5], to predict the balance of the game and find how to achieve an optimal situation.

### 2-1 Game theory and network selection:

Game theory is a mathematical tool used for understanding and modeling the competitive situations that involve the interaction of rational decision makers with potentially conflicting interests. It was adopted in the telecommunications environment, particularly in wireless networks, cognitive radio networks, and ad-hoc networks for studying, modeling and analysis of interactions between individuals.

When using game theory in heterogeneous wireless environment, several challenges and issues can be identified. Indeed, the 4G environment aims to provide a heterogeneous combination network, terminals and services [6]. In these multi-vendor multi-user environments, users with wireless multi-mode mobile devices will have the ability to connect to one or more access networks differing in technology, the range of coverage, available bandwidth, the supplier service, the monetary cost, etc.

In this context, the approach of game theory can model and analyze the cooperative or the decision makers interaction between them that we can describe as competitive who represent users and network operators. One of the primary challenges is to identify the players and to model the problem with the cooperative or noncooperative appropriate game [7]. The players, each user's strategy and objectives must be clearly defined as they represent the main components with the roles in the game.

### 2-2 Game theory principle:

This theory works on the assumption of rationality, which means it assumes that the players are rational individuals acting according to their interest. While the main interest of service providers is to increase revenues by increasing the number of their customers at the same time, users expect to get the quality of service they pay [5]. When considering the heterogeneous wireless environment, players are represented by network entities or user terminals, which are assumed to be rational. Different game templates were considered under different scenarios [8], most of the solutions presented by the theory of non cooperative games are used to define the interactions between players.

The users compete by adopting different strategies, such as the transmission rate available, the required bandwidth or submitting offers showing the agreement to pay. The cooperative approach is modeled as a set of bargain where users are free to negotiate to obtain the desired benefits. There is a competition between networks to increase their individual income using different strategies, such as the prices quoted, the available bandwidth, and service requests. The cooperation between the networks keep the scenario in which a number of different access networks form coalitions to handle service requests when a single access network can not provide it. In this scenario, cooperation is based on the assumption that wireless networks can cooperate [9], or because the requested service exceeds network capacity or because they can reduce some of their costs by cooperation.

By using game theory we can model realistic scenarios in which players compete against each other and each seeks to maximize profit. In a cooperative game, players are supposed to work together to maximize their earnings, but in some cases, they can act selfishly refuse to cooperate and to maximize their own benefit or maintain their own limited resources. Provocative mechanisms can be adopted in such bearings, to avert an overall degradation of QoS. The objective of using provocative schemes is to motivate the players to cooperate in maximizing overall profit. An important aspect that appears as a result of the dynamics of the wireless environment, is that some cooperative players can be seen as selfish because , wireless interference may generate some errors, or because of the collisions of packet [10].This may end in players cooperation ending ,and as a the consequence ,diminishing the global performance of network .

Another important aspect is the way the players make their decisions in a distributed or centralized. The centralized approach is rarely used in the resolution of the problem of multiple network access. This may be due to the computational load increases with increasing network size.

Generally game theory is more suitable approaches to distribution with features auto-configuration and a lower communication overload [6]. The common goal of the approaches of this theory is to improve overall system performance (for example, the efficient use of resources, maximizing throughput, ensuring QoS).

**2-3 Definition:**

Game theory is a field of science based on a set of analytical tools for understanding some phenomena observed when several decision centers interacting, especially when they have conflicting interests. These tools are efficient for analyzing the situations in which the decision of a player has influence on the utility function of other players in the game [11]. And it can also be defined as a mathematical approach, which consists of templates and techniques to analyze the critical behavior of rational individuals, usually games can be classified into two types: competitive and cooperative game play.

**2-4 the strategic game:**

The strategic game is the set of rules which governs player behavior and determines the gain of the players on the basis of actions according to this terminology; a strategic game requires a clear definition of the rules of behavior of the players.

**2-4-1 Typologies of the game:**

Strategic games can be typed according to some requirements such as behavior, information of the game and the decision.

**2-4-1-a Cooperative / competitive games:**

The games are typed according to the behavior of the player relative to other players, for a player it is either in cooperation / competition with other players.

**Cooperative games:**

A game is cooperative if the players can pass between themselves agreements which bind the binding manner. We then say that they form a coalition whose members work together.

**Competitive games:**

By definition, in a competitive game we specify all strategic options available to players, while the agreements behind the coalitions in a cooperative game are not described. Each player aims to get his property ignoring to the other players.

**2-4-1-b Games decisions with simultaneous / sequential:**

The games are typed in order of players' decision, the decisions of the players are taken either simultaneous or sequential.

**Games with simultaneous decisions:**

In these games, players take their decisions simultaneously, without knowing the decision of other players [8], we can cite some example: Prisoners Dilemma, rock-paper-scissors.

**Games with sequential decision:**

Here the decisions of players are sequentially, ie the player decisions are taken with a time lag. The decision of the player is influated by the decisions already taken by the other players, some examples of games to sequential decision, the more popular it is: the failure Thurs.

**2-4-1-c games in perfect information / Imperfect:**

In such games are typed according to information on the other players, in other saying is that the player know when he makes his decision. Perfect information games is a game or actions made earlier by influential player on the decision of the player wishing to make a decision because the player has information on the actions already carried out by other players and it takes the decisions of players are sequentially [12], excluding than the imperfect information game the player does not have all the information on the other players, or at least two decisions have already been carried out simultaneously, making the most difficult decision in the game has perfect information .

**2-4-1-d games in complete / incomplete information:**

This type is based on the information of the players against other players.

**Complete information games:**

All game elements are a prevalent expertise among the players, each player knows more precisely the set of behaviors possible for all other players and he knows all the payment.

**Incomplete information games:**

This is a game where each player does not know all the behavior of other players.

**2-4-2 the performances of the game:**

A game is defined as the number of players, the set of possible strategies for each player and the specification payments or utilities of players for each combination of strategies. Cooperative games are generally presented in the form of characteristics while non-cooperative game functions are represented in normal form or extensive form, there are different ways to formalize the theory of the game and of the decision and even more so following the type situations in question [13]. Thus, we distinguish:

**2-4-2-a Normal form:**

Which can significantly reduce the size and time graphical representation of a game as a array of gains but are inappropriate for repetitive games. A game in normal or strategic form game in shape is defined by: All the players, all the possible strategies for each player, the preferences of each player on the set of possible strategic combinations. All players must be over, All the strategies of each player can be: finished, each player decides to cooperate or not, or infinite, each player decides how much good he wants to produce and can choose any value in the set of positive real [6].Preferences may also be represented by a utility function or a gain function [10]. When one is a normal form game, it makes the implicit assumption that each player chooses his strategy without knowing the choices of other players.

**2-4-2-b extensive form:**

Which are shapes synoptic (tree, branch, leaf) useful to a simple understanding of the possible strategies and the outcome of a game is considered a sheet in which we find the vector of the respective gains of the players. This kind of representation becomes complicated when repetitive games. In all games, the decisions can be represented by a tree, each node is associated to the player to decide. Each option is a branch [7]. The gains are related to all endpoints, or leaves of the tree. A player, however, does not require knowing how it reached a node: one account the present state of the game, and the desired positions in the future. When certain movements are allowed only after a given event, this event is only one element to materialize in the present state of the game and does not need to be part of history [14]. An extensive form game is a decision tree that describes the possible actions of the players at each stage of the game, the sequence of rounds of play of the players, and the information available to them at every step to make their decision.

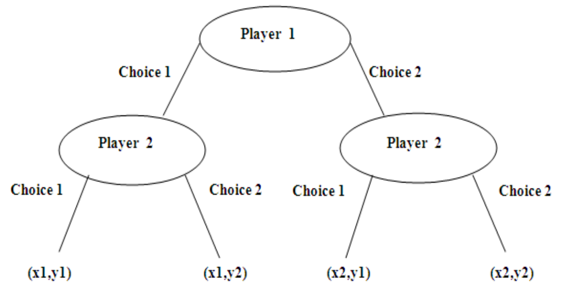


**Figure 1:** The extensive form of a strategic stake.

Figure 1 illustrates, well clearly shows the concept of extensive form of strategic game, the player 1 has two choices making the choice 1 and choice 2, player 2 also two choices choice1 and choice2, player 1 is the who plays first and player 2 is playing the second, if the player decides to take one choice as one decision then the reward is x1, and decides choice2 then the reward is x2, for 2 player if his choice is choice1 he will y1 as a reward and if he chose choice2 reward is y2, if the players selected choice1, 1 and 2 players chosen reward 1 choice of both players is x1 y1 respectively show what is the left leaf of the tree.

**2-4-3 solution concepts:**

A solution concept is a process by which the balance of a set are identified. They are employed as game predictions, suggesting what the result of the game [7], that is to say which strategies will or may be used by the players.

- **Dominant strategy equilibrium:**

A game has dominant strategy equilibrium if for each player, there is a strategy that dominates all other strategies, whatever the strategies of other players. In other words, whatever the strategies of other players, the payment I get playing this dominant strategy will be strictly greater than that obtained by playing another strategy [5]. A dominant strategy will be played by each player and obviously nobody's interest to deviate from this balance. The dominant strategy equilibrium is Nash equilibrium. When there, dominant strategy equilibrium is unique.

**Equilibrium by iterated elimination of dominated strategies:**

It is said that a strategy is dominated for a given player there is at least another strategy such that, whatever the strategies adopted by the other players, this alternative strategy is always at least as good as the first and strictly better in at least one of the situations [11]. If each player is rational, assumes that the other players are rational and assume that other players assume that it is rational, then we can set the game balance as would be achieved by the successive eradication of dominated strategies.

**Nash equilibrium:**

A player can make several decisions and chose one that will be the best for him. The usefulness of a player may depend not only on those decisions but also those of all other players [12]. The concept of solution of a non-cooperative game is often the Nash equilibrium.

The Nash equilibrium is a choice decision of all players as none can benefit by changing his decision alone. Competitions situations can occur at several levels which require the adoption of approaches: approach of considering only one criterion that an agent wants to maximize and multi-criteria approach of separate requirements and define notions of balance are sensitive to each of them. In the case where each agent has only one evaluation criteria, the objective is to determine decisions for each of them, optimal in the sense of the concept of Nash equilibrium. Suppose there are N agents for access to the service, each looking to maximize a single utility function. $U_n$ noted the decision of the agent n, and $J^n(u,x)$, its utility function [10]. This function depends on the action Un of the subscriber n, but also the actions of all the other agents, the variable u= (u1, …., un) is N-tuple decisions by N agents. x is a parameter representing the architecture and politics management service offered. For an architecture and service politics, x, fixed, N-tuple decisions $U^*(x)= (u^*_1,\ldots\ldots u^*_N)$ is said Nash equilibrium if none of N agents can enhance its utility function by modifying only its decision. Specifically, for all n Є {1,2, ......, N}.

We have:

$$J^n(u^*(x),x) = \max J^n(u^*_1,\ldots\ldots,u^*_{n-1},u_n,u^*_{n+1},\ldots\ldots,u^*_N,x) \quad . \quad \textbf{(1)}$$

But in reality each agent may try to make decisions to maximize several criteria[13], in this context, the utility function of a $J^n$ agent n is a vector, $J^n= (j^n_1, \ldots\ldots j^n_k)$ .

With the rise of wireless communication networks, emerged resource sharing issues (frequency bands, transmission power, scheduling, etc.) and configuration of networks giving autonomy of decision to the mobile terminals of the system. This is especially the case for wireless sensor networks, networks in the WBZ frequency bands (WiFi, Bluetooth, ZigBee), femto-cell networks and ad hoc networks in general. In this context, therefore game theory is a fully appropriate tool to study these networks stable states [14]. Another reason favor of game theory is that in such networks, configuring communications is not static, it evolves over time based on parameters such as the number of terminals in the system and the quality of means of transmitting terminals. Beyond the static game, game theory offers just repeated game models and stochastic games respectively consider the strategic implications of the repetition of a game and changes in playing conditions over time.

**3 -multiple-access techniques:**

The communication channel is basically a diffusion means. Therefore, a signal transmitted by a user may possibly be received by all the other users located in the area covered by the transmitter [15]. Though this possibility is very interesting for certain applications, such as broadcasting or television, it requires strict control of access mobile communications.

The aim of mobile communications is to provide communication channels on demand between a mobile terminal and a base station that connects the user with the fixed network infrastructure. Of tells the system design criteria include the capacity, complexity and quality of service. All these criteria are influenced by the method used to provide multiple access. Anyway, the opposite is true [16]: the access methods must be carefully chosen in the light of the relative importance of design criteria and characteristics of the systems.

There are several types of multi-user communication systems. A first type is a multiple access system with which a common channel of communications is used by a large number of users [17]. A broadcast network is a second type of mobile communication in which multiple receivers receives information from a single transmitter.

Multiple access techniques, wireless system is based on the isolation of various signals used in various connections. The support parallel transmissions in uplink or downlink is called multiple access.

A mobile communicates with a base station. For this exchange goes well there must first be a dialogue between the two allowing one hand synchronization messages and also to estimate the channel and establish the frequency and power of the corresponding emissions that they use when communicating [15]. The base stations regularly issue calls to mobile wishing to establish communication and continuously scan a communication channel where mobile give their request. In the case where the base station has available channels, it indicates to the mobile which frequencies will be used for communication. A mobile can make contact with several base stations

(Figure 2). They shall exchange the necessary information to decide the station with which the mobile will communicate. This will in principle the station that receives the better quality signals. This mobile station indicates at which frequencies will be used in the following the notification.

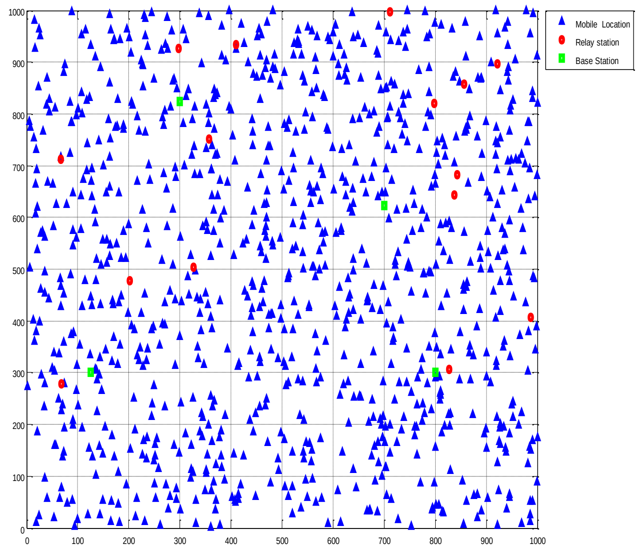


**Figure 2:** Location of mobile stations, locations of base stations and relay stations, here there are 4 base stations and relay stations 15.

### 3-1 allocation policies:

To administer different types of communication such as voice, packet data, etc wireless communication systems are extensively setted up. These systems can be multiple-access systems able of supporting communication with multiple users sequentially or simultaneously by sharing the available system resources [18]. Examples of multiple access systems include multiple-access systems by code division (CDMA), the multiple access systems by time division (TDMA) and the frequency-division multiple access systems (FDMA).

### 3-1-1 The static allocation methods:

The areas commonly used to provide the following access:

- Spatial Domain: All mobile communication systems use the fact that the signals undergo attenuation during their propagation. This means that the distant transmitters produce an interference which is negligible compared to the power of the desired signal [19]. The technique corresponding to such processing is called SDMA (Space Division Multiple Access).
- Frequency domain: Frequency bands occupying signals do not overlap, can be easily separated. Signals can be transmitted without interfering with each other. This method is called FDMA (Frequency Division Multiple Access).
- Time domain: Signals may be transmitted over time periods that do not overlap. In this way, signals attend the same frequency band; yet, can be effortlessly separated by their arrival time .This method is called TDMA (Time Division Multiple Access).
- Code domain: In the CDMA method (Code Division Multiple Access), different users emit very low correlation signals there between [20]. Correlators can therefore be used to extract individual signals from a mixture of signals transmitted at the same time and on the same frequency band.

In an OFDM transmission, the information relating to the transmission channel such that the SNR signal to noise ratio allow the transmitter to perform an adaptive allocation of subcarriers. This concept is used in practical systems, and OFDM is referenced as adaptive modulation or "BitLoading". Indeed, in the case of a system with multiple users, you need a very precise technique to be able to allocate to each of them its valuable resources [21]. Different methods of multiple access using the OFDM transmission exist:

#### 3-1-1-a multiple access time division:

In an OFDM - TDMA system, each user has a time interval during which all the subcarriers allocated to it (Figure 3). It is assumed that the duration of each time interval is equal to the duration of an OFDM symbol [19]. Modulation covers all subcarriers according to the channel conditions. This multiple access mode is better than other modes when random allocation is used, as it benefits from all the gain that has the channel.
The advantage of this type of multiple access is the reduction of energy consumption at the receiver which only works well determined moments.

The disadvantage of this type of system is the occurrence of problems in the case of remarkable propagation delay.

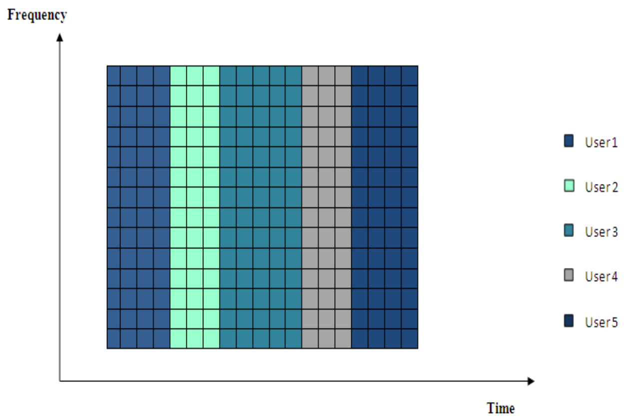


**Figure 3:** Multiple access OFDM-TDMA.

#### 3-1-1-b multiple access frequency division:

In an OFDM- FDMA system, each user allocates a portion of subcarriers in each OFDM symbol. For each allocated subcarrier applying an adaptive allocation method that depends on the SNR. This method has advantages and disadvantages opposite to those of OFDM TDMA method.

Different variations may occur, including:

### 3-1-1-b-1 block FDMA:

Each user is allocated a set of adjacent sub-carriers (Figure 4). The base station calculates the average gain of adjacent channels for all users and for all blocks. The allocation of a block to any user is to allocate a single block to each user. The first block will be allocated to the user who has the best SNR associated with that block [22]. Is continued by applying the same procedure with the blocks and the remaining users, until all the blocks are allocated.

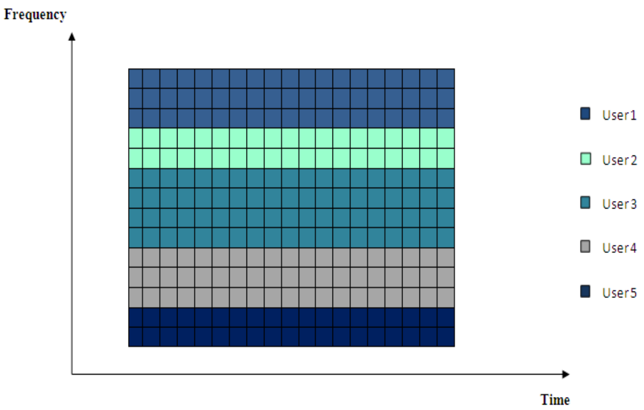


**Figure 4:** Multiple Access FDMA block

From the above stems the conclusion that the best combination is that user block which gives the maximum amount of frequency average earnings of all the blocks allocated to the users [23] .This method has a drawback in the case of presence of a hollow in the frequency response of the transmission channel, as all adjacent subcarriers will be affected by this hollow, and consequently the whole block will be well received.

### 3-1-1-b-2 Interleaved FDMA:

As a direct result of the disadvantage that this multiple access mode "Block FDMA," we can see that the coded data transmitted should not be simply assigned to OFDM subcarriers in a sequential order but we must interlace of first .So, users allocate subcarriers that are distributed on the frequency axis [24]. The adaptive modulation is applied on the subcarriers.

### 3-1-1-b-3 OFDMA Adaptive:

In this method, a subcarrier is allocated according to channel conditions. In a two-way communication system, the channel frequency response for each user on each subcarrier can be sent to the transmitter through a feedback or it may be estimated by the transmitter in the time division duplex systems [22]. The requested rate may be achieved, in the case of adaptive OFDMA, by several methods adaptive allocation of subcarriers. These approaches are all based on the fact that the channel gain is not the same for all sub-carriers, or for all users.

### 3-1-1-c multiple access code division:

Users are distinguished from each other by code. The version of CDMA-OFDM is the most widely used multi-carrier CDMA. In this type of access, the data signal is spread by direct sequence spread spectrum (Figure 5). The OFDM-CDMA advantage is the soft limit the ability of the user, and instead of OFDM -TDMA and OFDM-FDMA where the error probability of a bit depends on the channel state to the frequency by which it is modulated [25], in the case of OFDM CDMA each bit takes advantage of all the channel gain spikes.

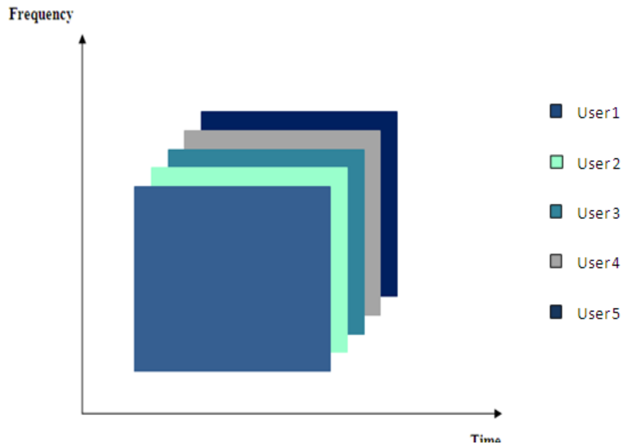


**Figure 5:** Multiple Access OFDM-CDMA.

### 3-1-1-Allocation of subcarriers:

Among the N OFDM subcarriers, each user chooses his randomly n subcarriers. It is possible that two or more users select the same sub-carriers, which leads to [26] collisions. Consider the two following cases:

A subcarrier may be allocated to a single user: Actually, if a subcarrier is chosen by more than one user, it will be eliminated and it will bear no information. This technique has simplicity in the modulation and demodulation [27]. This presents a great simplicity from the viewpoint signaling protocol between the base station and the terminal.

A subcarrier may be allocated to two users: In fact, a subcarrier allocated by both, or by a single user, of course, is properly received. This technique is only possible if the two signals transmitted on this subcarrier are orthogonal. Or the two terminal stations have different locations with respect to the base station; their channel attenuation factors are then different, which affects the orthogonality [28]. Of course, this technique requires a good signal between the base station and terminals.

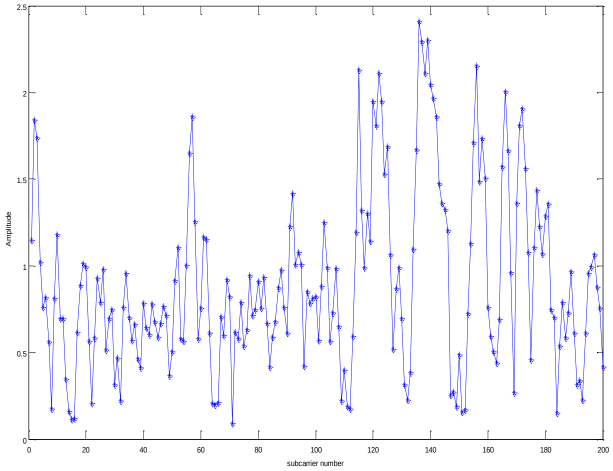


**Figure 6:** the amplitude of 200 subcarriers.

### 3-1-2 The dynamic allocation methods:

The allocation of resources is seen at the physical layer (frequency allocation and power). This part is devoted to's Survey OFDM techniques that enable resource allocation depending on the quality of service requested, ensure optimal system performance, assuming that the information on the corresponding channel to subcarriers are available. Therefore, two alternatives are considered [29]. The first deals with the random access point of view of the problem, while the second is adaptive appearance.

### 3-1-2-a method of random allocation:

The number of subcarriers in a communication system has increased and the demand for higher throughput persists [30]. In this section, we will describe a random OFDM system based on Multi Carrier FDMA, where each user randomly selects subcarriers. In a randomized OFDMA system, each user randomly allocates a set of n subcarriers, this set differs from one user to another. Because of this random selection, multiple users can choose the same subcarriers [31]. If two or more active users select the same sub-carrier, then the latter will collide and can not transmit payload data (in cases where a subcarrier can not be allocated to more than one user). As the number of users varies helpful when the number of subcarriers that are in collision still varies, which affects the data transmission rate [32]. This system has advantages and disadvantages, of these disadvantages:

The problem of the collision of the subcarriers resulting in a loss of capacity [33], non-optimized use of subcarriers in terms of minimizing the total power and do not meet the requested QoS: it does not ensure asked throughput .

These advantages include: The non-necessity of a signaling protocol for allouement subcarriers for users because each user knows its subcarriers and the base station knows the subcarriers of each user, uniqueness sets selected subcarriers allows users to make handover simple [34], because it needs to change the subcarriers when changing a cell, each user can move in the whole system by using sub-carriers.

### 3-1-2-b adaptive allocation method:

If the transmitter knows the information about the transmission channel and by using an adaptive modulation, the system performance can be highly improved. In particular, the sub-carriers with a large channel gain is modulated with high order to transmit more bits / OFDM symbol, while subcarriers fade deep are modulated with a low order to transmit or zero bits per OFDM symbol [35]. As for the different subcarriers channel status varies, and as the rate transmitted on the subcarriers varies also, then the power must change with users and subcarriers [36]. The criteria according to which is the allocation are: power, the flow rates and the fact that a subcarrier can not be allocated by a single user.

## 4- Theoretical approach:

In this work, we study power control techniques and algorithms distributed allocation of resources.

We first study the case of distributed power control, or optimization focuses on the convergence and stability of the concurrent use of a resource in the system. This type of allowance generally corresponds to a single-resource system, such as CDMA.

Our algorithm provides an iterative power control method, whose convergence is guaranteed when certain criteria are respected. The method involves making the following iterative allocation:

$$P(k+1) = FP(k) + u \quad \textbf{(2)}$$

With F defined as:

$$F_{ij} = \begin{cases} 0 & \boldsymbol{i = j} \\ \gamma_i \dfrac{g_{ij}}{g_{ii}} \quad \text{if} & \boldsymbol{i \neq j} \end{cases} \quad \textbf{(3)}$$

Where P is the vector of the powers allocated to users and $u_i = \dfrac{\gamma_i \sigma_i^2}{g_{ii}}$ $\gamma_i$ is the target SINR and $g_{ij}$ is the channel gain between the j i transmitter and receiver. This applies to a channel sharing between multiple transmitters and receivers (channel interference, such as ad-hoc networks or cellular). F is a matrix representing the quality of a link with respect to interference, weighted by the SINR targets, the lowest values are best. The main contribution is to show that if the largest absolute eigenvalue of ρF F. In addition, it converges to the optimum solution P* is the power minimization under constraint SINR target. If this matrix F does not satisfy this criterion, then the algorithm diverges. In a distributed system, the matrix F is not known by the different actors of the network. A distributed method is to apply the following power allocation:

$$P_i(k+1) = \frac{\gamma_i}{R_i(k)} P_i(k) \qquad \textbf{(4)}$$

Where $R_i(k)$ is the SINR achieved at time k by the receiver i.

The distributed application is nevertheless based on the assumption that F satisfies the conditions for convergence, or this matrix is not known by the entire network. Unless a centralized coordinator will inform each issuer, such an algorithm is therefore based on trust no transmitter seeks to have too high a SINR, which would differ throughout the system. In addition, this method is applicable on static channels, but can be generalized to dynamic channels.

In general, the target SINR are predefined and algorithms assume that they allow the convergence of the system. It SINR false check that the targets are compatible with the state-owned system. If one rather instead is in a system that wants to define itself the target SINR values, in order to ensure the convergence thereof, note that the F matrix is set by the values of target γ of each transmission. To ensure convergence, there must be ρF <1.

Mathematically, we have $\min_i \sum_j F_{ij} \le \rho_F \le \max_i \sum_j F_{ij}$ and $\sum_j F_{ij} = \frac{\gamma_i \sum_{j\neq i} G_{ij}}{G_{ii}}$ in other words, the ratio between the target SINR and SIR "uncontrolled power". A simple criterion is to require transmissions satisfy: $\gamma_i \prec \frac{G_{ii}}{\sum_{j\neq i} G_{ij}}$

Note that this constraint has the disadvantage of not being flexible: each communication is limited by his own ($\gamma_i \prec \frac{G_{ii}}{\sum_{j\neq i} G_{ij}}$) channel gains and assumes the worst case all the neighboring communications seeking the largest possible target SINR to ensure, whatever the application SINR neighbors, the convergence of the system. Or if some nearby communication link to have a lower SINR demand maximum threshold, then this link might choose a higher target SINR $\frac{G_{ii}}{\sum_{j\neq i} G_{ij}}$ has its limit without diverging the system.

To ensure a minimum flow to the users, an optimization criterion may be to minimize the number of dissatisfied users. A dissatisfied user is a user who does not reach the minimum flow $r^{\circ}_{u,b}$, this is an outage. Called probability of failure or outage of the ratio between the number of users who do not reach their minimum rate and the number of total users. In a communication system, the probability of poor reception (outage probability) is defined as the probability that the quality of the link between a source and destination is less than a certain threshold.

$$P_{outage} = P\left(\frac{S}{N} \le seuil\right) \qquad \textbf{(5)}$$

Or P (x) is the probability of the event x .We consider a communication system in which the signals propagate through several network nodes for going from a transmitter to a destination. Relay playing the part of intermediate nodes.

For the system with regeneration, the relays can decode the information and encode again before the broadcast quality .The link to the system with regeneration is then determined by the measurements of each link or an outage in any link leads to outage of the total system. This implies that the outage is the probability that the minimum signal to noise ratio SNR $\gamma_{\min}$ of N hops is below the threshold $\gamma_{th}$.

$$P_{out} = P[\gamma_{\min} = \min\{\gamma_1, \gamma_2, .............., \gamma_N\} \le \gamma_{th}]$$
**(6)**

As against the non-regenerative system, the relay will not decode the received signal but merely amplify and transmit .In result; the outage will occur if the equivalent end to end SNR is below the threshold $\gamma_{th}$.

$$P_{out} = P\,|\,\gamma_{eq} \prec \gamma_{th}\,| \qquad \textbf{(7)}$$

Interestingly, for users, to achieve throughput fairness .The users can expect similar rates independent of their conditions.

**5. Simulation and results:**

Free access to scarce resources inevitably leads to conflicts that penalize inefficient use all participants. Indeed, each user tries to maximize his personal interest and tends to appropriate resources excessively to the detriment of others.

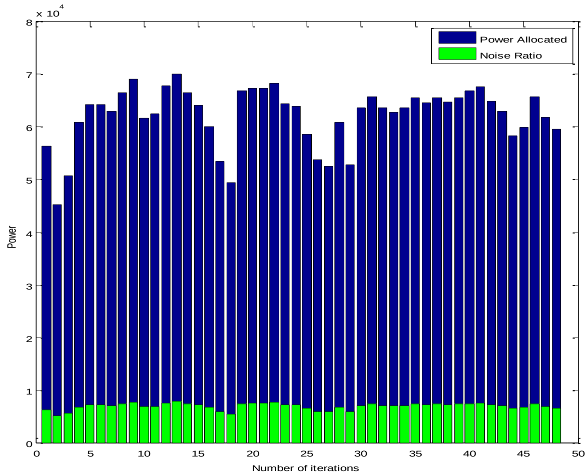


**Figure 7:** Amount allocated power.

One solution to address this problem is to organize the management of these resources. This management must propose regulatory mechanisms to ensure a fair share to different users. In this work, we propose a framework for multi-user optimization and present an axiomatic equity through allocation problems and scheduling resources.

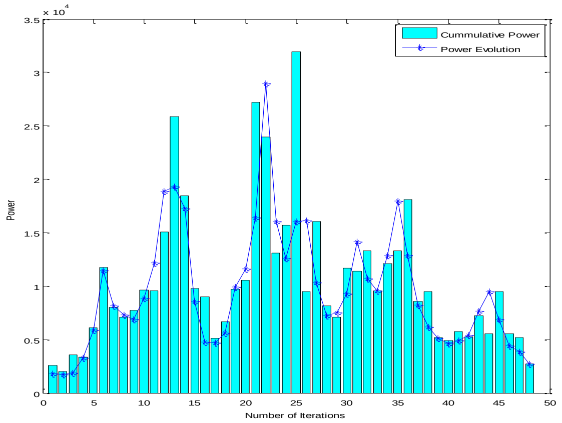


**Figure 8:** noise ratio on the channel.

In fact when designing resource sharing systems to users, considerations of equity are among the major concerns. We therefore analyzed the situation where a set of resources are distributed to a set of users having the same rights to access and where fairness to the users is a desirable goal. Due to resource limitations, multiple users are potentially in conflict. Thus, equitably distribute these resources is a major problem. This is particularly the case of the sharing of computer resources such as storage or computation time. We will apply these concepts to the search for equitable allocation policies in a resource allocation problem and a problem of scheduling jobs submitted continuously modeled by periodic arrivals.

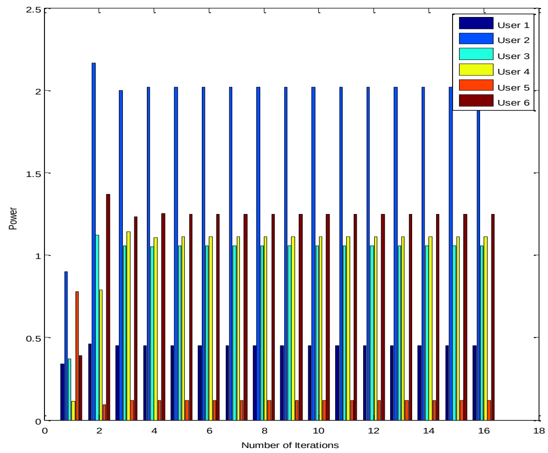


**Figure 9:** Evolution of the power vs. number of iterations, fairness optimization.

The equitable sharing of resources involved when a game is interrupted is an unsolved problem. Indeed, to legalize gambling practices it is necessary to give conditions for these games so it becomes fair. Legitimacy is therefore linked to the notion of fairness. Equity is the rule that must dictate the distribution. The same kind of problem occurs when it comes to distributing resources equitably as possible between people. Equity is an important assessment factor in all issues of allocation, distribution and sharing between users resources; this includes among other distributed systems. The original approach in this work is to focus on the equitable sharing in the case of scheduling. Most of the time in production scheduling, we are interested to establish an organization that will help maximize the gain, minimize costs and delays, the term fairness is characterized by the following properties:

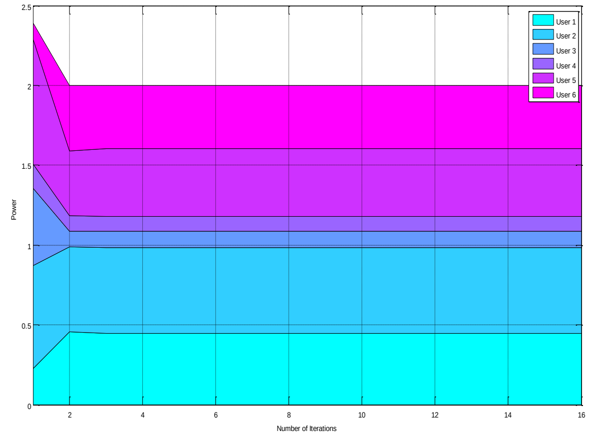


**Figure 10:** Power Quantity allocated for each user, fairness optimization.

- The first property required for equity is impartiality: its characteristic is not to favor one over the other. Conversely, fairness does not neglect some users to other. It does not put forward a group of people over another and avoid all forms of discrimination. This therefore results in symmetry or being unable to make distinctions between individuals according to their identity.
- The second property is based on the recognition of individual rights. But the respect of each individual involve to guarantee protection against all forms of domination. This is an equality of rights, not in conditions, but according to the needs of individuals and in their treatment, it seeks to lead to a situation after which no wrong remains.

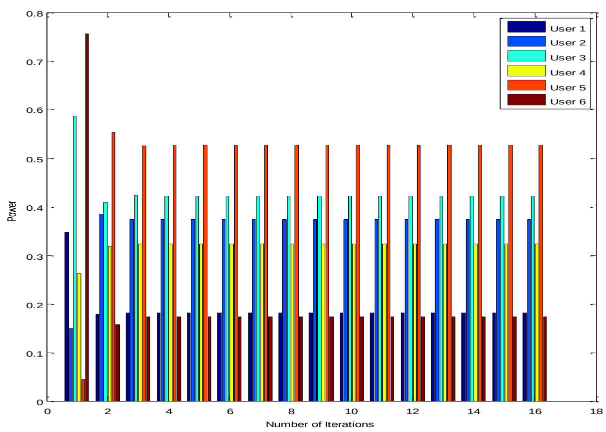


**Figure 11:** Evolution of the power vs. number of iterations, SINR optimization.

For these properties, fairness respects efficiency but at the same time exceeds it. The efficiency and equity are a complementary concepts without being incompatible. There is no conflict between efficiency and equity. The effectiveness or performance of a company determines the standard of living while equity reflects the distribution of the standard of living among individuals.

For example, when each individual seeks to maximize his individual performance indicator, each will tend to run several transfers in parallel in order to monopolize the bandwidth and this at the expense of others. At the level of collective performance measurement indicators, some tasks will be rejected in order to maintain an acceptable level of average service quality, such as admission control mechanisms in networks.

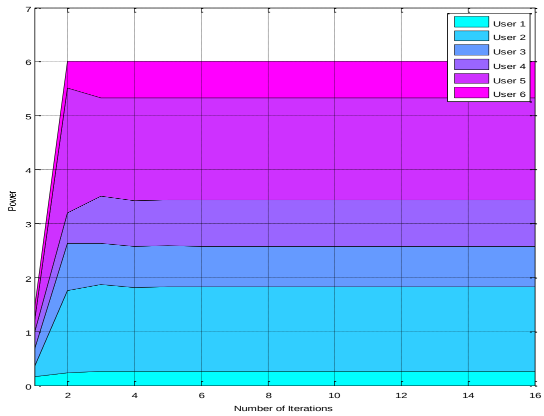


**Figure 12:** Quantity of power allocated to each user by maximizing the SINR.

Thus, a fair scheduling to users encourages their participation, while an unfair scheduling causes the abandonment of participation. In addition, some methods are able to justify the choices made and to show that the treatment is fair, help resolve conflicts. Each user research methods independently to maximize its profit. The collective dimension is unfortunately sacrificed by these arguments in which the other is reduced to a role of opponent or a tool to achieve its ends, in an interested way.

There are issues of fairness when requests exceed available resources. In this case, the implementation of a resource allocation policy is necessary to separate the users. These policies resource allocation must obey certain rules; which allows automating, assessing and verifying. The choice of relevant policy is therefore a company decision, a social choice. When resources are not sufficient for all users and a conflict occurs, the allocation policy is then mediate and allocates resources among users. It then seems important to design arbitration principles, which are based on the notion of fairness to the users. It is essential to find fair trade rules that meet everyone. Productivity and profitability are not contrary to equity. Productivity is encouraging but should be subject to limits that promote relationships etiquette together. It will seek fairness, that cares about efficiency, that is not a strict egalitarianism, but equality in rights, which take into account situations. Where the importance of defining terminals; not those who refuse the right of everyone to property, but which define the borders and keep the actions of men in good terms, without it there is no freedom.

In this part we are interested in the joint allocation of resources and power, so every resource, communications channel, OFDMA type, may have a power independent of other resources. The proliferation of these degrees of freedom, however, makes it difficult to achieve global optimization centrally.

First, the problem to solve is often non-convex, and requires knowledge of a large number of variables in the distributed network. The exhaustive search of the optimal solution is therefore impracticable. The allocation of resources and power in wireless networks is a topic that is the subject of research for many years. In the literature we can find several recent syntheses involving different techniques. Most of it formalize many types of optimizations related to the allocation of resources and power, focused on interference management. These optimizations are sorted according to the objectives and constraints and existing algorithms for each problem. The existing algorithms are based on scenarios where channels are static.

Overall, the power allocation problem is broken down into two main categories:

- Maximize utility under maximum power constraint.
- Minimize constrained to the power utility.

Utilities are related to the ability of users, communication channels or target SINR.

When the problem involves a network with interference, such as in a cellular context, the integration of these is essential and complicated algorithms, each allocation becoming interdependent.

Second, in a realistic system, the environment changes, for example the effects of fading and masking change, user needs may vary, etc. An adaptation that can follow such a dynamic is therefore highly desirable. That is why in this part we will study the power of resource allocation systems focused on the following two aspects:

- Distributed :a centralized system to monitor the evolution of the network and solve generalized optimization problems is unrealistic in practice, the exchanges necessary between cells, is the complexity of the overall problem and the speed with which the system must answer,

 

- Dynamic: the network conditions vary over time, due to the user mobility, the effects of fading, as well as by changing the interference.

## 6. Conclusion:

Fair approach is on the contrary to generally considered all gains or losses. It seeks to provide satisfactory solutions for the assembly of equilibrium and arbitration rules established for this purpose. Fairness is "what recognizes everyone's rights in justice." The main objective of fairness is how to establish a system of rules to prevent prejudice against certain users. Indeed, there are issues of equity only where there are conflicts. To solve these, a regulatory authority is generally required. A mediator or manager is then appointed to maintain order and resolve conflicts. It must be fair, impartial and have the desire to do good distribution. Furthermore, equitable distribution is not equal in the strict sense. It's a "fair measure", a balance that allows you to make an acceptable form of inequality, where equality would not be acceptable. This measure should help find ways to meet the needs.

The objectives of the base station and terminals are different because we consider that the base station aims to maximize the energy efficiency of the entire cell, while the mobile terminals only seek to maximize signal to noise ratio. So rationally, mobile devices have an interest in channel gains that support their individual interests; even if this reduces the overall network performance. This has encouraged us to study the effects of strategically channel gains on wireless cell performance. For this, we studied the issue of carry-channel gains as a static game in which players are mobile devices that choose their deferral to maximize the power allocated to them by the base station, the allocated powers being selected by the base station to maximize energy efficiency a function of the cell. By limiting our analysis to the power allocation, we can achieve formal results to compare a power allocation with real gains channels and a power allocation with forward gains channels strategically.

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