AIKTC

Optimization of LTE Signal using Genetic Algorithm

DEPT. Of EXTC Engineering

Optimization of LTE Signal Using Genetic Algorithm

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering

in

Electronics and Telecommunication

By

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2019-20

CERTIFICATE

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This is to certify that the project entitled **"Optimization of LTE Signal Using Genetic Algorithm"** is a bonafide work of (**Syed Saad Mohammed – 14DET122 , Azmi Abdul Basit -16DET78 Sahil Inamdar – 16DET85, Siddiqui Shahalam – 13ET46)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Department of Electronics and Telecommunication Engineering.

Supervisor

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Project Report Approval for Bachelor of Engineering

This project entitled **"Optimization of LTE Signal using Genetic Algorithm"** by (**Syed Saad Mohammed – 14DET122 , Azmi Abdul Basit -16DET78 Sahil Inamdar – 16DET85, Siddiqui Shahalam – 13ET46**) is approved for the degree of **Bachelor of Engineering in Electronics and Telecommunication** .

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Supervisor

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Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. we understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgments

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals . I would like to extend my sincere thanks to all of them.We am highly indebted to (Name of your Guide) for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.We would like to express my gratitude towards my parents & Staff of Anjuman-I-Islam's Kalsekar Technical Campus for their kind co-operation and encouragement which help me in completion of this project. We My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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Abstract

This paper presents a technique to increase the data throughput in Multiple Input Multiple Output (MIMO) systems. The technique uses a meta-heuristic to optimize the data throughput and to choose the best solution. The optimization is based on Genetic Algorithms (GA), with the objective of finding out the best antenna configuration to achieve the highest data throughput from the variation of the distance between the antenna array elements and the number of antennas. Simulation results show an increase of more than 15% in the data throughput considering 4x4 MIMO channels. MIMO systems; data throughput; genetic algorithms; optimization.

Contents

Keywords And Glossary

Keywords :

Use of Genetic Algorithm

Optimization of LTE signal

Reduced bit error rate (BER)

Improved signal to noise ratio (SNR)

Glossary :

In compter science, Artificial Intelligence, and Mathematical optimization Is a heuristic technique designed for solving a problem more quickly when classic methods are too slow for finding an approximate solution

Chapter 1

Introduction

The Multiple Input Multiple Output (MIMO) system is a technique to increase the throughput and achieve the radio channel capacity, for fourth generation (4G) and fifth gener- ation (5G) cellular networks. It uses multiple antennas in the transmitter and the receiver, to enhance the energy and spectral efficiencies. Consequently, more data can be transmitted by the wireless channel. The MIMO technology is embedded in the Long Term Evolution (LTE) standard, that uses two to four antennas in the mobile unit and up to eight antennas in the base station (per cell)

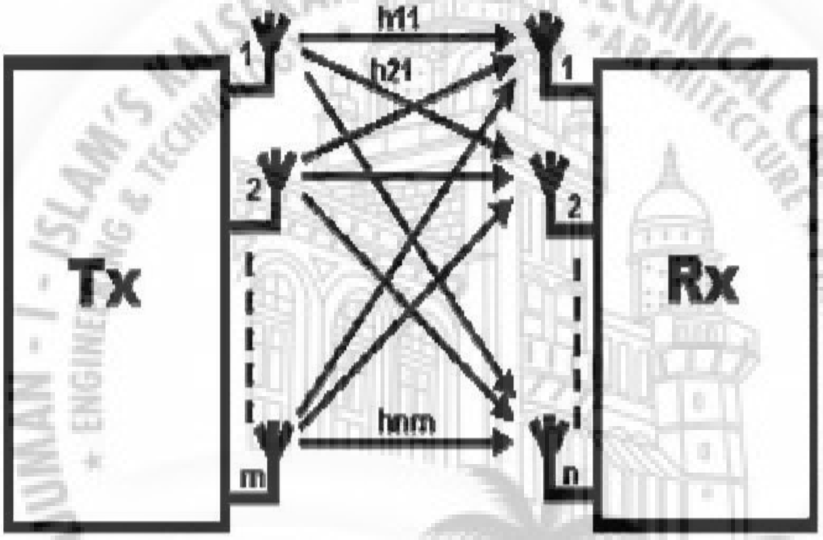


Figure-5 : MIMO - Multiple Input Multiple Output

The spatial diversity provided by the MIMO technique shows that the use of an antenna array increases the system quality. This ensures that the transmitted signal will arrive at the receiver with an appropriate Signal-to-Noise Ratio (SNR). This technique takes advantage of multipath propagation phe- nomenon to increase the channel throughput in environments subject to reflection and diffraction. The channel capacity may be achieved varying the number of antennas in the transmitter and in the receiver

The MIMO technology can significantly improve the system throughput, the coverage area and the Quality of Service (QoS). The transmission optimization using MIMO depends on the design of the antenna array in both transmitter and receiver In general, optimization is a complex and costly task. Thus, researchers and engineers have developed efficient optimization techniques to permit MIMO projects that are practical and affordable Artificial intelligence algo- rithms are used to optimize the data transmission in the context of Cellular Mobile System (CMS).

Several studies presented in the literature deal with MIMO systems, in order to increase the performance of wireless

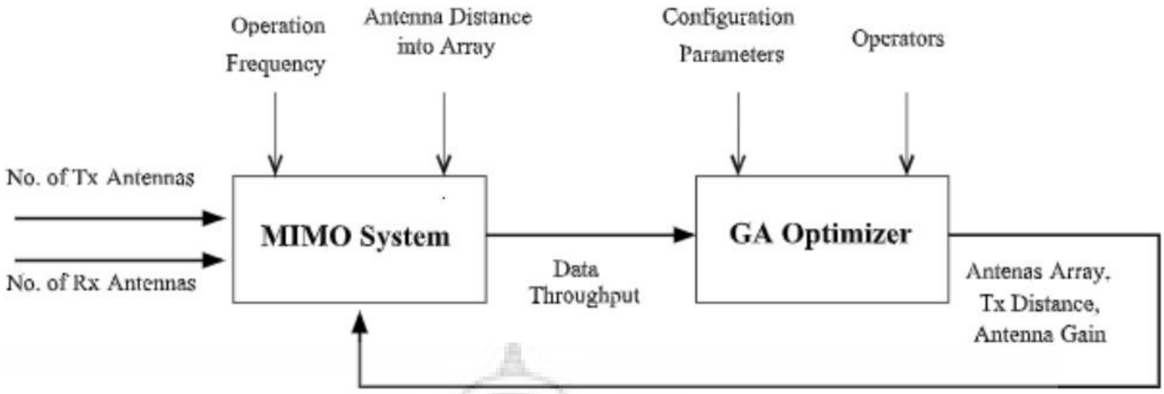


Fig. 1. Block diagram of the MIMO system simulator with optimizer.

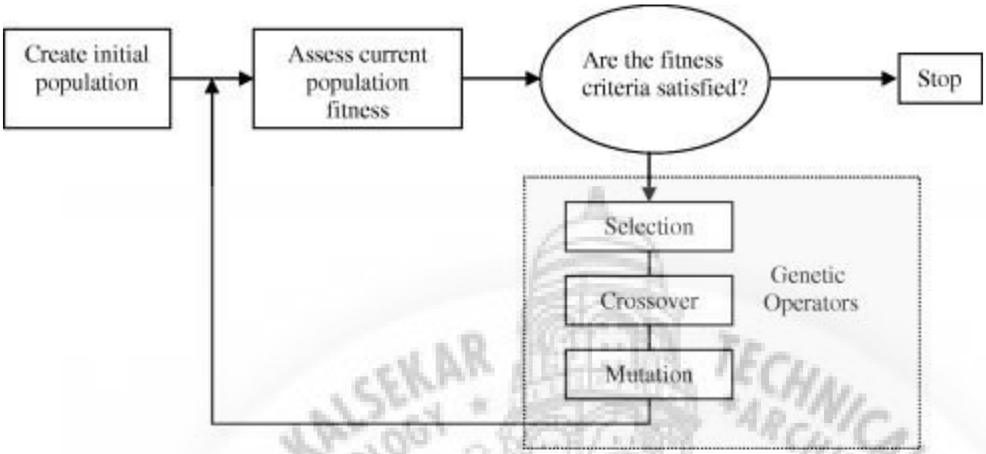
The research is performed to define the quantity, positioning and gain of the antennas, optimization of channel quality, reduction of interference, technology sharing in the same system, and order of digital modulation

Heuristics and meta-heuristics have appeared in the last decades as alternatives to handle complex optimization prob- lems, providing promising solutions. Researchers have been inspired by nature to find good solutions for large-scale optimization problems, in a reasonable execution time. These bio-inspired algorithms present interesting features when applied to engineering problems, such as efficiency and robustness.

In Genetic Algorithm (GA) is used to obtain the position and orientation of each antenna in the array that maximizes the capacity of the MIMO channel. The authors assume a channel model that interfaces from the propagation environment to the set of receiving antennas of a mobile terminal. In the problem modeling, the authors use the geometric channel model in simulations. In present paper, a methodology based on GA is also applied for optimization of the data throughput in the CMS by changing the number of the antennas in the array and the distance between these antennas in the transmission array. The goal is to achieve the best configuration which result in highest data throughput in the MIMO system. It is worth to mention that the Clark model was used in the present paper to calculate the spatial correlation matrix for the problem modeling.

This paper is organized as follows: Section II presents general concepts of the MIMO systems, as well as, the channel capacity and correlation coefficient computation. Section III introduces the main characteristics of the Genetic Algorithm, considering optimization problems. Section IV presents a proposal to increase the data throughput in MIMO system. The simulation setup and the results of this simulation are dis- cussed

Project Architecture



Motivation

Nature is biggest motivation for this project it is based on the principle of genes formation from biology, but as we are dealing with computer science with the help of mathematical equations we found solution for certain LTE signal parameters

Objective and Scope

Gives a clear description for class of problems genetic algorithm should excel

Executes by population reshuffling using each objective function

Its advantage is that the worse individual of the population will have very little probability of selection here as the best individual will not dominate the selection process, thus ensuring diversity

Chapter 2

Literature Review

Our group has studied various journal papers related to signal optimization and genetic algorithm

Optimal placement of training for frequency selective block fading channels from IEEE transaction on information technology author name adireddy, s, tong, & vishwanatham (1)

Alexandre, hf, Dias & joao, av 2002, multiobjective genetic algorithm applied to solve optimization problems , IEEE transaction on magnetics (2)

Author name Ali, jane, c & mohammed T 2014, 'bit error rate analysis of MIMO LTE system' Proceeding of the nine international conference on wireless mobile communications (3)

Alanki SR & Srinivas, s2014, 'A new BER & SNR calculations for MIMO systems ', international journal of inventive engineering and sciences (IJ IES), (4)
Vol.2 , no.8, pp. 1-4.

Weaknesses

New hypothesis, it is idea that proposes a tentative explanation about a phenomenon.
Coding of fitness function, wrong choice of fitness function may lead to critical problems or sometimes a wrong solution to the problem.

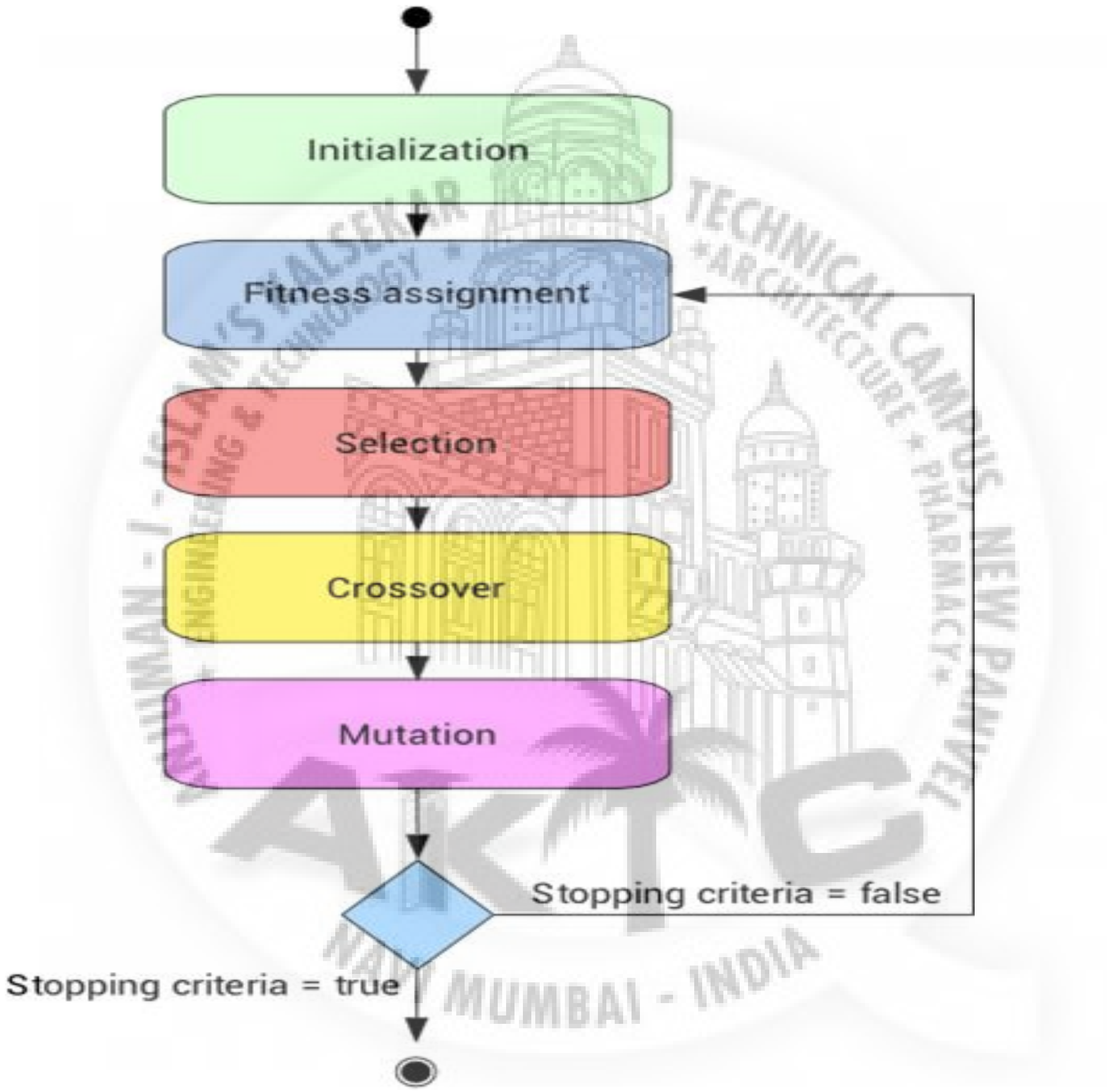
How to Overcome-

By using other techniques like
swamp optimization,
Bird flocking and no. of other techniques

Chapter 3

Methodology

In computer science and oprations research, Genetic algorithm is a metaheuristic inspired by the process of natural selection



1. Initialization

The first step is to create and initialize the individuals in the population. As the genetic algorithm is a stochastic optimization method, the genes of the individuals are usually initialized at random. to illustrate this operator, consider a predictive model represented by a neural network with 6 possible features. If we generate a population of 4 individuals, then we have 4 different neural networks with random features. The next figure illustrates this population.

2. Fitness assignment

Once we have generated and initialized the population, we need to assign the fitness to each individual. To evaluate the fitness, we need to train the predictive model with the training data, and then evaluate its selection error with the selection data. Obviously, a high selection error means a low fitness. Those individuals with greater fitness will have a greater probability of being selected for recombination.

	Selection error	Rank	Fitness
Individual 1	0.9	1	1.5
Individual 2	0.6	3	4.5
Individual 3	0.7	2	3
Individual 4	0.5	4	6

3. Selection

After fitness assignment has been performed, the selection operator chooses the individuals that will recombine for the next generation. The individuals most likely to survive are those more fitted to the environment. Therefore, the selection operator selects the individuals according to their fitness level. The number of selected individuals is N/2, being N the

4. Crossover

Once the selection operator has chosen half of the population, the crossover operator recombines the selected individuals to generate a new population. This operator picks two individuals at random and combines their features to get four offsprings for the new population, until the new population has the same size than the old one.

5. Mutation

The crossover operator can generate offsprings that are very similar to the parents. This might cause a new generation with low diversity. The mutation operator solve this problem by changing the value of some features in the offsprings at random.

To decide if a feature will be mutated, we generate a random number between 0 and 1. If this number is lower than a value called the mutation rate, that variable is flipped. The mutation rate is usually chosen to be 1/m, where m is the number of features. With that value for the mutation rate, we mutate one feature of each individual (statistically).

The next image shows the mutation of one of the offsprings of the new generation. As we can see, the fourth feature of the offspring has been mutated.

At this point, we have the new population

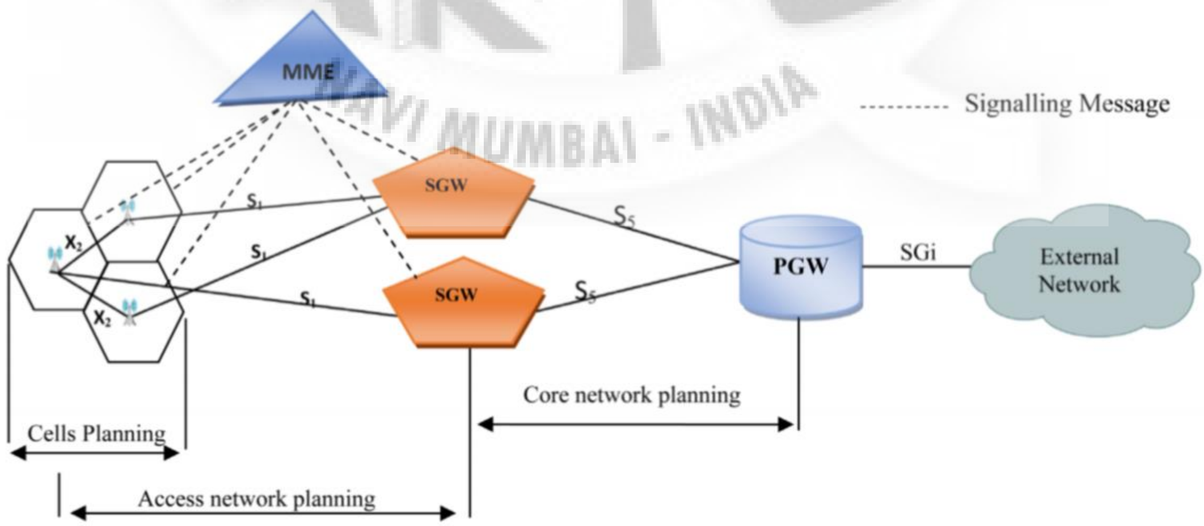
The Network Architecture

The 4G LTE-Advanced network is a flat network all IP. The geographical area is divided into small area called hexagonal cells, the centre of which is the eNode B which may be interconnected via the X2 interface, themselves connected to the SGW in the user plan (through the S1-U interface) and the control plan MME to the S1-MME interface. The SGW are connected to the MME in the control plan by the S11 interface and PGW user plan by the S5 interface. The PGW are connected to other external networks by SGi interface (Figure 2). In this article, we propose a comprehensive planning model of LTE Advanced network architecture based on a “centralized control, distributed bearer” [8] fully resolved by considering three assignments in the user plane. The functional entity centralized control of MME is responsible for: To treat signalling exchange between the handheld and the EPC; -To establish a user session and select the SGW and PGW entities that will be used to implement the data transport channel during a query. Thus we abstract equipment HSS and PCRF (Figure 1) for the following reason. This equipment though in the core network is located at a higher level and is entities of the control plane. Indeed, entities: eNode B, MME, SGW and PGW can communicate directly with each other without having to make round trips with top-level equipment. Moreover, they are not involved in the data transfer plan.

The Planning Problem

The problem of an Advanced LTE mobile network planning is a complex issue. However to make it affordable, it can be divided into three sub problems compared to three levels in the architecture of the network 4G/LTE-A of Figure 2: Cell planning, radio access network planning and core network planning. Cells planning is to interconnect the eNode B together with the X2 interface (optional). This sub problem is to minimize the total cost of the network by minimizing the costs of connection and costs associated with handoff operations; Planning the access network is to assign the eNode B to SGW through the S1-U interface in the data plan. This sub problem is to get a better latency (optimizing link costs between these two entities and reduce the costs of complex operations of handoff following a change of SGW); Core network planning is to interconnect the SGW to PGW through the S5 interface in the user plan (data plan). The objective of this sub-problem is protocol to reduce costs of network to enable reliable transmission of data packet transport IP over the whole network.

data packet transport IP over the whole network.



Formulation of the Mathematics Model

Assumptions

To model our problem, the following assumptions about the network architecture must be considered:
The network consists of n eNode B installed in each one of the network cells, s SGW and pPGW which are
respectively identified by the indices 1 to 3 so that:
- I n = {1, 2,3, , □ } the set of eNode B.
- J s = {1, 2,3, , □ } the set of SGW.
- K p = {1, 2,3, , □ } the set of PGW.
- To each eNode B in the center of a cell is connected to a single SGW and can be interconnected with other
eNode B in cells;
- Each is connected to a SGW and PGW one;
- Each SGW and PGW to a well determined capacity;
- The position of the eNode B, SGW and PGW are known;

- The total capacity of the links connected to an entity (SGW and PGW)cannot exceed the capacity of this en-
tity (bit per second).

Finally, the problem of global planning is divided into three sub problems:

The interconnection of the eNode B among them, the assignment of the eNode B to PGW, and SGW assign-
ment to PGW.

Mathematical Model

Consider the constant parameters: 11 Cii′ : The link cost between eNode B i (i ϵ I) and eNode B i' (i' ϵ I) withi ≠ i'.
12 Cij : The link between the eNode B i (i ϵ I) and the SGWj (j ϵ J).
23 Cjk : The link between the SGW j (j ϵ J) and thePGW k (k ϵ K).
11
ii h ′
: The cost ofhandoffoperation per unit time between the eNode B i and i' with no change of SGW.
11
ii h ′ ′ : The cost of a handoff complex operation per unit of time report between the eNode B i and i' without
SGW.
21
ii h ′
: The cost of single handoff operation per unit time between the eNode B i and i' involving a change of
SGW.
21
ii h ′ ′ : The cost of handoff complex operation per unit time between the eNode B i and i' involving a change of
SGW.
11 11 11
ii ii ii h h ′ ′′ Φ= − ′ represents the reduced cost per unit of time of a complex handoff between two eNode B i and

i' with SGW not changing.
21 21 21
ii j ii ii h h ′ ″ Φ= − ′ represents the reduced cost per unit of time of a complex handoff between eNode B i and i'
with a change of SGW.
2
j ω : The maximum capacity of the entity SGW J in (bps: bit per second).
3
k ω : The maximum capacity of the entity PGW k in (bps: bit per second).
12
ij γ : The data volume supported by the interface S1 between the eNode B i and entity SGW j.
23
jk γ : The data volume supported by the interface S5 between the entities SGW j and PGW k.
Consider the following decisions variables:

( ) ( ) 11
1 if the eNode B is connected to the eNode B et
0 otherwise
ii ii I ii I i i
x ′ □□ ∈ ″ ′ ∈ ≠ = □
□□
( ) ( ) 12
1 if the eNode B is connected to SGW
0 otherwise
ij ii I j j J
x
□∈ ∈ □ = □
□□
( ) ( ) 23
1 if the entity SGW is connected to the entity PGW
0 otherwise

To better understand the cost incurred by a handoff operation with change of SGW, we define the following
additional variables:
12
ii j
z ′ and 12
ii y ′
: representing the cost allocation of eNode B i I ∈ et i I ′∈ au SGW j J ∈ .

So

12 12
12 ; ; ii j
ij i j z x x i i i et i I et j J ′ =∀ ∈ ′ · ≠ ∈ ′ ′ (1)

So that:

12 12 ; ; , ii ii j
j J
y z i i i et i I et j J ′

∈
′ = ∀ ∑ ≠ ∈∈ ′ ′ (2)
( )
12 ( )
if the eNode B and are both connected to only a single
and same SGW among the SGW
otherwise
1
0
ii

i ii i
y jj J ′
′ ′ ≠
∈

□
□ = □
□
□

The total cost of the objective function F is the sum of total depreciation costs of connections and reduced
costs per unit time of the handoff operations throughout the network defined below:

11 11 12 12 23 23 11 11 (1) Φ12 12 (1) ii ii ij ij jk jk ii ii ii ii
i Ii I i I j J j Jk K i Ii I i Ii I
i i i i i
F cx cx cx φ x y ′ ′ ′ ′ ′ ′
∈∈ ∈∈ ∈∈ ′ ∈ ∈′ ∈
≠

′
′

∈ ′ ≠ ≠
= ∑∑ ∑∑ ∑∑ ∑∑ ∑∑ + + + − + − (3)

Then it will minimize the cost function F defined in (3) under the following constraints:

The constraints on the uniqueness of the assignments:

- Each SGW is interconnected to one and a single other eNode B
11 1; ii
i I
x iI ′
′∈
∑ = ∀∈ (4)

- Each eNode B must be assigned to only one SGW
12 1; ij
j J
x iI
∈
∑ = ∀∈ (5)

- Each SGW must be assigned to one PGW

23 1; jk
k K
x jJ
∈
∑ = ∀∈ (6)

The constraint on the ability of nodes (SGW and PGW)
The network is flat in IP. There is only one type of traffic flowing across the network. The data are carried by IP.
The signalling messages in the MME control plane are not taken into account.
The constraints on the ability of these different nodes are defined below:
The Constraint on the ability of SGW: The amount of data coming from i eNode B should not exceed the
capacity of SGW.

12 12 2 ; ij ij j
i I
γ ω x jJ ∈
∑ ≤ ∀∈ (7)

The Constraint on the ability of PGW: The amount of data coming from j SGW does not exceed the capacity of the p PGW.

23 23 3 ; jk jk k
j J
γ ω x kK ∈
∑ ≤ ∀∈ (8)

Nonlinear constraints

Relation (1) is nonlinear. Therefore, the problem cannot be solved with traditional methods of linear pro-
gramming. Thus Merchant and Senguptain [44] [45] proposed a set of equivalent stresses. So relation (1) is

equivalent to:

12 12 ; and , ; ii j ij z x i i ii I j J ′ ≤ ∀≠ ∈ ∈ ′ ′ (9)
12 12 ; and , ; ii j i j z x i i ii I j J ′ ′ ≤ ∀≠ ∈ ∈ ′ ′ (10)

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12 12 12 1; and , ; ii j ij i j z x x i i ii I j J ′ ′ ≥ + − ∀≠ ∈ ∈ ′ ′ (11)
( ) 12 0 with and ; and ii j z i i ii I j J ′ ≥ ≠ ∈∈ ′ ′ (12)

Summary of the planning problem formulation

The proposed model is an objective function of cost minimization under the constraints:
- From the uniqueness of assignment between entities located at each level of the architecture;
- From SGW and PGW nodes Capacity in the data plane user of the core network.

Thus, we have:

Min 11 11 12 12 23 23 11 11 (1) Φ12 12 (1) ii ii ij ij jk jk ii ii ii ii
i Ii I i I j J j Jk K i Ii I i Ii I
i i i i i
F cx cx cx φ x y ∈∈ ∈∈ ∈∈ ∈ ∈ ∈ ∈
≠ ≠
′ ′ ′ ′ ′ ′
′ ′ ′
′ ′ ≠
= ∑∑ ∑∑ ∑∑ ∑∑ ∑∑ ++ + −+ − (3)

11 1; ii
i I
x iI ′
′∈
∑ = ∀∈ (4)
12 1; ij
j J
x iI
∈
∑ = ∀∈ (5)
23 1; jk
k K
x jJ
∈
∑ = ∀∈ (6)
12 12 2 ; ij ij j
i I
γ ω x jJ ∈
∑ ≤ ∀∈ (7)
23 23 3 ; jk jk k
j J
γ ω x kK ∈
∑ ≤ ∀∈ (8)
12 12 ; and , ; ii j ij z x i i ii I j J ′ ≤ ∀≠ ∈ ∈ ′ ′ (9)
12 12 ; and , ; ii j i j z x i i ii I j J ′ ′ ≤ ∀≠ ∈ ∈ ′ ′ (10)
12 12 12 1; and , ; ii j ij i j z x x i i ii I j J ′ ′ ≥ + − ∀≠ ∈ ∈ ′ ′ (11)
( ) 12 0 with and ; and ii j z i i ii I j J ′ ≥ ≠ ∈∈ ′ ′ (12)

(3) Reflects the objective function to minimize: The first three terms respectively represent, the total cost al-
locations between the eNode B in the cells, the total cost of the eNode B and SGW assignments in the access

network and the total cost of the SGW and PGW assignments in the core network. The fourth and fifth terms

respectively represent the reduced cost per unit of time of complex handoff without involvement of the SGW in
the cells, and the reduced cost per unit of time of complex handoff with a change of SGW in the access network.
(4), (5) and (6) represent the constraints linked to the assignments uniqueness and we only successively have
an eNode B that can only be interconnected to one and only one other eNode B in the cells, each eNode B
should be assigned to one and only one SGW finally in the core network each SGW must be assigned to one and
only one PGW. (7) and (8) impose the constraint on the capacity of PGW and SGW.
Finally constraints (9), (10), (11) and (12) are linearized to be equivalent to (1) to reduce the problem to an
integer programming [44] [45].
Despite the transmutations carried out, the problem of allocation in an LTE-A network is still quite complex
to solve. In the following section, we study the complexity of the model established in (3) to show that it is more

convenient to use a heuristic to solve our model to obtain a feasible solution close to the optimum in a reason-
able computation time.

Complexity Study of the Planning Model
The study of the complexity of the mathematical model set up in (3) is influenced by the three (3) levels seen
in the architecture and the numbers of equipment available (Figure 2).
Indeed, it's about making a triple assignment, first the interconnection between eNode B in the cells, and then
a sub allocation of eNode B in the sub SGW access network, and finally a sub allocation of SGW the PGW at
the core network level. And by analyzing more closely the second sub assignment, with the eNode B to PGW in
terms of data users plane in the access network, we notice that it is similar to the cell assignment problem to
switches in work carried out for second generation mobile networks [44] [45] where the authors show
the equivalence of this problem to the partitioning of graphs. Thus by analogy, each cell served by an eNode B will
be considered a vertex of the graph. Transaction costs of handovers due to mobility of users between each pair
of nodes represent, in this case, an arc connecting two vertexes of the graph. In fact, this assignment problem in
this context belongs to the class of NP-hard problems that are well known in operational research: the transport
problem or concentrator's location [46] [47] and the partitioning of graphs [48] [49]. Their resolution by an
enumerative method usually leads to an exponential growth of the execution time. We must exclude the use of
an exact method.
In our case, we have in the first eNode B n sub assignment that we want to connect at the cell level, which
will require an algorithm with exhaustive enumeration of nnnn combination analysis to solve part of

the problem.

Then we must also affect the eNode B n to SGW s in the sub access network, which will also focus on examin-
ing s

n combinations, finally the assignment of s SGW top PGW at the core network level will also focus on ex-
amining another ps combinations. With this computing time which raises exponentially, we would not be able to

find a solution in a reasonable time. On this basis, we concluded that we are faced with a hard-NP problem.
Therefore, we search rather close to the optimum solution by developing heuristics or metaheuristics for its
practical problem solving in a reasonable computing time.
Among the known heuristics, we have chosen the genetic algorithm approach presented in the next section..

Approach of Resolution by Genetic Algorithm

The genetic algorithm belongs to the class of evolutionary algorithms developed separately and almost simulta-
neously, by different scientists:

- The evolutionary programming (L. Fogel 1966) [50];
- Strategies of evolution (J. Rechenberg 1973) [51];
- Genetic algorithms (J. Holland 1975) [52].

The objective is to obtain a feasible solution to an optimization problem when it cannot be solved with an exact
method in a reasonable time. From 1990, these three fields have been grouped under the Anglo-Saxon term of
Evolutionary Computation.
In our article, we treat genetic algorithms based on Neo-Darwinism that is the union of the theory of evolution
and modern genetics. They are built on different techniques derived from it: crossing, mutation, selection...

Adaptation of the Genetic Algorithm Method

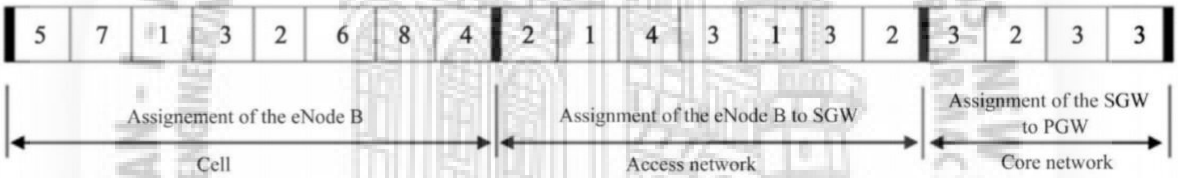
Genetic algorithms all follow the same principle [53] and the method used in this article is no exception. We
distinguish a coding principle of the element of the population (chromosome), a creation phase of the initial
population, an alteration phase of that population by genetic operators, an evaluation phase of each member of this
population, selecting the best elements (based on the principle that only the best will be able to reproduce). Every
generation is supposed to provide the most efficient components than previous generations.
Intuitively, a large population with a large number of generations must be able to lead to a more refined solution
hoping that the last generation will contain the right solution, however, is not necessarily the best.

Coding of Chromosome

In our adaptation, we chose to make a non-binary coding of chromosomes [54].
Each chromosome of the population defines a feasible solution of the problem
For example, for our case, assuming a network 7 eNode B, 4 SGW and PGW 3.

A representation of the chromosome in Figure 3 is a constituent of the population that defines a feasible solu-
tion of the problem considered.

Each chromosome being a configuration after three sub assignments would be:
- The length of the chains in the cells and the access network is equal to the number of eNode B because all
eNode B should be interconnected and be assigned to the SGW.
- The length of the chains at the heart network is equal to the number of SGW because all the SGW must be
assigned to PGW.
Thus, the length of the chromosome for our adaptation is equal to twice the number of eNode B added to the
number of SGW.



The reading of chromosomes is from left to right; so:
- The first bit of chromosome contains the number of an eNode B to which the eNode B 1 is connected.
- The eighth bit contains the number of a SGW which the eNode B 1 is assigned in the access network.
- The fifteenth bit contains the number of a PGW which is assigned a SGW in the heart network.
This configuration represents a given topology (one assignment scheme) and respects the constraints of single
assignment but not the constraint on the ability of the switches (SGW and PGW).

Formation of the Initial Population

The first member of the initial population is that obtained when the three sub assignments are made according to the metric of the smallest Euclidean distance. When an entity to allocate (eNode B respectively SGW) is equidistant from two or more other entities (eNode B respectively PGW), is assigned to the first in the order specified by the problem. This first chromosome is created deterministically. The other elements (chromosomes) of the population are randomly created respecting the principle of non-duplication (each chromosome is unique). This principle ensures heterogeneity of the population, thus good coverage of space to explore.
The population size is fixed and must be inferior or equal to all possible assignments to maintain the principle of unduplicated population.
Therefore, they must verify the feasibility of each solution, that is to say, the constraint on the ability of the switches. Indeed, in every generation, the population must be made feasible solution after application of genetic operators so that the latest generation of the best contains chromosomes than those of previous generations.

Crossing Operator

The operation is to create two new solutions (children) exchanging one or more genes of two existing solutions (Parents).
To do so, we randomly generate an integer in each of the intervals:
-[1, number of eNode B], at the cell level and the access network.
-[1, number of SGW], in the core network.
These numbers will match the crossing position for the two selected parents' chromosomes. Each crossing new solutions are created. The new solutions will be retained if they are feasible.

Mutation Operator

Mutation is the process whereby the value of a random gene in a chromosome is regenerated. This process occasionally occurs in a genetic algorithm. By randomly changing the value of a bit in a string, the mutation is useful to

bring genetic material that would have been forgotten by operators of selection and breeding. This operator mutates, under a certain probability, elements of the population.

To do so, a mutation position is identified by randomly generating a positive integer in the following intervals:
-[1, number of eNode B], at the cell level and the access network.
-[1, number of SGW], in the core network.
Then, the variable corresponding to the selected position is randomly generated within the following ranges:
-[Min_N˚eNode B, max_N˚eNode B], at the cell level.
-[Min_N˚SGW, max_N˚SGW], in the access network.
-[Min_N˚PGW, PGW max_N˚], in the core network.
NB: min_N˚and max_N˚are respectively the values that can take the various entities.
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The Function to Be Optimized

A key element of the genetic algorithm is the evaluation function or fitness of the individual that is the cost of the network configuration it represents. It is on this basis rests the choice of candidates.
The evaluation is to determine whether the chromosomes meet the constraint on the ability of switches and to determine which has the lowest cost while respecting the constraint of capacity switches.

The Selection Operator

The objective of the selection operator is to build a new population from the population obtained after application of the mutation and crossover. Overall, we want to calculate a probability of selection for each individual of the population is even higher than the value of his fitness is good. The percentage is calculated for each chromosome compared to the total fitness.
The simplest way to define the probability of selection is to make it directly proportional to its fitness.
Let f(i) the value of the fitness of individual i (i = 1, 2...total pop). One can then define ps(i), the individual probability of selecting i, as follows:

$$ps(i) = \frac{f(i)}{\sum_{k=1}^{Total\_pop} f(k)}$$

Once the selection probabilities are calculated for all individuals in the population, it remains to be using it to build the next population.

The generation number is set initially. In every generation a new population is created. The size of the population is kept for each generation. Figure 4 indicates the pseudo genetic code.

```
Start
For i: = 1 Generation_number
New population generation
While<population size not reached >do
        Crossover
                Mutation
                Fitness calculation
                Check the homogeneity of chromosomes
                Feasibility of the solutions (Constraint on capacity)
                Saving the best solutions
                Selection
    End
End
 Choice of the best chromosome
End
```

By the same principle, starting from a population of initial solution (checking the capacity of the switches),
propagation is by growing two individuals and is applied to the two individuals chosen generic operators: the

crossing and mutation. Reproduction gives two children who are placed in the new population. Repeating play-
back until we have completed the new (the size of the population should remain constant).

Once reached, we replace the old population by the new one, and the process is repeated according to the
number of generation set.
NB: In every generation, we save the best individual and at the end we chose the best.

Results

Experimentation Background

The performance of the adaptation of the genetic algorithm is based essentially on a good choice of its parameters.

In the absence of actual data, our experiment was performed by considering a number of tests generated by a
Matlab program.

We will make considerations as in some previous work. The cost of link between the various entities is pro-
portional to the distance separating them, with a coefficient of proportionality equal to unity [44] [45].

- Traffic Modelling

Traffic in a telecommunications network is the volume of information transported or processed by the network.
Unlike the 3G UMTS technology in a 4G/LTE-A network, there is only one type of traffic that transport data in
packet form between the EPC and the mobile terminal. And as users' behaviour is random, we consider that traffic
follows a Markov chain in continuous time through a process of birth and death. As there are no mathematical
laws to model accurately the behaviour of the packet-switched traffic in a 4G network, suppose that all the cells in
our network are considered queues M/M/1 forming a Jackson network [55].
Thus, the process of arrival of data packets is fish αi rate and tenure of the cell follows an exponential law of
parameter μi (ααii and μi is strictly positive). A steady state (μi./αi ≤ 1).
To facilitate the generation of data for our simulations, we make the assumptions below:
- The fi data rates from a cell i with mean gamma distribution and variance equal to unity.
- The service time (residence time: for example, the talking time or download time of a file) data within cells
are distributed according to an exponential law of parameter equal to unity.
- If a cell j has neighbour k, [0,1] is divided into k + 1 in k intervals by choosing random number uniformly
distributed between 0 and 1. At the end of the period of service in the cell j, the data packets may either be

transferred to the i

th neighbour (i k = 1,2,3, ,) with a probability of transfer rriiii equal to the length of the i
th

interval, be closed with a probability equal to the length of the k + 1th interval.
To find the volume of data and the coherent succession rate, the αi rate data in cells at equilibrium are obtained
by solving the following system:

1

1,2, ,

n
i i i ij
j
f r avec i n α α=
=− = ∑

where n is the number of network cells and rij, the probability of handover between cells i and j.
fi being the traffic data rate from cell i.
It is selected as the data volume of an eNode B, the average length of its queue.
The succession rate hiiii is defined by: hij = firij.
• All sSGW have the same capacity packet M0 calculated as follows for the purposes of the simulation:

0

1
1 1
100
n
i
i
k M f
s =
  = +   ∑

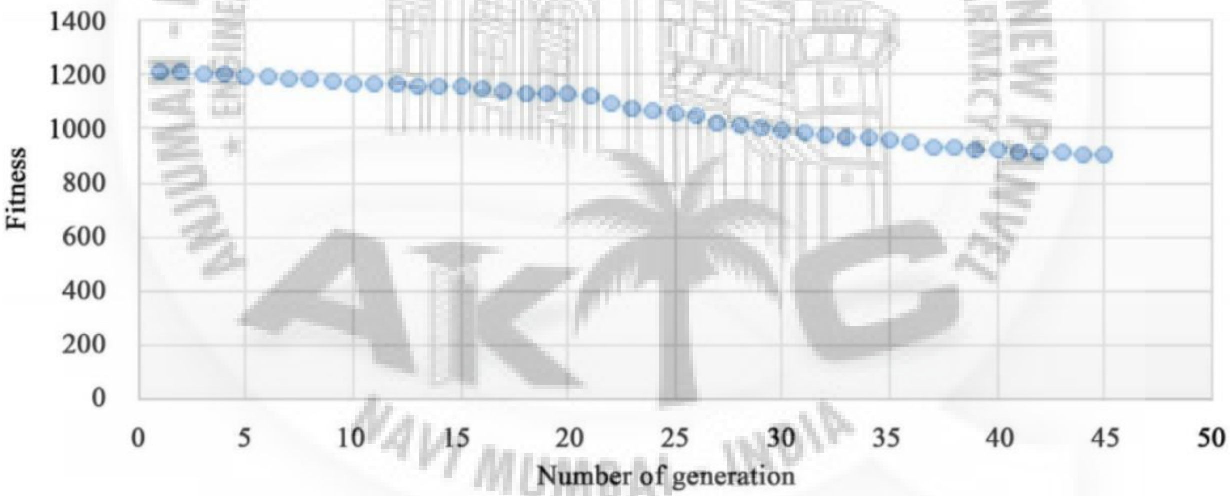
where k is uniformly distributed between 10 and 50, which ensures an overall surplus of 10 to 50% of the capacity
of SGW compared to the data volume of the eNode B.
• All p PGW have the same capacity M1 calculated as follows:
1 0
1
1 1
100
n
i
k M M
p =
  ′ = +   ∑

where k' is uniformly distributed between 10 and 50, which ensures an overall surplus of 10% to 50% of the ca-
pacity of PGW relative to the volume data from the SGW.

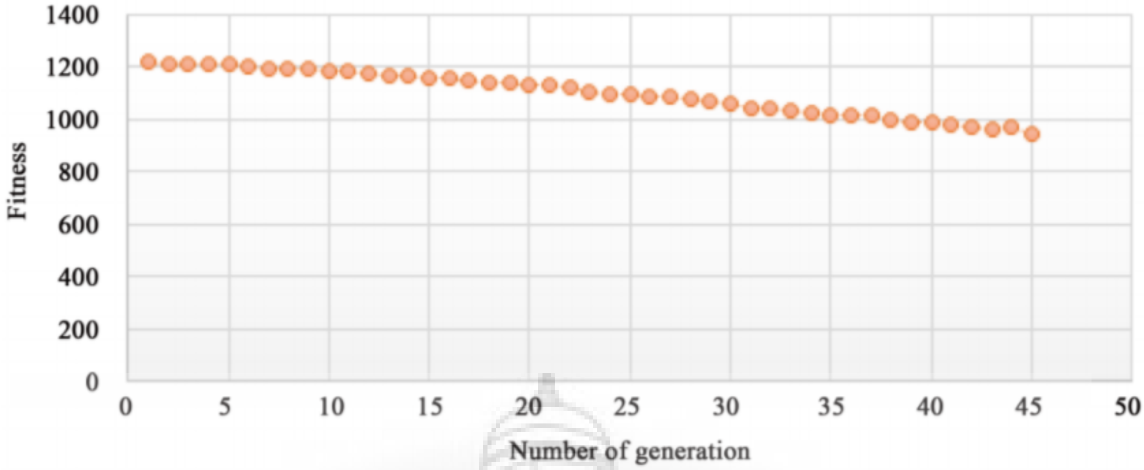
Experiment Plan

In order to verify the performance of our adaptation, a series of experiment was performed.
Considering a network of 15 eNode B-7 SGW-5 PGW, we generated the data needed to experience using a
program Matlab R2015b. The program is executed on a computer whose characteristics are: Intel®CoreTM
i3-3110M CPU@2.40 GHz 2.40 GHz.
The parameters used for the simulation of our adaptation are:
- Population size: 80.
- Number of generation: 45.
- Crossing probability: 0.9.
- Mutation probability: 0.2.
- Inversion probability: 0.25.

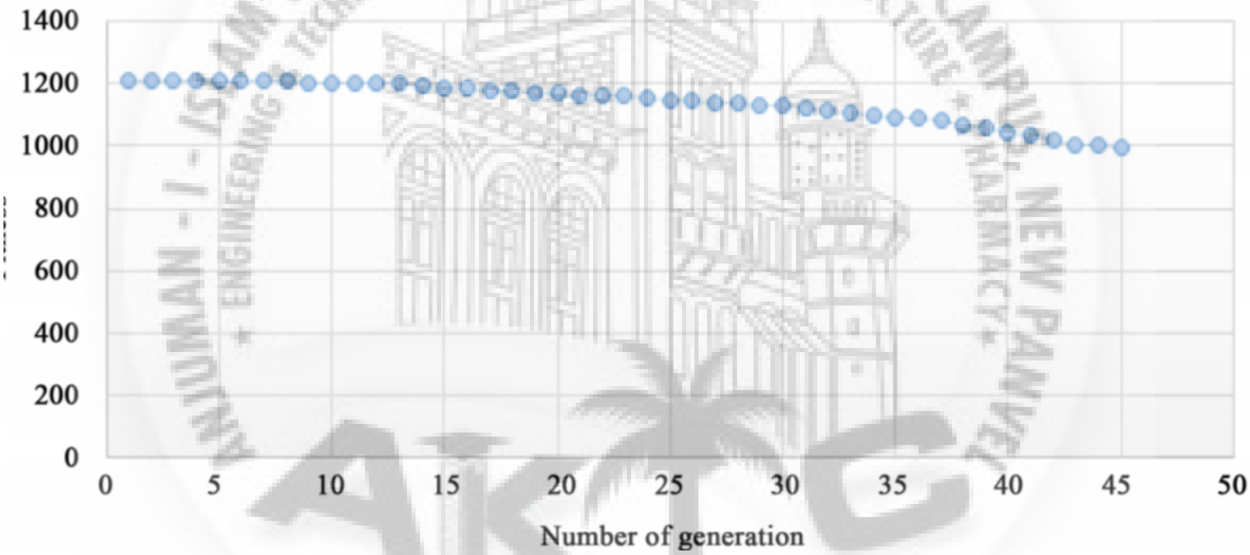
We executed our adaptation respecting the simulation parameters set out above (Test N ̊1).
The results show that the algorithm performs well because the optimum is reached in the last generation



shows the variation of the optimum of 45 generations in the genetic process for a network of 15 eNode B, 7 SGW and PGW 5.
Comment: We note that the process starts with a value of 1207.2 units in the first generation. This optimum undergoes an increase of 0.25% or an evaluation of 1210.2 units in the second generation from the optimum value to the first generation. A marked improvement in the optimum value of 0.42% was observed in the third generation or an evaluation of 1205.1 units. From the third generation, the algorithm performs very well, and we get good value for the optimum in the 45th generation of 870.2 units, an improvement of 27.79% and 27.91% compared to the optimum of the first generation. This improvement is due to the fact that only feasible solutions were chosen to form a new population. Study of the influence of the population on the optimum value 2nd series of experiments with a population equal to 60 chromosomes



Comment: We note that keeping the same parameters except the population size this time that equals 60 (TestN°. 2). We obtain the optimum in the 45th generation of a value of 942.8 units except that it is not better comparedwith that found previously in



Comment: We repeated this same experience to a size of the estimated population of 40 chromosomes (Test No. 3), made the observation that if the algorithm performs well but also the optimum value is degraded; an in-crease of 14.76% relative to the optimum test N° 1 of the first experiment and 5.92% relative to the optimum test N°2 of the second experiment.Thus, a large population ensures good exploration of the search space, which allows to have a refined optimal solution. However, a small population could lead so quickly to a good solution provided that operators are judiciously applied. Finally, the experiments have shown that the processing time increases with a growth in population, this is probably due to the heterogeneity of the members in population. Thus, concerning the search space, the algorithm explores the neighbourhood of each feasible solution to determine the global optimum.

Project Requirements

Software requirements – MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include: Math and computation.

Chapter 4

Market Potential

Market Potential of Project

Genetic Algoritm has abiity to avoid being trapped in local optimal solution unlike traditional methods which search from a single point (v blast, d blast, stbc)

Competitive Advantages of Project

The most effective technology to optimize LTE signal as compared to stbc, Vblast, Dblast LS and MMSE and all the the other technology used in previous generation

Chapter 5

Conclusion and Future Scope

Conclusion-

The main focus of this research is the estimation and optimization
of the channel in MIMO-OFDM systems using various algorithms. The
performance of various OFDM systems are analysed and results plotted and
tabulated. Genetic algorithm optimization scheme is proposed to detect the
position of the pilot in this system
Hence, we have studied the Concept of Genetic Algorithm and the research work has been
implemented using highly scientific computational sotware Matlab

Future Scope-

Implementation of research work can be extended to other benchmark function such as increase in signal to noise ratio(snr), Increase in bandwidth, and control bit error rate (BER) and many more

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