BB-DCA Based Adaptive Beam Forming for Wireless Communication System

Sekhar Babu P (✉ sekharbabupamula@gmail.com)
Sai Spurthi Institute of Technology
Naganjaneyulu P V
Sri Mittapalli Institute of Technology for Women
Satya Prasad K
Vignan's Foundation for Science Technology and Research

Research Article

Keywords: Dynamic Channel Allocation, Adaptive Beam forming, ZigBee Network, MIMO, CCS, Branch and Bound.

Posted Date: June 17th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-603015/v1

Abstract

The traditional mobile radio channel has suffered always from multipath fading which invites many researchers to provide better solutions using MIMO systems. Adaptive beam forming is necessary to obtain maximum signal strength by using uplink and downlink channels. Many researchers have found different technologies to increase the performance of channel allocation. One such technology is to adapt DCA technique – Dynamic Channel Allocation in which the channels are allocated effectively by avoiding the channel interference using CCS- Cooperative Carrier Signaling technique. Also, optimization after allocating channels by defining the lower bound and upper bound in the search space using Branch and Bound technique. There are different methods of state space search available to optimise the solution. The aim of this work is to use branch and bound technique which is considered to be an effective method of finding optimal solutions by having set of feasible solutions in the search space. Multiuser MIMO system will be implemented by using this branch and bound method which is assumed to be a powerful technique among all the available existing approaches. Heuristic search is one of the efficient techniques to be applied in search space tree to find out the optimal solution among all the feasible solutions. It is designed to use MATLAB for simulating the results. This proposed Branch and Bound Dynamic Channel Allocation (BB-DCA) system using optimal search will be compared with the existing approach Channel allocation with respect to new model of channel allocation. The results of the simulation indicate that the suggested approach outperforms other current techniques.

I. Introduction

In order to provide high bandwidth performance, coordinated wireless network MAC protocols require advanced channel borrowing and spatial reuse mechanisms in cellular systems that overcome the rare features of mobile networks. To optimize channel allocation and improve overall throughput, the number of antennas is increasing daily in MIMO systems. Using a distributed dynamic channel assignment (DCA) algorithm based on spectrum sensing and a cooperative load balancing algorithm, the main effort is to achieve better channel allocation. Based on resource availability, nodes can make use of their channel access providers. Besides, the wireless network's energy efficiency is exploited by a secondary radio and clusters are dynamically optimized to fulfil the bandwidth requirements of all nodes. In order to produce well-distributed cluster heads for the purpose of reducing time complexity problem and to minimize control overhead using multi cluster tree topology protocol Model.

Frequency crosswise over remote systems with various radio technologies can affect serious obstruction and reduce correspondence dependability. The conditions are particularly troublesome for ZigBee systems (Liang et., [2010]) that share the 2.4 GHz ISM band with WiFi senders suitable for 10 to several times higher transmission control. The device first discusses the obstruction designs at the bit-level granularity between ZigBee and WiFi networks. ZigBee exercises can cause a neighboring WiFi transmitter to back off under particular circumstances, in which case the header is always attached as the main piece of the compromised Zig-Bee packet.

In contrast to the asymmetric areas where the ZigBee signal is too weak to be recognized by WiFi senders, the symmetric interference zone, however, WiFi action can degenerate any bit in a ZigBee packet continuously. To minimize WiFi obstruction by header and payload redundancy, these perceptions need to be treated. By giving ZigBee nodes multiple chances to discern incoming packets that are to be transmitted, multi-headers give header redundancy.

There are two separate approaches to search for barrier or intrusion avoidance: static channel allocation and dynamic channel allocation (i.e. channel hopping).In a static channel task approach (Tan et al., [2008]), one agrees that a fixed number of channels are used in the 802.11 system and that the IEEE 802.15.4 system is given to use frequency bands that are left unused by WiFi. The channel allocation leaves a limit of two 15.4 channels free of potential interference with 802.11 (Hauer et al., [2009]). Besides, because of node flexibility and gradual WiFi organizations, the static channel assignment technique cannot work as arranged. In dynamic channel assignment method, diverse nodes in a sensor network, or a similar node over various focuses in time, will utilize distinctive 15.4 channels to maintain a strategic distance from adjacent WiFi sources.

To analyze and measure the interference designs somewhere in the range of 802.11 and 802.15.4 systems need a bit-level granularity. To clarify how an IEEE 802.15.4 hub may change the conduct of adjacent 802.11 transmitters making symmetric impedance between the two radios. It is important to identify the presence of 802.11 traffic and organize channel selection (Pollin et al.,[2006] & Gummadi et al.,[2007]) among 15.4 senders and collectors. Also, interference avoidance technique permits substantial portion of the spectrum unused even when there is minimal 802.11 traffic among them. This wastefulness is particularly harming for extensive and dense sensor networks that can't contribute the desired application throughput utilizing a solitary 15.4 channel. The main intention of this work is to increase the channel allocation in order to increase the frequency reuse and its efficiency.

A solution-based approach that can be extended to different extraordinary kinds of problems is the branch and bound technique. The branch and related approach relies on the rule that it is possible to split all the feasible solutions into a smaller number of subsets of solutions. They will then be able to test these smaller subsets effectively before the best arrangement is found. As MIMO systems are applied to the branch and bound technique, it is utilized effectively to allocate the channels effectively among all the available channels. There are many problem solving techniques available in the real world which includes top down approach or data driven approach, bottom up approach or goal driven approach, Heuristic approach and metaheuristic approach and so on. This branch and bound is assumed to be an effective metaheuristic technique to solve the problem of channel allocation recursively in MIMO system.

Section II describes the literature survey in the field of MIMO systems using branch and bound technique in order to produce effective channel allocation, Section III deals with the proposed technique using DCA – Dynamic channel allocation technique with Branch and bound technique, Section IV elaborates the results and discussion in simulation network and last section V describes the conclusion and future work.

Ii. Literature Survey

Landau & Lamare [2017] stated the theory of the branch and bound precoding for the multiuser MIMO approach using 1-bit quantization. The 1-bit digital to analogue device precoding architecture is used to produce the maximum threshold with a minimum distance. Authors designed a system model which consists of M-transmit antennas with K users in its Base station. Proposed phase-only precoding (PoP) was constructed with constant magnitude to define the optimization problem. Precoder method was modelled with 1-bit DAC (Digital to Analog Converter). In the 1-bit Precoder approximation methodology, lower bound was set by relaxing the input constraints. Branch and bound technique was applied on the precoding vector to optimize the results.

In the multivariable model predictive control technique, Mendonca et al.[2010] developed branch and bound optimization. MPC – Model Predictive Control which is represented as a model based control strategy in order to apply in a large number of processes. The structured search technique used to provide a small number of possible solutions is said to be branch and bound, while the remaining solutions appear to be excluded by the specified lower and upper limits. Using a full set of discrete control actions along with a vector of potential control actions, the branch and bound search tree was constructed. The use of the branch and bound algorithm includes the initialization step, the estimation of the lower bound, the application of the branch condition, the calculation of a new optimal solution, the branch of the best-generated node, and the application of the backtracking process. Authors depicted the schematic picture of the container gantry crane and then the control to improve the results.

Khurshid eta al., [2011] discussed the application of heuristic and metaheuristic algorithms which are used for symbol detection in MIMO systems. Authors explained that heuristic search is used to find optimal solutions. Notation and channel model was described using the signals that are transmitted from the appropriate transmitter. Spatial multiplexing system was developed which consists of MIMO transmitter, receiver, channel coding and decoding with rich scattering fading channel to produce the output bits. The authors explained the details of linear and non-linear MIMO detectors, which are followed by the colony optimization basics of 1-OPT and ANT. Flowchart depicting the structure of ACO algorithm was used to produce the summarized results.

Santos et al., [2012] compiled Ant colony optimization for backward scheduling of production. To define the ACO metaheuristic concept, writers used the Ant system graph for 3 jobs and 2 machines. Structure of the implemented software was analysed using certain parameters such as number of ants, number of travels of each ant, quantity of initial pheromone, quantity of added pheromone, evaporation percentage and best response valorisation. Various object classes, such as ACO SFS, Ant SFS, Config ACO SFS, Graph SFS, Edge SFS, Node SFS, Feasible Node SFS and Way SFS, are included in the ACO framework class structure. Using 16 specified scenarios, data for the study of the 26 factorial experiments was tabulated. The authors detailed the study of the ACO metaheuristic efficiency compared to branch and bond. For the studied scenarios, product quantity in production orders was tabulated with Makespan results and machine time. Compared with BB, the authors summarised the findings of the ACO efficiency review. MSE Optimal 1-bit precoding via branch and bound for multiuser MIMO explained by Jacobsson et al., [2017].MSE represents Mean-Squared Error for small to moderate multiuser MIMO system using branch and bound. The authors reformulated the original NP-hard precoding problem as a tree to maximize productivity and achieve optimality. Authors modelled QP- Quantized precoding problem by computing the precoded vector. Rewriting the QP problem was also computed before applying branch and bound condition. By simplifying (QP *) for Constant-Modulus Alphabets, branch and bound condition, and bounding the cost function, BB-1: 1-bit branch-and - bound Precoder was formulated. Five tricks were used by the authors to render BB-1 faster, including Depth-First Best-First Tree Traversal with Radius Reduction, Radius Initialization, Sorted QR Decomposition, Future Prediction and Search Tree Preprune. Jens Clausen [1999] elaborated branch and bound algorithms, principles and examples. B&B terminology and general overview, including bounding mechanism, strategy for selecting the next sub-issue, branching rule, and developing an initial solution, were provided by the author. The author shared personal experiences with GPP and QAP to solve the graph partitioning problem in parallel and to solve the QAP problem in parallel. He explained to B&B users his ideas and pitfalls, including points for sequential B&B and parallel B&B.

Zhao et al. [2017] have described adaptive fuzzy hierarchical sliding mode control for

a MIMO system class that is a non-linear time-delay system with input saturation. The nonlinear control system concept was modeled by considering a class of unknown MIMO nonlinear time-delay systems using 5 input saturation lemmas. Analysis of the nonlinear control system was carried out, followed by the development of a fuzzy logic system, including the fuzzy rule base, the fuzzifier, the fuzzy inference engine, and the defuzzifier. The writers described the surfaces of the hierarchical sliding mode and the design of the adaptive controller. Various theorems and proofs for stability the analysis was given in the stated process.

Nouri & Uysal[2018] specified spatial mode switching adaptive MIMO FSO communication systems for which apertures are used for M transmit and N receive. The pictorial representation of the adaptive MIMO FSO communication device for both transmitters and receivers was demonstrated by the authors. Spatial multiplexing mode outage performance, diversity mode outage performance and hybrid mode outage performance have been established. For a 4 x 4 adaptive MIMO FSO system, the authors tabulated LUTs assuming different targeted outage probability values and assuming different connection distances. For a 6 x 6 adaptive MIMO FSO system for research, they also tabulated LUT.

Iii. Proposed System Methodology

DYNAMIC CHANNEL ALLOCATION MODEL

The goal of beamforming is to use multiple antennas to form beams for a receiver, increasing the SINR, and thus the throughput. It currently supports two beamforming methods:

- Maximum Ratio Transmission (MRT): maximizes the beam between Tx and Rx points (adaptively).
- Precoding Tables: allows a user to identify tabulated beams, supporting a variety of methods (codebooks, etc.) to choose from predefined beams.

To form an optimal beam to the receiver, MRT uses information about the channel between the transmitter and receiver antennas. In practice, for a time-division-duplexing (TDD) system, in which the uplink and downlink share the same band, this technique can usually be used to allow the receiver to send a pilot signal that can be used by the base stations to form this optimum beam adaptively.

The precoding tables in nature are a more general purpose. Several sets of predefined beam forming weights may be specified by a consumer and the various weightings will be evaluated and the strongest beam will be selected for each receiver stage. This simulates a predefined beam MIMO base station (e.g., codebooks) and uses one of several techniques to decide the best to use for a given channel.

A. MIMO and BER

Instead of considering the BER or the attainable rate as the objective function, we consider a design criterion that was previously proposed by Landu et al., [2013] in the sense of inter-symbol interference, and was later also used in (Mo & Heath[2015] & Gokceoglu et al. ,[2016]). The design criterion means that X is selected in such a way that the minimum distance denoted by ϙ to the decision threshold is maximized, which provides robustness against disruptions of the signals obtained. It is considered in the proposed Branch and Bound techniques that each x m have a constant magnitude. By using the corresponding inequality instead, the the problem of optimization can be expressed as:

$$\begin{aligned} \text{Xopt}= \text{argMaX}_{(x,E)} \; &\Rightarrow \text{s.t.Re}\{\text{diag}\{s\}\ \text{Re}\ \{Hx\}> 1\text{to } L\} \\ &\Rightarrow \text{Im.}\{\text{diag}\{s\},\ \text{Im}\ \{Hx\}>1\text{to}L\} \end{aligned}$$

where the negation is applied to obtain a Maximization problem. If needed, the equality |xm | = 1 / √ M *E is subsequently introduced by scaling the entries of x_{opt}

B. Branch-and-Bound Precoding

This method employs a general branch-and-bound approach, which branches on integral and continuous variables. In each node of the branch-and-bound tree, a relaxation is solved, which might be strengthened using gradient cuts for convex constraints. For an integral (binary) variable with a fractional solution value, one generates two branches in which the variable is fixed to 0 and 1, respectively. In order to guarantee satisfaction of a possibly violated nonlinear constraint, one also creates branches on a continuous variable by subdividing its feasible region into two parts. The reduced regions allow strengthening further variable bounds via so-called domain propagation. This in turn allows strengthening the relaxation. Under appropriate assumptions, the method is guaranteed to converge to a global optimum and terminates in finite time if one considers so-called ε – δ -feasibility.

This is a classical algorithm for finding optimal solutions to various optimization problems, first proposed by Land and Doig [1960]. A simple approach to solving the antenna allocation problem is to enumerate all possible antenna combinations if the computational burden is not taken into account. Thus, relative entropy function values for all variations are measured and compared. The optimum solution is an antenna distribution that leads to the greatest function value. However, for issues involving large numbers of antennas, the number of antenna combinations will increase exponentially, which will make the computational burden overwhelming.

An enumeration of all candidate antenna allocation solutions also consists of the branch and bound algorithm. A tree structure, the nodes of which are the antenna subsets of all combinations, is the search method for all antenna combinations. Branching is called the phase that separates an antenna set into two or smaller antenna sets. The step that calculates upper and lower limits within a given antenna set for the relative entropy value is called bounding. A tree node is discarded if it's upper bound is lower than the lower bound of every other node. (Lund & Doig [1960] and Zhao et al., [2014:2012]). This phase is called pruning. A large number of fruitless candidate solutions can be discarded using this algorithm, which will ease the computational burden to some degree. The problem (Godrich et al., [2011]) can be written to use the branch-and-bound algorithm in our problem as the integer programming problem:

C. BB-Cooperative Carrier Signaling

The study describes a structure that creates a new mechanism called Branch and Bound Based Cooperative Carrier Signalling (B-CCS) that neglects the normal involvement of ZigBee nodes in orchestrating their WiFi WLAN link. To discharge a carrier signal (busy tone) simultaneously with the ideal transmission of ZigBee information, B-CCS uses a different ZigBee hub, thus upgrading the ZigBee's perceptibility to WiFi. It uses an innovative approach to simultaneously schedule a busy tone and data transmission without disrupting the impedance between them.BB-Cooperative load balancing algorithm where nodes randomly choose the resources available on the network from their channel access providers.

- The 'HETERONET' framework clusters the network dynamically using the bandwidth, resources, and application form of each node.

The main problem in the technique of channel allocation is that the busy-tone of the signaller must occur simultaneously with the transmission of data using the branch and bound model (without interrupting it). A frequency flip mechanism that distinguishes the busy-tone from the transmission of frequency domain data, but ensures that WiFi senses the presence of ZigBee transmission, must be developed to resolve this obstacle. The inherent spectrum heterogeneity between ZigBee and WiFi is exploited by the frequency flip. Each WiFi channel on the 1.75 GHz ISM band overlaps with the orthogonal ZigBee channels. The signaler hops to an adjacent channel while running the frequency flip before beginning the busy tone, and hops back to the original channel immediately after transmitting the busy tone. This approach guarantees the orthogonal busy tones to the data packet, but it still overlaps with the WiFi channel and can cause the transmission to be deferred.

B-CCS harmonizes the co-existence of ZigBee with WiFi with cooperation between the organizer, customers, and a special ZigBee node known as the signaler. Figure 3.1 demonstrates the architecture of BB-CCS in which BB-CCS operates at the top of the optimum layers. It includes a signal classifier that triggers the signaler by calculating wireless channel interference strength; and a coexistence manager that coordinates the behavior of the ZigBee network to prevent MIMO channel disruption. The three key components of this BB-CSS system are

- Frequency domain: a temporary hopper of the channel that prevents the signaller.

- Interrupt a ZigBee Network data packet 's continuous MIMO.

- Temporary domain: a signalling scheduler that secures the desired data packet while conforming to the CSMA-based spectrum MIMO protocol, ensuring the busy-tone sent by the signaler.

- Spatial domain: a signal configuration system that configures the signaler's position and power with a rough approximation of network parameters such as the maximum contact distance of the Zig Bee Network.

At a high level, BB-CCS works as follows. Initially, it performs the signaler configuration when the optimal topology is established. The ZigBee nodes achieve an estimate of the frequency of wireless channel interference and packet loss rate using the signal classifier. In view of the estimation, the organizer chooses whether to trigger the signaling operation or not. At the point, when the signaling is enacted, the signaler runs the temporary channel hopper to abstain from interfering with data packets if it hears busy-tones.

The organizer, the clients, and the signaler plan the busy tones together, as per the MAC mode (TDMA or CSMA) by Hass & Geng [2002]. In the event that the WPAN receives delay sensitive applications, BB-CCS should be dynamic perseveringly to prepare for bursty wireless channel interference. Hence, a DC-powered ZigBee hub with comparable power as wireless channel is fundamental as a signaler.

a) Initialization

Zigbee network and wireless nodes are added along with node id and name which is optional in this CSS framework. Signaler node should be chosen from available Zigbee nodes and added by specifying the transmission range. Also, for all transmitter nodes to be modified to define the interference range of any signaler node, the transmission range is randomly determined.

Algorithm 3.1

System Initialization

```
Notation:
Zigbee Node zn
Wifi Node wn
Signaler sg
Set 0 ⊠ n for zn node
Set 0 ⊠ n1 for wn node
Set n1,n2…n-1 for sg
For i ∈ n to sg range
For j ∈ n1 to sg range
Transmission Range Calculated Randomly
End
```

b) Temporary channel hopper

If ZigBee runs on channel 20 and WiFi channel 6 is interfered with, if it hops to channel 10 on the right side, suppose the signalling will be ineffective. The ZigBee signaler first sends busy tones on the left-side channel (LSC) to solve this problem, e.g. 19. For eg, if the packet loss is not alleviated, channel 10 will switch instead of signaling to the right-side channel (RSC). If packet loss persists, the Cooperative Carrier Signal agrees that two partially overlapping WiFi bands 7 and 5 respectively interfere with the current channel, i.e. 20. This issue only happens when intense traffic is responsible for both bands, which can be solved by using two signalers that jump to channel 18 and channel 10, respectively.

Algorithm 3.2: Temporary channel Hopper

```
Zigbee Node zn
Wifi Node wn
Signaler sg
If zn and sg switch to nearby channel then
Scheduling signal sg
else
Send busy-tone
```

```
for Busy-tone ∈ wn frequency
if transmission frequency equal to θ then
inform wn and zg transmission
end
return original sg
end
```

c) Signaling scheduler (Fig. 3.2**)**

CCS retains the ZigBee legacy scheduling protocol that allows the signaler to transmit the busy tone at the right time, so that the signaler can transmit the busy tone at the right time.

- It eliminates the wireless channel's pre-emption over ongoing or pending ZigBee transmissions and
- It minimizes the possible impact on WiFi efficiency. The signaling scheduler is planned for these tradeoffs to be handled. This helps the wireless channel to coexist with both ZigBee's CSMA and TDMA modes.

Algorithm 3.3

Signaling Scheduler

```
Zigbee Node zn
Wifi Node wn
Signaler sg
Time time
If sg buy tone at appropriate time then
reduces wn preemption ongoing or forthcoming zg transmission
else
Mode change CSMA & TDMA ∧ wn node
end
```

d) CSMA Scheduler

Specifically, a sender surveys the recipient before transmitting information, and when it is ready to receive, the recipient returns a 5-byte affirmation packet (referred to separately as RTS, CTS). The signaler starts the transitory channel-hopper after receiving the CTS affirmation and immediately emits the busy sound.

In addition to the ACK hold up span and a guard cycle, the busy tone duration increases to the information packet length. The length of the information packet is a piggy-backed one-byte field inside the CTS. In addition to a backoff slot (320 μs), the ACK hold up period involves the broadcast duration of the ACK packet (352 μs), the rx / tx exchange time (192 μs), which is required to guarantee space boundary alignment.

The signaller also senses the channel after switching to the new channel to overcome unwanted WiFi interference. If more than 5 CCA back-to-back attempts are distinguished from a busy channel, signalling starts only if the channel during one CCA slot is idle and the signalling aborts. The other ZigBee network transmitters are unaware of the actions of the signaler and require that CCA be carried out autonomously. The signaler, therefore, does not run back off and requires only one CCA slot to survey a clear channel, usually providing a busy tone before the information is transmitted (Demirkol et al., [2006]).

The RTS / CTS packets are transmitted without carrier sensing to minimize the overhead due to extreme CCA and back off. RTS / CTS can also be lost because of a collision with WiFi packets. RTS / CTS packets are often much shorter than information packets; the probability of a collision is smaller. Each RTS packet is retransmitted for RETX times to further reduce such packet loss and the recipient responds with CTS at whatever point an RTS is received. The RETX meaning, as a one-byte tag, is piggy-backed into the CTS packet.

E) TDMA Scheduler

CCS takes advantage of ZigBee in TDMA mode to assign set slots to clients. In the coordinator's beacon message, the slot allocation data is carried. Upon receiving a beacon, a confirmation packet is sent via CSMA by both the client and the signaler.If the confirmation is absent, the beacon is retransmitted. Once a scheduled TDMA slot expires after assigning effective slots, the signaler will give the busy-tone.

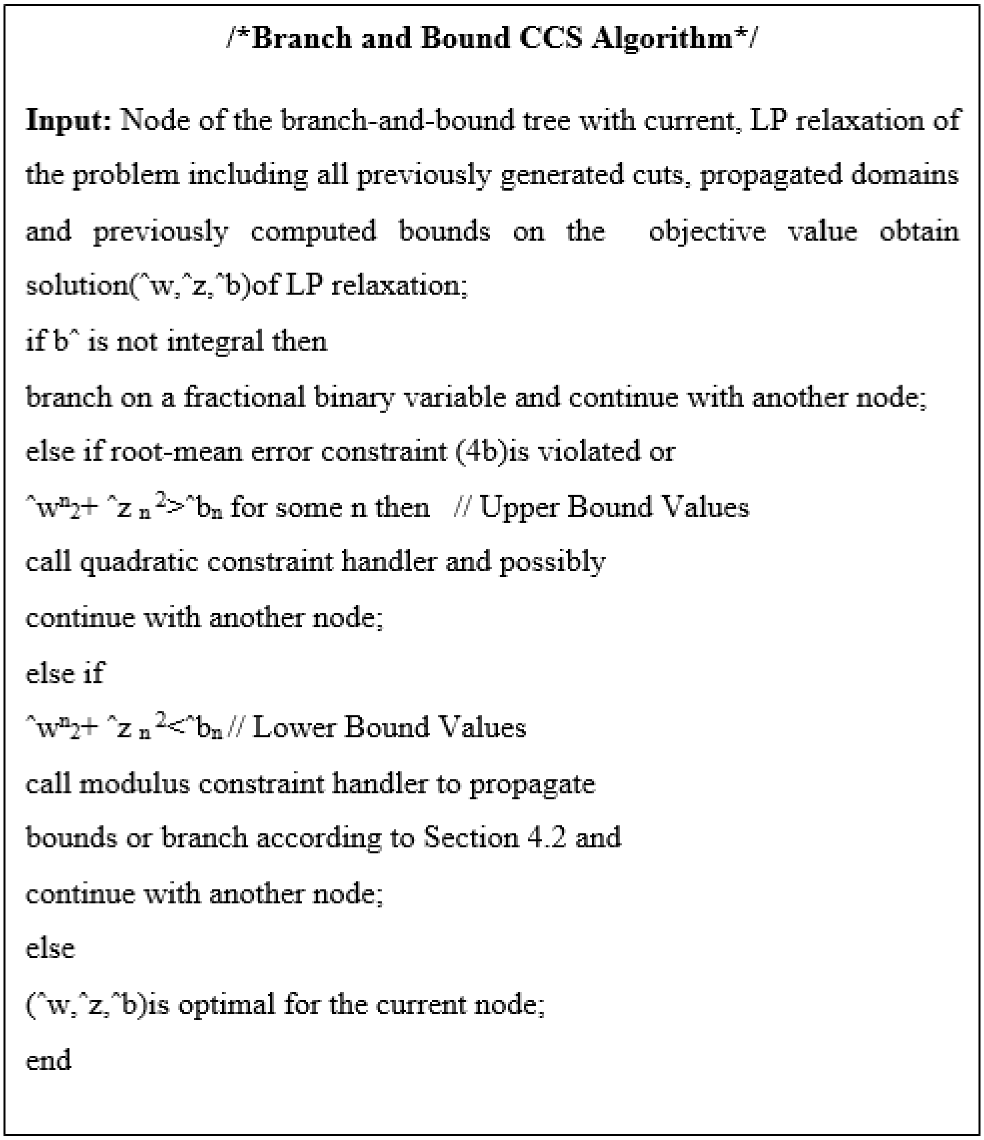
The signaler starts CCA δ time units earlier than the scheduled ZigBee transmission (δ is called pre-signaling time) to overcome unessential interference with an ongoing WiFi transmission. It starts signalling on the first idle CCA, and cancels the signal if the channel stays busy prior to the TDMA transmission.

F) Heteronet

This stage is proposed to be a multi-radio mobile network clustering strategy that is bandwidth-aware and energy-efficient. To minimize WLAN power consumption on mobile devices, Bluetooth is used. It dynamically reconfigures the clusters based on users' bandwidth requirements to avoid performance degradation.

G) Branch and Bound CCS Algorithm

A (1-q) sub-optimality is given by the Branch-and - Bound algorithm, where q is a small non-negative constant. The branches are formed based on a branching variable. Then, each branch is represented by a subproblem of the original problem. In each iteration step to explore it, the algorithm selects a subproblem from the list. The branching variable selection approach is considered the key factor in the Branch-and-Bound algorithms' efficiency. Besides, the selection of the correct branch variables results in a drastic reduction in the number of problems required for an instance to be solved. At each problem node, the traditional branching strategy thoroughly evaluates variables and selects the best variable in terms of the narrow distance between the best possible solution and the new bound solution.



```
/*Branch and Bound CCS Algorithm*/

Input: Node of the branch-and-bound tree with current, LP relaxation of the problem including all previously generated cuts, propagated domains and previously computed bounds on the objective value obtain solution(^w,^z,^b)of LP relaxation;
if b^ is not integral then
branch on a fractional binary variable and continue with another node;
else if root-mean error constraint (4b)is violated or
$\hat{w}^{n}{}_{2}+\hat{z}_{n}^{2}>\hat{b}_{n}$ for some n then   // Upper Bound Values
call quadratic constraint handler and possibly
continue with another node;
else if
$\hat{w}^{n}{}_{2}+\hat{z}_{n}^{2}<\hat{b}_{n}$ // Lower Bound Values
call modulus constraint handler to propagate
bounds or branch according to Section 4.2 and
continue with another node;
else
(^w,^z,^b)is optimal for the current node;
end
```

Iv. Performances Analysis

The following Table 4.1 describes experimental result for comparison between existing and proposed system using Dynamic channel allocation for wireless node. The table contains channel allocation; number of node communication details, average of allocation node in DCA system and average allocation channel in BB-DCA system details are shown.

Table 4.1
Comparison for DCA and BB-DCA system in Channel Allocation

S.No	**Channel Allocation MHZ**	**Number of node Allocation**	**DCA Average of Allocation Channel (%)**	**BB-DCA Average of Allocation Channel (%)**
1	5 MHZ	25	33.23	36.11
2	10 MHZ	30	38.12	40.56
3	15 MHZ	35	43.55	46.65
4	20 MHZ	40	50.17	53.44
5	25 MHZ	45	57.87	61.33
6	30 MHZ	50	61.45	65.46
7	35 MHZ	55	69.07	72.34
8	40 MHZ	60	75.90	78.39
9	45 MHZ	65	82.96	85.76
10	50 MHZ	70	85.33	89.86

The following **Fig. 4.1and** Fig. 4.2 describes experimental result for comparison between existing and proposed system using Dynamic channel allocation for wireless node. The figure contains dynamic channel allocation for number of node communication details, average of allocation node in DCA system and average allocation channel in BB-DCA system details are shown

The following Table 4.2 describes experimental result for comparison between DCA and BB-DCA for in MIMO using average time taken channel allocation. The table contains Channel allocation for MHZs; number of node allocation details, average of time taken for DCA system and average of time taken from BB-DCA system details are shown.

Table 4.2
Comparison for DCA and BB-DCA Channel Allocation (Time)

S.No	**Channel Allocation MHZ**	**Number of node Allocation**	**Channel Allocation Time (DCA) (ms)**	**Channel Allocation Time (BB-DCA) (ms)**
1	5 MHZ	25	33	29
2	10 MHZ	30	35	31
3	15 MHZ	35	42	39
4	20 MHZ	40	54	48
5	25 MHZ	45	63	57
6	30 MHZ	50	72	68
7	35 MHZ	55	81	75
8	40 MHZ	60	95	84
9	45 MHZ	65	99	87
10	50 MHZ	70	103	95

The following Fig. 4.3 describes experimental result for comparison between DCA and BB-DCA for in MIMO using average time taken channel allocation. The figure contains Channel allocation for MHZs; number of node allocation details, average of time taken for DCA system and average of time taken from BB-DCA system details are shown.

Fig. 4.4 shows the results based on MIMO formulas for calculating average normalized MSE with respect to MMSE, optimal, MMSE heuristic, one-side linear, optimal, two-side linear, optimal and MIMO optimal.

Fig. 4.5 shows the proposed system adaptive beamforming for MIMO using BB-CCS optimal solution using various iterations along with best score values. Fig. 4.6 shows the symbol error for the proposed system and Fig 4.7 shows the maximum error for DCA and BB-DCA in the first 100 samples.

Fig. 4.8 represents the standard deviation for the proposed system BB-DCA and then the existing system DCA and Fig.4.9 depicts the BB-CSS channel allocation SNR values for average channel capacity of different number of transmitting antennas.

Fig.4.10 shows the CSMA and TDMA allocation technique with respect to probability of capacity < Given capacity and CDF of the capacity at SNR = 5dB.

Figure 4.11 represents the HETERONET allocation of BB-DCA for normalized probability of all the values.

V. Conclusion And Future Work

Channel allocation is very important in multiuser MIMO system hence it invites many researchers to propose various channel allocation techniques in recent years. It introduced BB-CCS, a network-level platform for enhancing CSMA and allowing coexistence with ZigBee-WiFi. To emit carrier signals, CCS adopts a separate ZigBee network signaler, which increases the perception of WiFi and prevents ZigBee from unwanted interruptions. BB-CCS implements a scheduler to synchronize the signalling with ZigBee data transmission and a temporary channel-hopping mechanism to prevent interference between the signaler and the transmitter. When low duty cycles are working, both BB-CCS and the original ZigBee has a marginal effect on the performance and delay of WiFi. The main aim of this work is to apply Dynamic Channel Allocation (DCA) for Multiuser MIMO system to strengthen CCS. Optimizing channel allocation technique also plays an important role since it is required to increase the receiving antennas and transmitting antennas time to time. This optimization is achieved by specifying the upper and lower bound while allocating channels in the MIMO system. Branch and Bound is a powerful metaheuristic approach to achieve this optimization in terms of channel allocation. In future, trust and authentication based approaches should be adopted to strengthen the security in multiuser MIMO system.

Vi. Declarations

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

Availability of data and material : Not Applicable

Code availability : Available based on Request

Authors' contributions : P.Sekhar Babu – Article Preparation, Design, Implementation. Dr P.V. Naganjaneyulu and Dr K.Satya Prasad - Conceptual Analysis, Design, Review and approval, Language Editing

Vii. References

1. Lukas T. N. Landau, and Rodrigo C. de Lamare [2017], “Branch-and-Bound Precoding for Multiuser MIMO Systems with 1-Bit Quantization”, IEEE.
2. L.F. Mendonc¸a C.A. Silva J.M. Sousa [2010], “Branch-and-Bound optimization in multivariable model predictive control”, IEEE.
3. Kiran Khurshid, Safwat Irteza, Adnan Ahmed Khan, S. I. Shah [2011], “Application of Heuristic (1-Opt Local Search) and Metaheuristic (Ant Colony Optimization) Algorithms for Symbol Detection in MIMO Systems”, Communications and Network, 3, 200-209.
4. Leandro Pereira dos Santos,Guilherme Ernani Vieira, Higor Vinicius dos R. Leite, and Maria Teresinha Arns Steiner [2012], “Ant Colony Optimisation for Backward Production Scheduling”, Hindawi

Publishing Corporation Advances in Artificial Intelligence Volume 2012, Article ID 312132, 12 pages, doi:10.1155/2012/312132.

5. Sven Jacobsson, Weiyu Xu , Giuseppe Durisi , and Christoph Studer [2017], “MSE-optimal 1-bit precoding for multiuser MIMO via Branch and Bound”, IEEE.
6. Jens Clausen [1999], “ Branch and Bound Algorithms - Principles and Examples”, March 12, 1999, IEEE.
7. Xudong Zhao, Haijiao Yang , Weiguo Xia, and Xinyong Wang [2017], “Adaptive Fuzzy Hierarchical Sliding-Mode Control for a Class of MIMO Nonlinear Time-Delay Systems With Input Saturation”, IEEE TRANSACTIONS ON FUZZY SYSTEMS, VOL. 25, NO. 5, OCTOBER 2017.
8. Hatef Nouri and Murat Uysal [2018], “Adaptive MIMO FSO Communication Systems with Spatial Mode Switching”, J. OPT. COMMUN. NETW./VOL. 10, NO. 8/AUGUST 2018.
9. L. Landau, S. Krone, and G. P. Fettweis [2013], “Intersymbol-interference design for maximum information rates with 1-bit quantization and oversampling at the receiver,” in Proc. of the Int. ITG Conf. on Systems, Communications and Coding , Munich, Germany, Jan. 2013.
10. Mo and R. W. Heath [2015], “Capacity analysis of one-bit qua ntized MIMO systems with transmitter channel state information”, IEEE Trans. Signal Process. , vol. 63, no. 20, pp. 5498–5512, Oct 2015.
11. A. Gokceoglu, E. Bj ornson, E. G. Larsson, and M. Valkam [2016], “Spatiotemporal waveform design for multi-user massive MIMO downlink with 1-bit receivers,” IEEE J. Sel. Topics Signal Process. , Nov. 2016.
12. Godrich H., Petropulu A., Poor H.V. [2011], “Power allocation strategies for target localization in distributed multiple-radar architectures”, IEEE Trans. Signal Processing, 2011;59:3226–3240.
13. Land A.H., Doig A.G. [1960], “An automatic method of solving discrete programming problems”, Econometrica. 1960; 28:497–520.
14. Zhao Y., Chen J., Goldsmith A., Poor H.V. [2014], “Identification of outages in power systems with uncertain states and optimal sensor locations”, IEEE J. Sel. Topics Signal Process. 2014.
15. Zhao Y., Goldsmith A., Poor H.V.[2012], “On PMU Location Selection for Line Outage Detection in Wide-area Transmission Networks”, Proceedings of the IEEE Power and Energy Society General Meeting; San Diego, CA, USA. Jul, 2012. pp. 1–8.
16. C-J. M. Liang, N. B. Priyantha, J. Liu, and A. Terzis, “Surviving Wi-Fi Interference in Low Power ZigBee Networks,” in Proc. of ACM SenSys , 2010.
17. S. Pollin, I. Tan, B. Hodge, C. Chun, and A. Bahai, “Harmful Coexistence Between 802.15.4 and 802.11: A Measurement-based Study,” in Proc. of CrownCom, 2008.
18. J-H. Hauer, V. Handziski, and A. Wolisz, “Experimental Study of the Impact of WLAN Interference on IEEE 802.15.4 Body Area Networks,” in Proc. of EWSN, 2009.
19. S. Pollin, M. Ergen, M. Timmers, L. Van Der Perre, F. Catthoor, I.Moerman, and A. Bahai, “Distributed Cognitive Coexistence of 802.15.4 With 802.11,” in Proc. of CrownCom, 2006.

20. R. Gummadi, D. Wetherall, B. Greenstein, and S. Seshan, “Understanding and Mitigating the Impact of RF Interference on 802.11 Networks,” in Proc. of ACM SIGCOMM, 2007.
21. Z.J. Haas and Jing Deng, “Dual Busy Tone Multiple Access (DBTMA)−a Multiple Access Control Scheme for Ad Hoc Networks,” IEEE Transactions on Communications, vol. 50, no. 6, 2002.
22. I.Demirkol, C. Ersoy, and F. Alagoz, “MAC Protocols for Wireless Sensor Networks: a Survey,” IEEE Communications Magazine, vol. 44, no. 4, 2006.

Figures

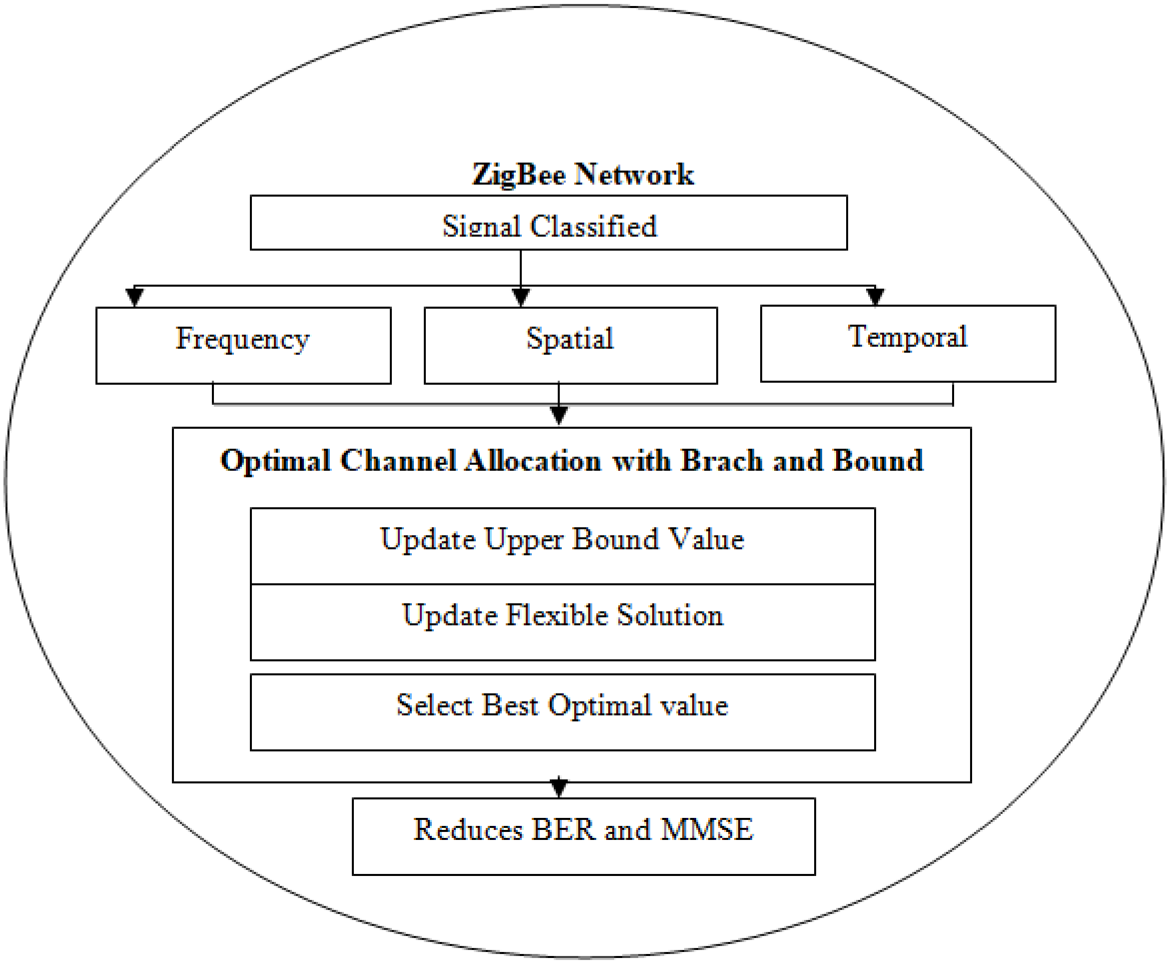


Figure 1

Architecture of the BB-CCS Framework

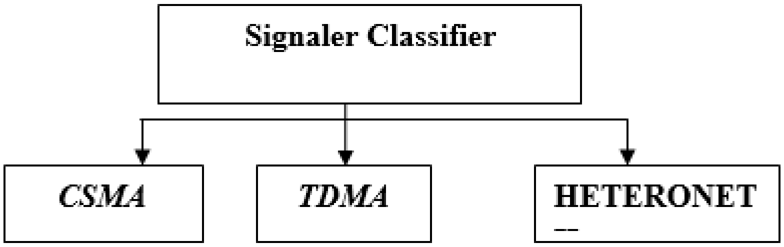


Figure 2

Signaler Classifier

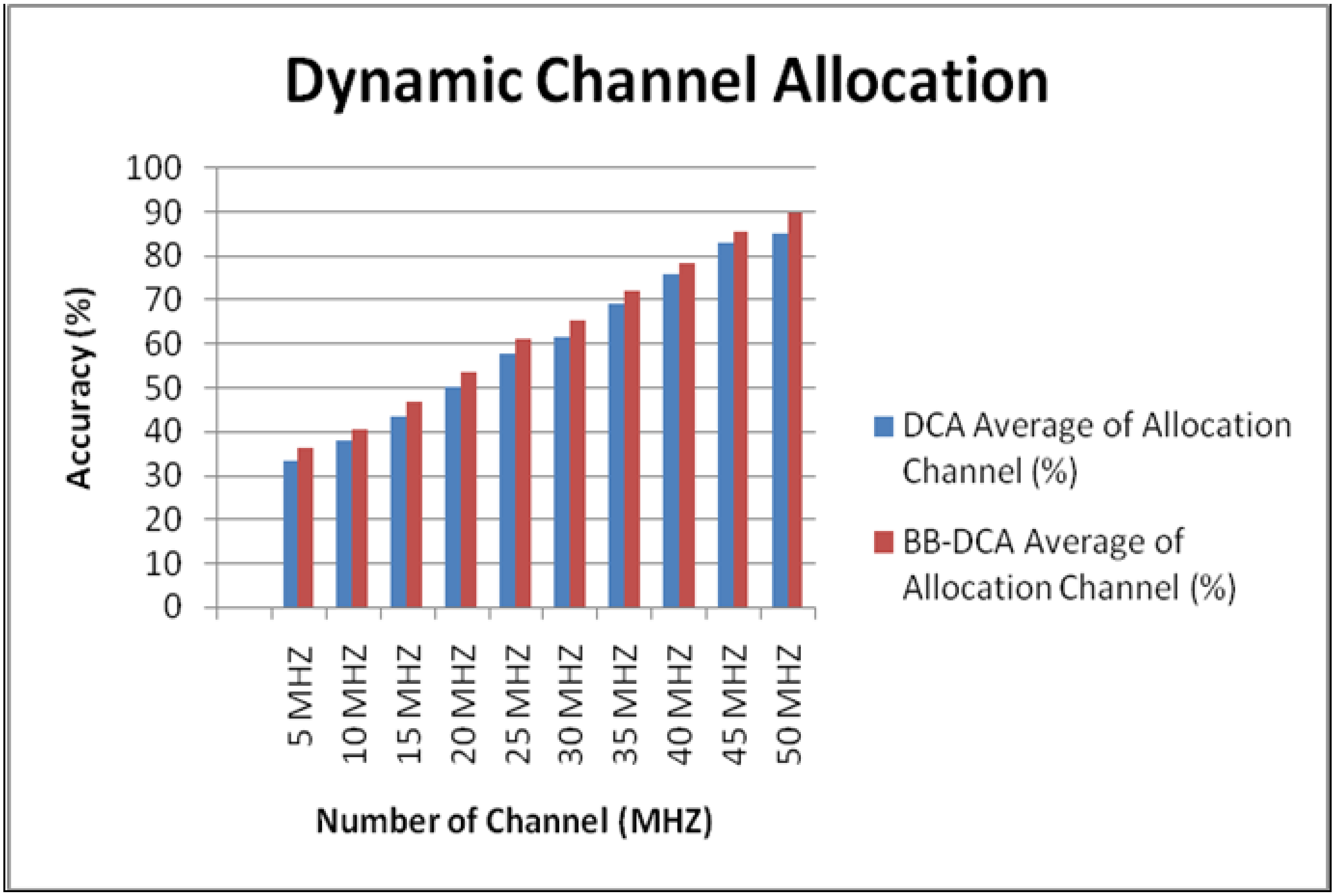


Figure 3

DCA and BB-DCA System Channel Allocation

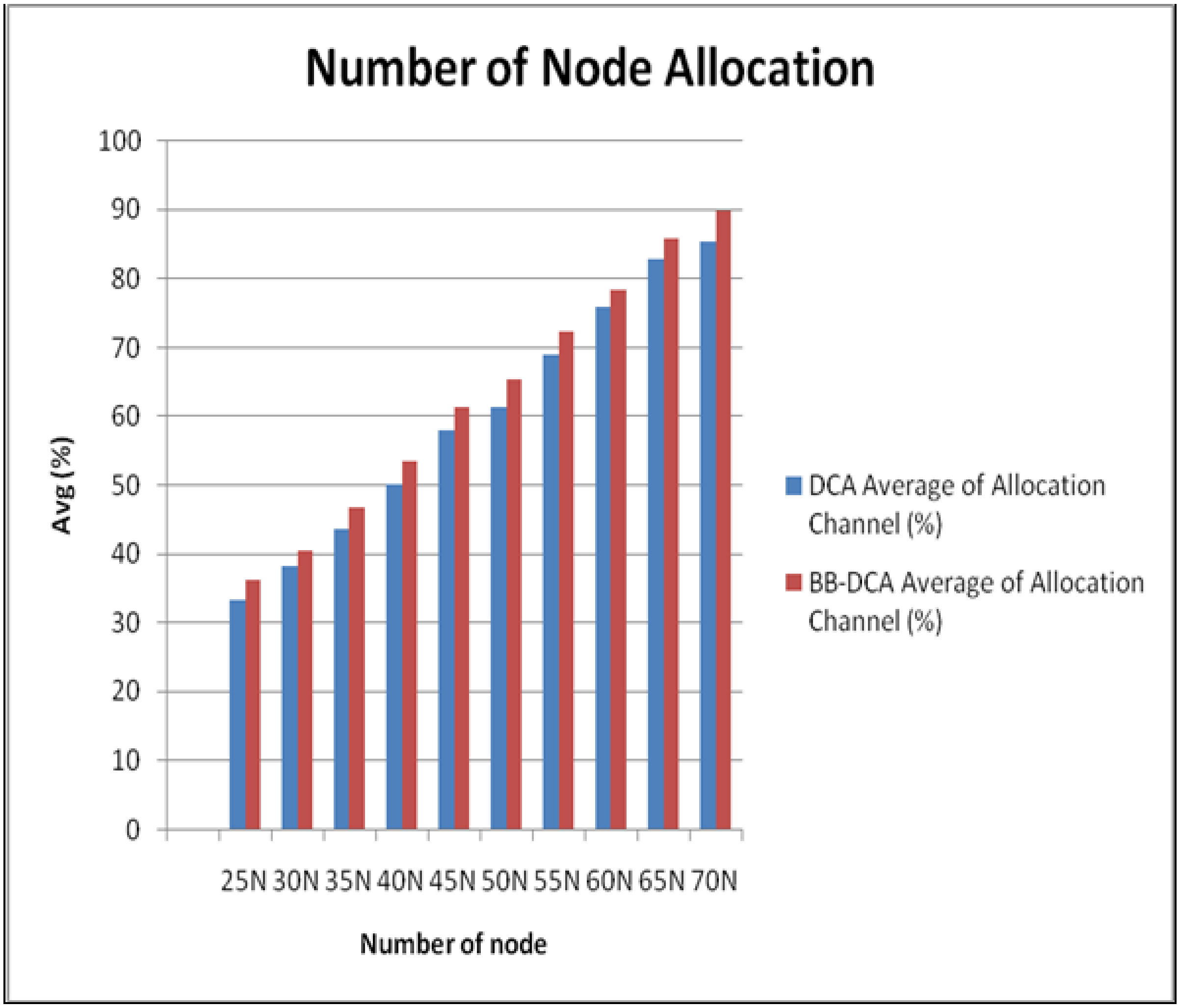


Figure 4

DCA and BB-DCA System Number Node Allocation

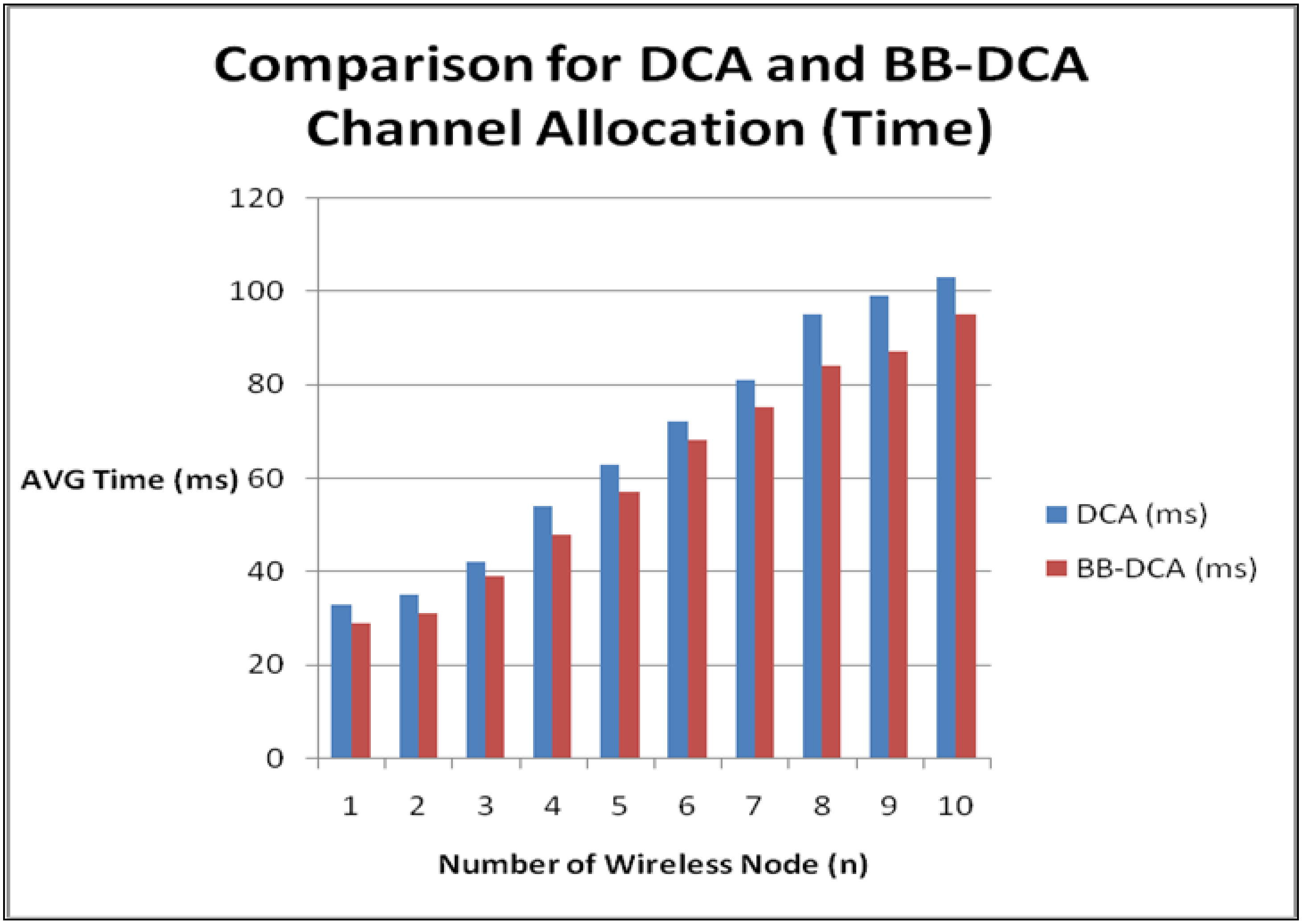


Figure 5

Comparison for DCA and BB-DCA Channel Allocation (Time)

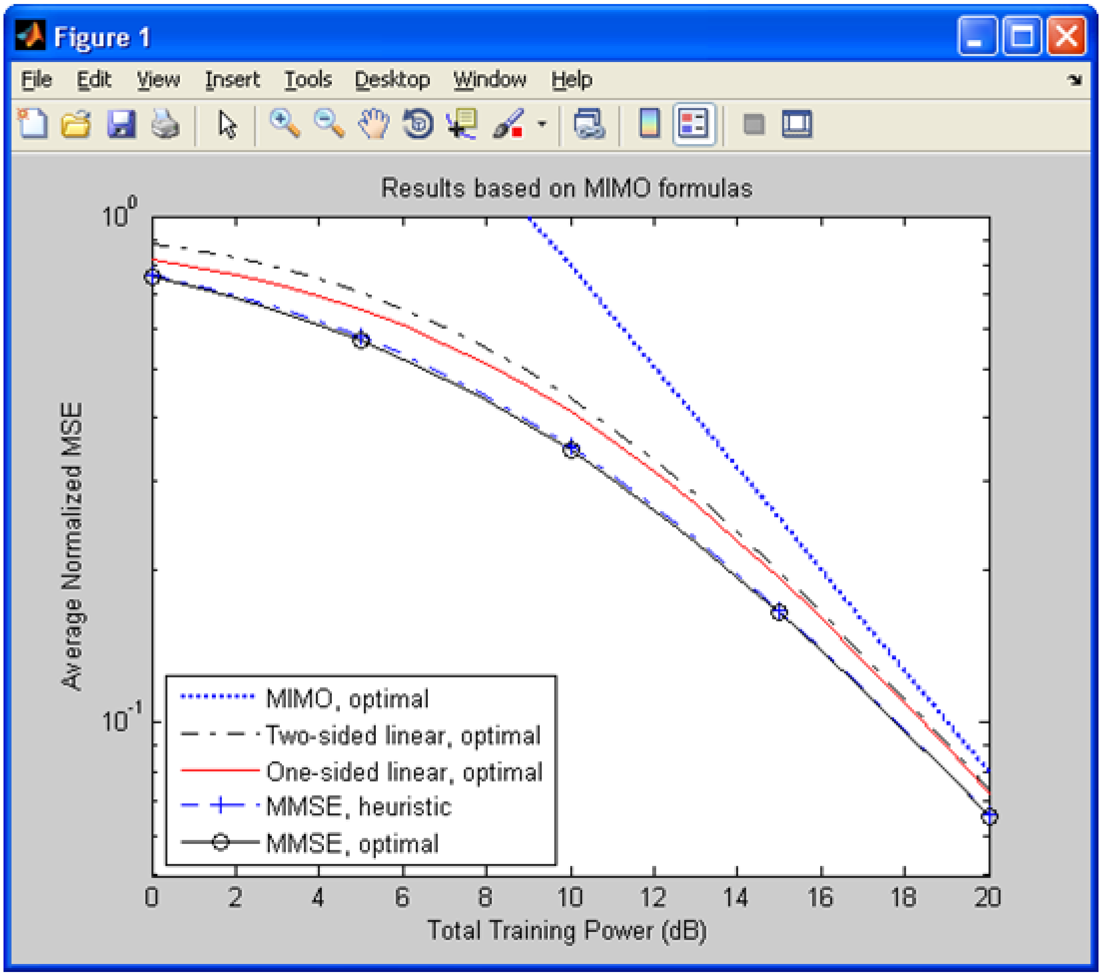


Figure 6

MIMO MSE VALUE

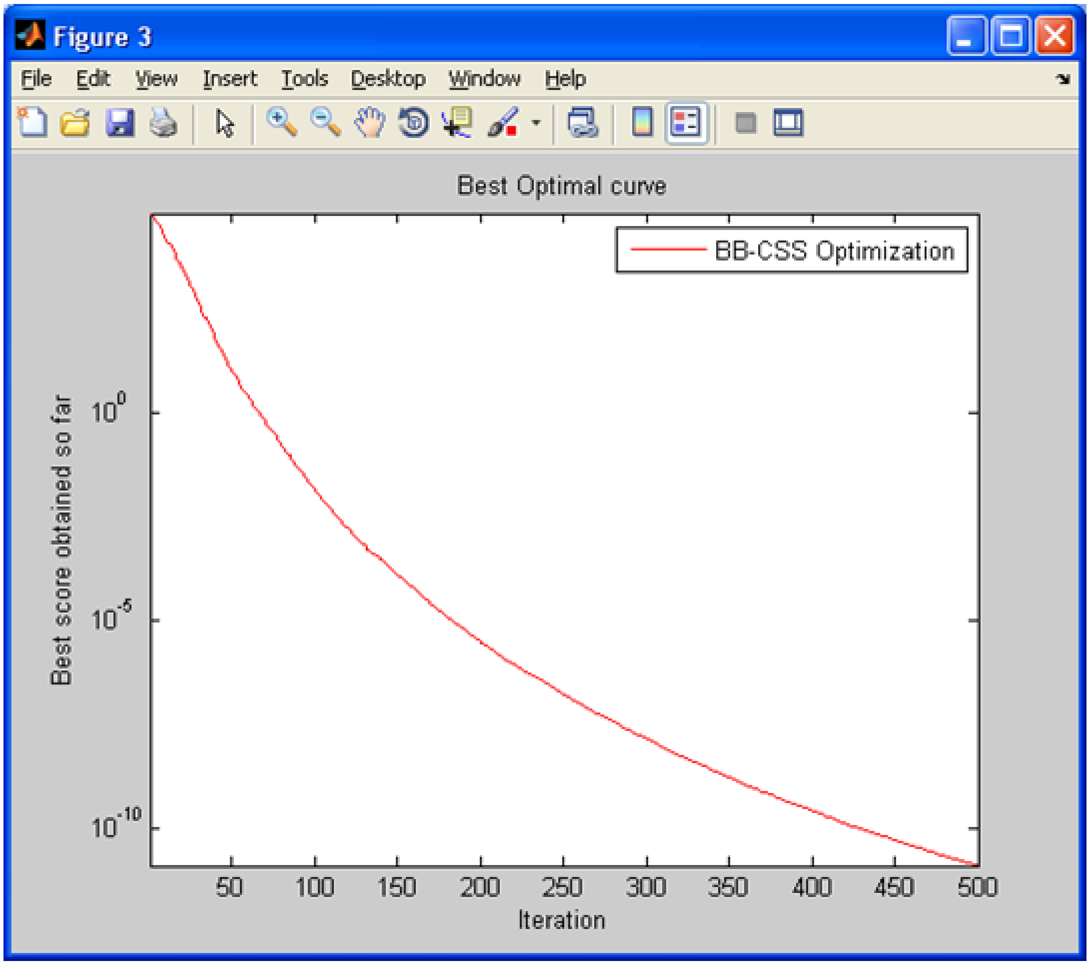


Figure 7

BB-CCS OPTIMAL SOLUTION

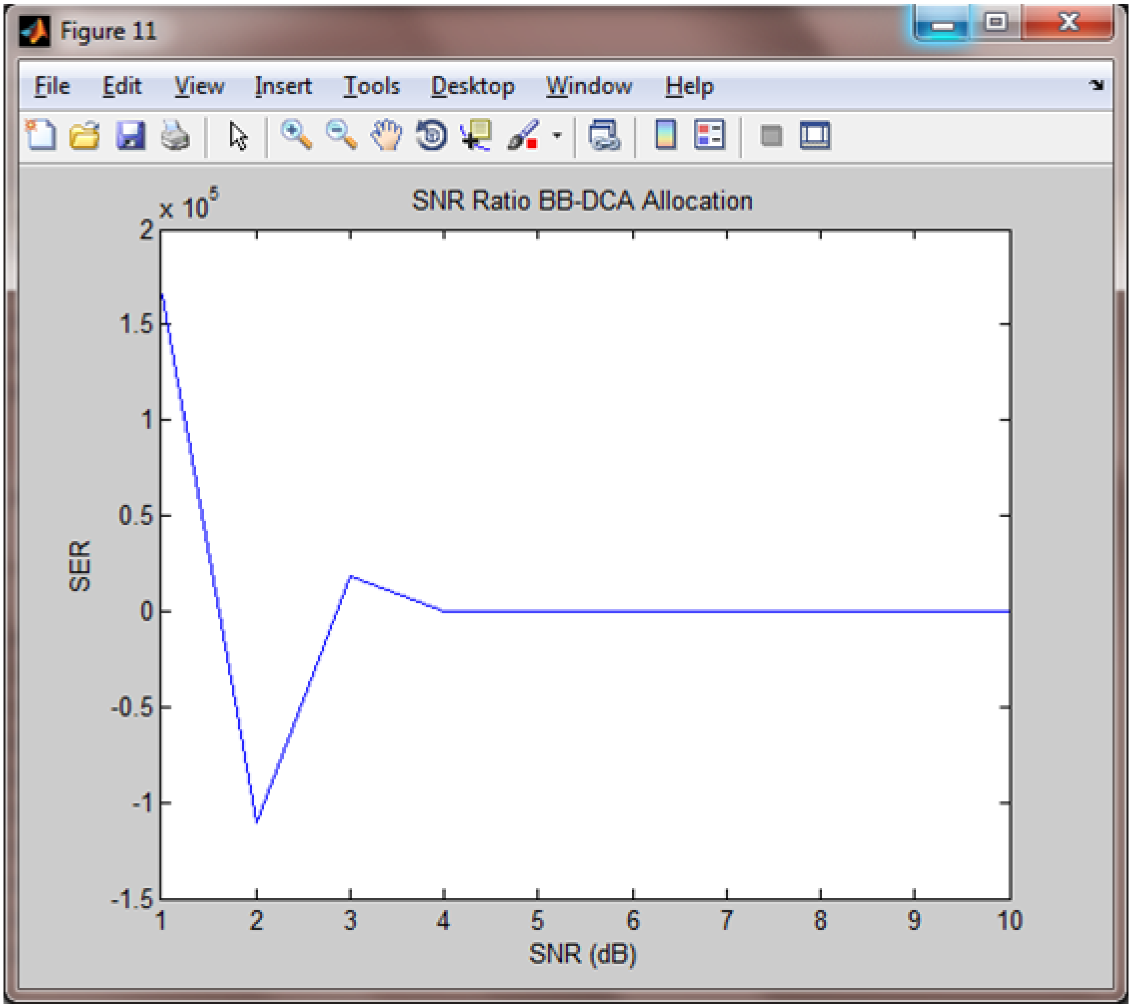


Figure 8

Symbol Error Rate across the channels

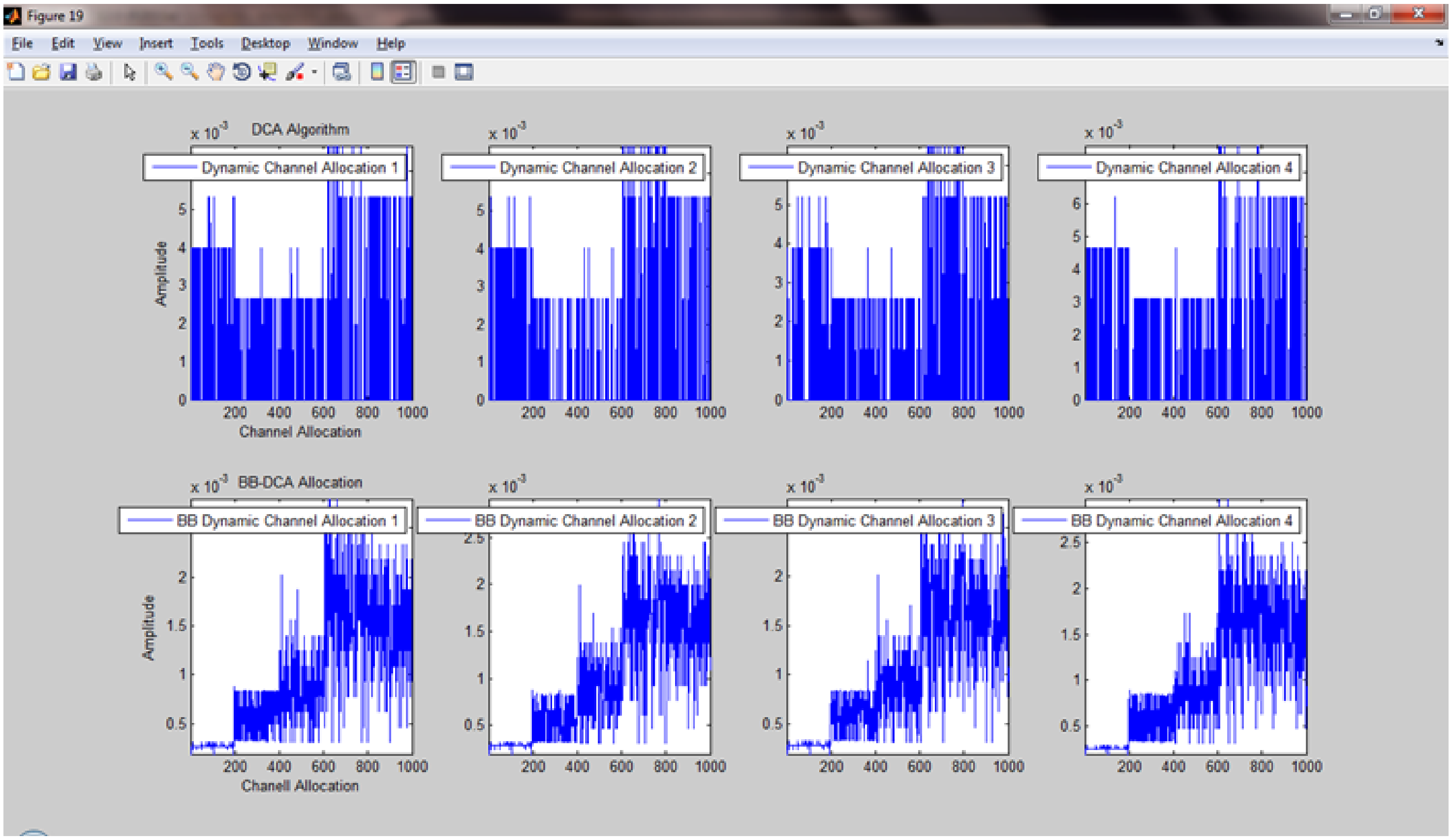


Figure 9

Maximum Error in First 100 samples

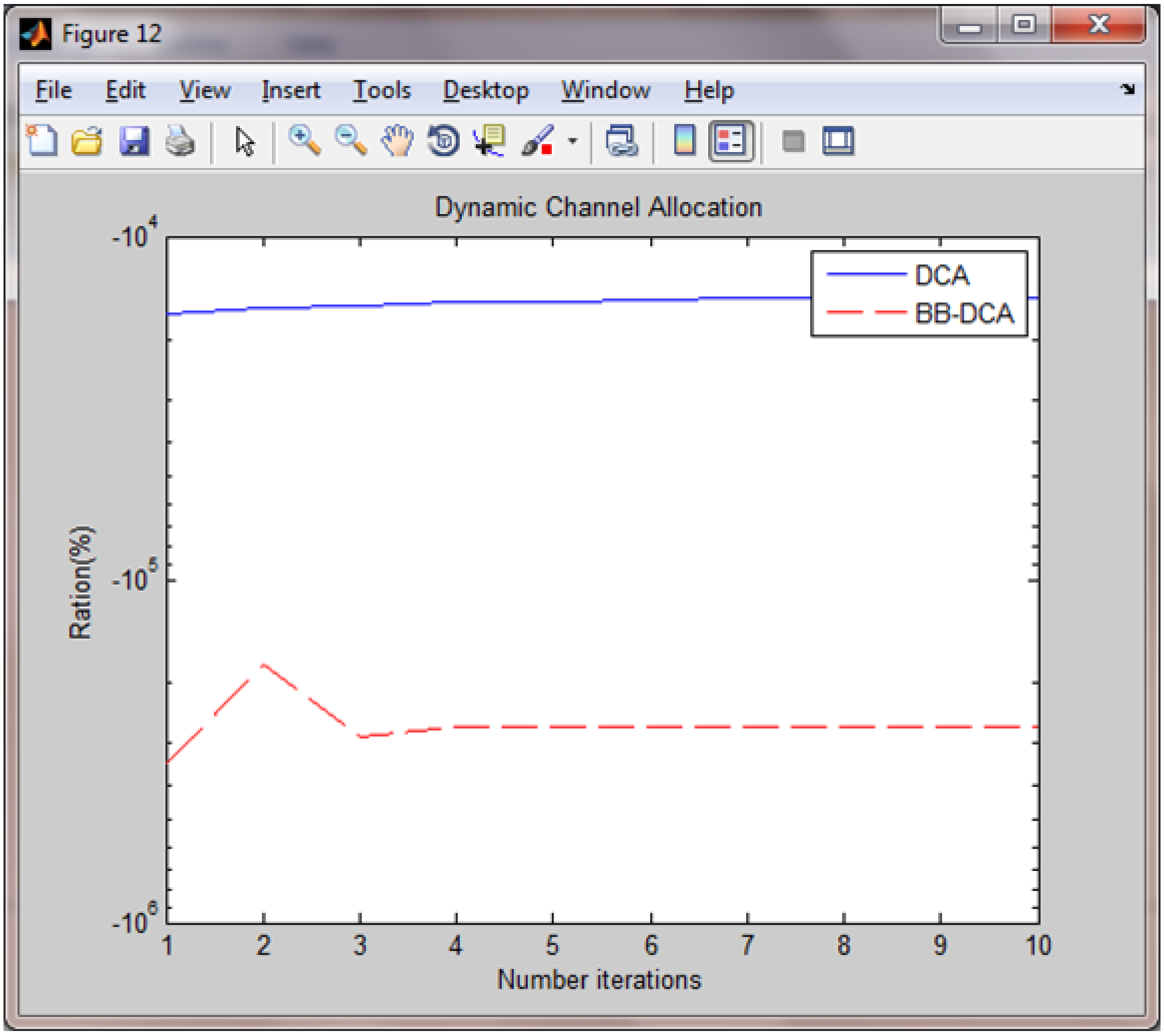


Figure 10

Standard Deviation

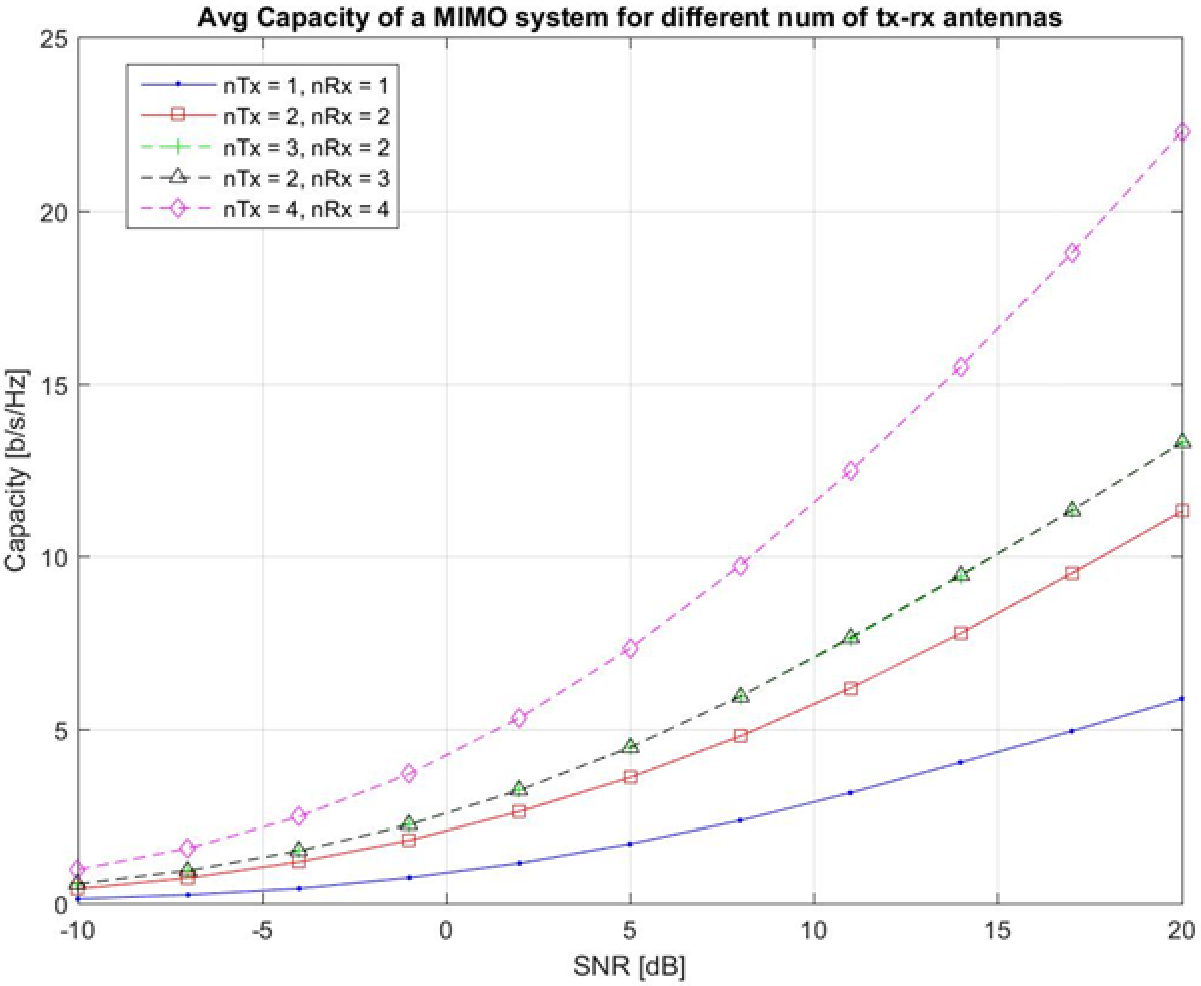


Figure 11

BB-CCS Channel Allocation SNR Values

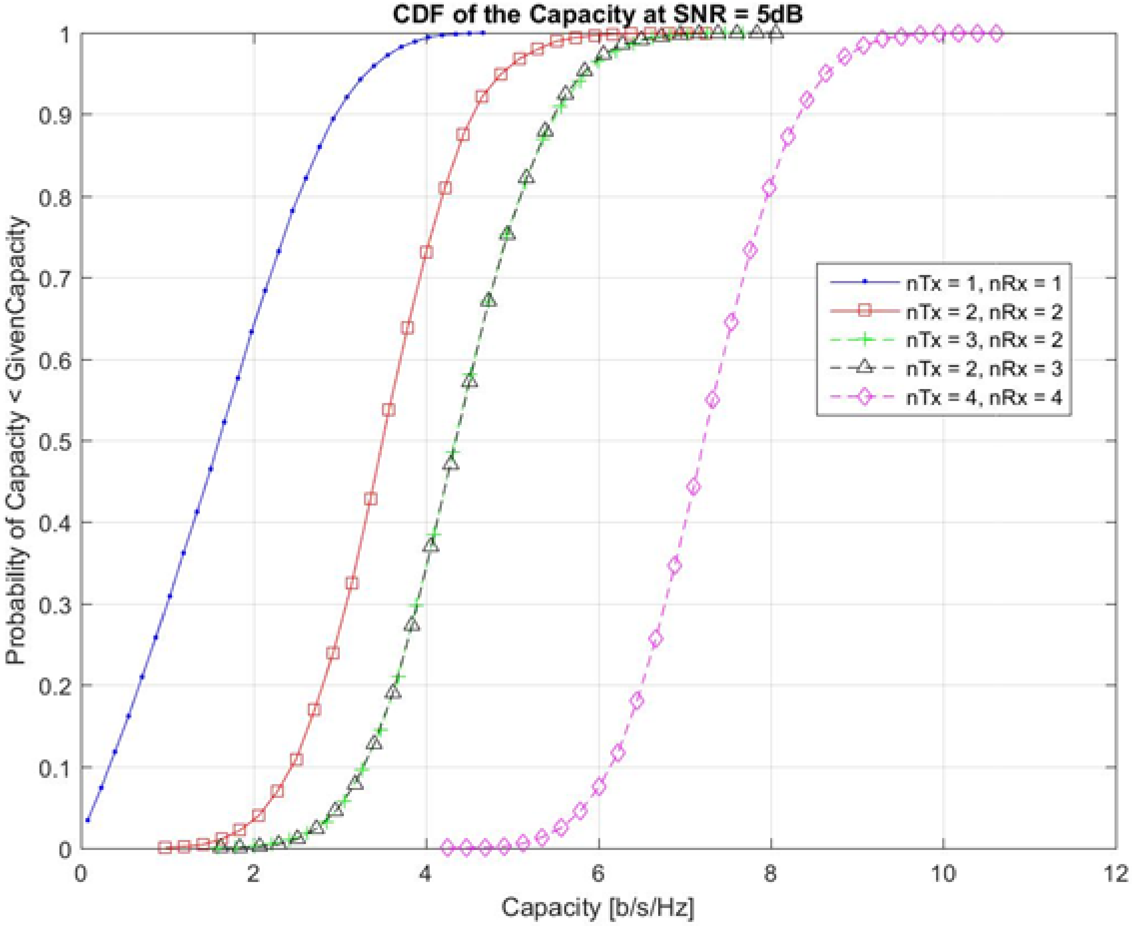


Figure 12

CSMA and TDMA allocation of BB-DCA

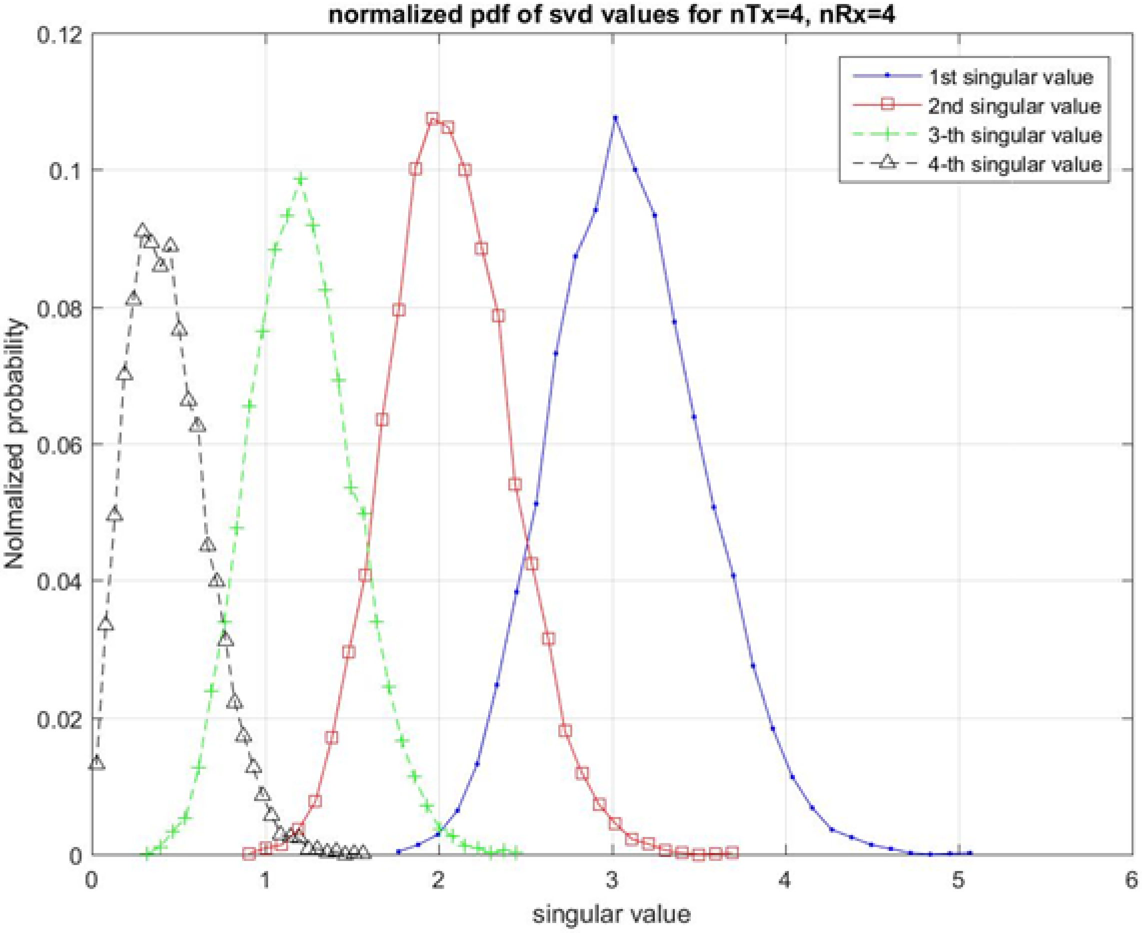


Figure 13

HETERONET allocation of BB-DCA