INCREASE IN CAPACITY OF MULTIUSER OFDM USING DYNAMIC SUBCHANNEL ALLOCATION

DISSERTATION-II

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ABSTRACT

The next generation wireless communications systems need to be of a higher standard in order to provide the customers with the multitude of high quality services they demand. In recent years, Orthogonal Frequency Division Multiplexing (OFDM) has been successfully showed that it is a strong candidate for the modulation technique of future wireless systems. This thesis work is concerned with how well OFDM performs when Channel is allocated dynamically to different users by allocating different users with different subcarriers in a multicell. The algorithms which are used for the channel allocation in multicell is MAX-MIN, resource allocation and subcarrier assignment. In order to investigate this, a simulation model was created and implemented using MATLAB. The OFDM signal was transmitted over different subcarriers in contrast to various signal-to-noise ratio (SNR) values and Bit Error Rate (BER) values. To evaluate the performance, for each SNR level, the signal was plotted for different BER for variant subcarriers and users and data was compared to the original information. The result of the simulation is shown in a plot of the BER versus SNR, plot between normalized ratio of proportion versus corresponding cell number for which the number of user's is activate and perform transmission of data over various subcarriers dynamically with the increase in system capacity as MIN method has the higher capacity as with the increase in user's number, average system capacity also raised The plot shows that OFDM performance is good over this type of dynamic channel allocation.

CERTIFICATE

This is to certify that the dissertation titled " **Increase In Capacity Of Multiuser OFDM Using Dynamic Subchannel Allocation**" that is being submitted by "***Kimmi Salaria***" is in partial fulfillment of the requirements for the award of MASTER OF TECHNOLOGY DEGREE, is a record of bonafide work done under my guidance. The contents of this Dissertation, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Mr. B.Arun Kumar

Lovely Professional University

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KIMMI SALARIA

DECLARATION

I, Kimmi Salaria, student of B.Tech.-M.Tech(Dual Degree) under Department of Electronics and Communication, Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation-II report is based on my own intensive research and is genuine.

This dissertation does not, to the best of my knowledge, contain part of my work which has been submitted for the award of my degree either of this university or any other university without proper citation.

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PUBLICATIONS

[1]. Kimmi Salaria and B. Arun Kumar, "Dynamic Channel Distribution with Power Sharing and Bit Insertion for Downlink Multiuser OFDMA". International Journal of Computer Applications (IJCA), Vol-107, NO. 7, pp.40-43, Dec 2014.

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CHAPTER 1
INTRODUCTION

This report accent to the multicell dynamic channel allocation (DCA) concept experimented in MATLAB for OFDM and allocation of resources dynamically by various algorithms taken into account. And ultimately resource allocation algorithm through proportional fairness with Margin Adaptive as well as Rate adaptive algorithm chosen which performs Resource allocation along with Subcarrier assignment. This work gets started with the introduction of OFDM and its appliance followed by multipath effects from which DCA can be inherited.

1.1 Background of OFDM

OFDM found to be a modulation technique which is used to raise the robustness opposed of narrowband interference and frequency selective fading. In a single carrier unit, any sort of disturbance tends to fail the complete link whereas in multicarrier systems only small fraction of all subcarriers will get suffered. Numerous error rectification methods have been developed for correction of flawed subcarriers. The idea of parallel data uplink and downlink with the consideration of frequency division multiplexing came into existence in the mid-1960s.

In parallel data system, various frequency sub-channels are generated by dividing the total frequency band by N non-overlapping bands of frequency. Separate symbol is being used to modulate each subchannel while considering the N subchannel is of frequency multiplexed. And it appears better to reject the spectral overlapping of the channels to eradicate interchannel interference [1]. Although, this cause to unproductive utilization of the accessible spectrum. This kind of inefficiency can be handling with the idea discovered in the mid-1960s which emphasis on the operation of parallel information along with FDM through overlapping of sub-channels. It carries a signaling rate ‘b’ which is separated ‘b’ units apart in terms of frequency for neglect the work of shrilling speed equalization and it resist impulsive noise, multipath distortion with complete utilization of offered bandwidth. As depicted in Figure 1, through the appliance of overlap of multicarrier technique of modulation 50% of bandwidth can be saved. To get comprehend of this technique by crosstalk diminishing of subcarriers which suggest to be the availability of orthogonality in between diverse modulated carriers.

There is a specific mathematical link in system having different frequency of the subcarriers is known as orthogonal. In regular FDM systems, several carriers are put at different location in a way that the data signals will be received through filters as well as demodulators [2]. In those receivers to lower the efficiency of spectrum guard band are host between carriers along with frequency domain.
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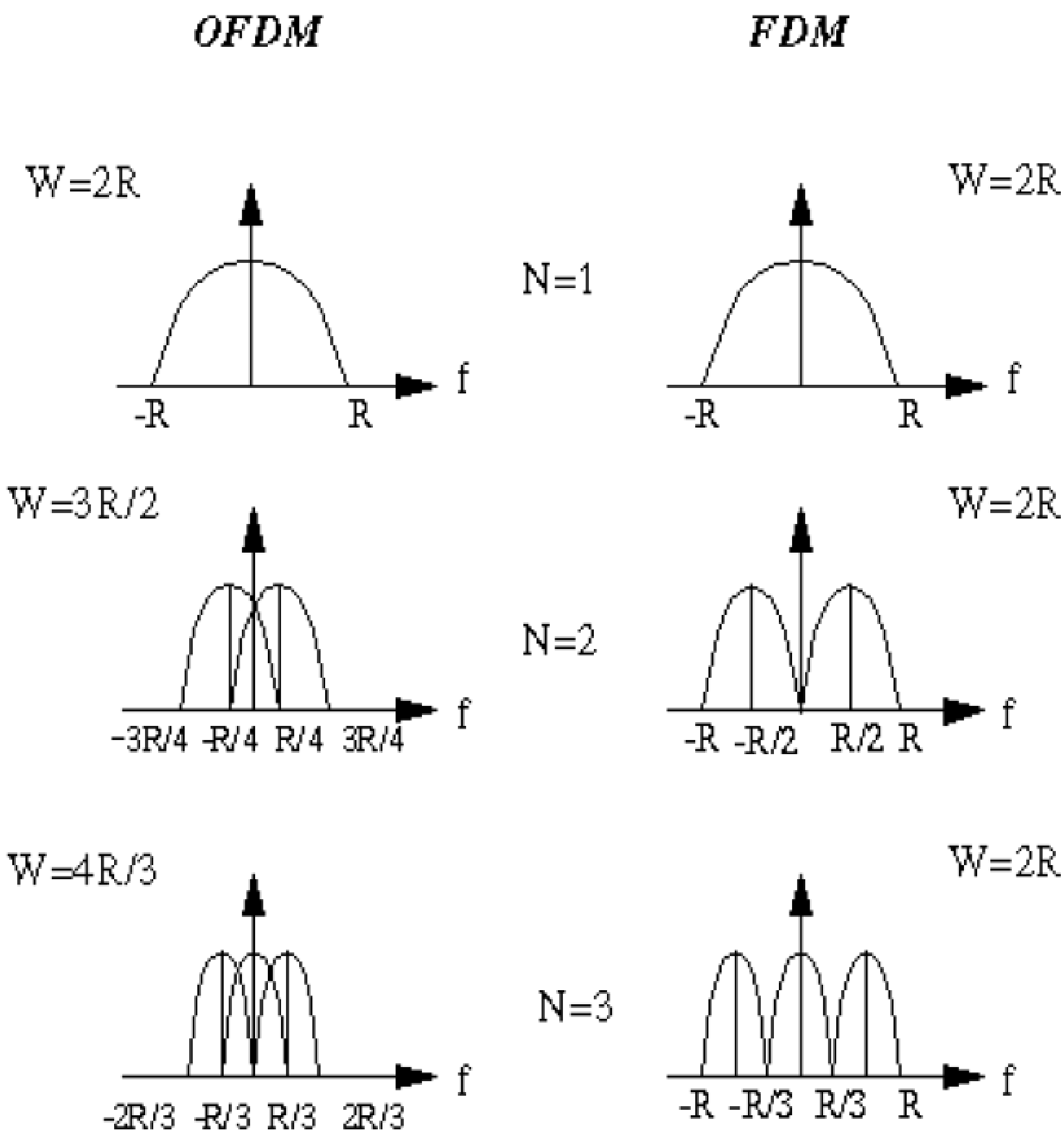


Fig. 1.1 Behavior of OFDM Signal

It benefits with the receiving of signals without taken into consideration of the nearby carrier interference through arrangement of carriers in the OFDM signal. To acquire this, there must be orthogonality in the carriers while the signal receiver consist of tank of demodulators, changing every carrier towards DC and to regain the raw information the resulting signal will be integrated for a symbol period. In the time domain every other carrier will beat down every frequency than it contain whole number of cycles for the symbol having period T. This causes the integration process to be zero participation from rest of the carriers [3] which results in the linear independency of all the carriers if their spacing was set to be a multiple of reciprocal of T.

In the early 80's OFDM was in research for high density recording, high speed modems and digital mobile based communication. Among them the systems which realized OFDM techniques for was multiplexed QAM through (Discrete Fourier Transform), with steady carrier and control on frequency of clock and also trellis coding was designed. In spite of this, numerous high-speed modems being manufactured for various telephonic networks.

In the late 90's OFDM was again in researchers hand for the wideband information transmission and receiving over channel which are mobile based radio FM like HDSL for 1.6Mbps, ADSL upto 6Mbps, VDSL for 100Mbps, DAB and HDTV broadcasting in the terrestrial lane.

Here the list of the advantages which describes why OFDM transmission scheme is better for above applications:

- As OFDM is impervious to frequency selective fading in comparison to single carrier system because it split the whole channel into various sub-channels of flat-fading.
- Through the application of cyclic prefix OFDM can get rid of ISI and IFI.
- In OFDM, the spectrum can be utilized in an efficient way.
- In case if the symbols get lost in the communication process it can be recovered with the help of channel coding along with interleaving which happened due to the frequency selective of channel.
- It helps to make easier channel equalization with the use of adaptive equalization method of single carrier system.
- As there is not any sort of requirement to perform channel estimator if it is in concurrence with the differential modulation scheme.
- Less vulnerable to timing offsets of the samples.

- Good resistant to co-channel interference with impulsive noise due to parasitic.

There are some drawbacks too for the OFDM which are listed below:

- OFDM signal has wide dynamic range with noise like amplitude and because of which it needs RF power amplifiers and this amplifier should contain the ration high peak and average power
- Highly sensible to offset of carrier frequency and drift which occurs from the leakage of DFT.

1.2 Effects of Multipath

1.2.1 Frequency Selective Fading

In the RF communication, it seems that the channel spectral response is not found to be flat with some ups and downs while perceptive because of reflections which cause the rejection of certain useful frequencies at the receiver node. Whereas the reflection generated from the nearby objects tend to production of direct signal of analogous signal power for same multipath signals and it has impact on the cavernous nulls which are caused by destructive interference in the received signal. For shallow bandwidth transmissions the entire bandwidth gets lost only if nulls happen to occur in the frequency of transmission. It can be deal with two ways.

In a spectrum any sort of dips could outcome in demise of signal power through the transmission of wide bandwidth signal in spite of total loss. However one more method is to separate the transmission in several bandwidths of carriers as made in COFDM or OFDM transmissions. Since any nulls are rarely to happen at every carrier frequency due to the spreading of original signal upto a wide bandwidth which may cause the drop of some carriers in spite of complete signal. And through the extra forward error corrections being sent which make the availability of the information being lost in the carriers.

1.2.2 Rayleigh Effect of Fading

In any radio transmission link, signal sent from the transmitter side get reverted back from things such as buildings, vehicles and hills which give mount to numerous transmission ways at the receiver. The comparative phase of several signals can make destructive or constructive sort of interference at receiver's node. If it is happened at smaller distances than it is called fast fading and it varies 10-30dB for these distances. While Rayleigh distribution presents the statistical time changing property of received information signal power. The probability of how much signal level is there after it fades is known to be Rayleigh fading.

1.3 Doppler Shift

When the wave of the source and the receiver moves in comparison to each other the frequency for the signal received is not as same as frequency of source. If both the source and receiver waves move headed for each other and the signal received with higher frequency and the overall frequency reduces as they move further. It is said to *Doppler Effect*. The example can be quoted from daily life as the variation in pitch of the car horn if they tend to passes by. In the design of mobile radio system this is an important effect to be considered. The variation in change of frequency because of Doppler Effect linked from the comparative motion in between source wave and receiver wave and also on speed of wave propagation. It can be formulated as:

$$\Delta f \approx \pm f_0 \frac{v}{c} \tag{1.1}$$

Where Δf is source sustain at receiver side with change in frequency, *fo* is source frequency, v is source and transmitter speeds difference and speed of light is denoted by c.

1.4 Multiple Access of OFDM

The Inverse Discrete Fourier Transform are used to modulate the data x_k on the N subcarriers with the consideration of the final L samples and preclude it to generate the s_k OFDM symbols. After that the data vector is made to serial transmission on the channel. At the receiver the extraction of cyclic prefix is performed and the signal r_k was demodulate through DFT. Assuming the ISI can be eliminated through the introduction of cyclic prefix and saves the orthogonality in between various subcarriers which concludes I/O relation [4].

$$y_k = x_k \cdot h_k + n_k \qquad k = 0,......,N-1 \tag{2}$$

Where the attenuation present in the channel at kth subcarrier is represented with h_k and the AWGN is denoted by n_k. Consider K resources is assigned to every user in for each interleaving frame, n_t symbols is consider to depict the resources in the format of rectangular block and in each block there is n_f subcarrier. As for K=4, shown in Fig.1.3.

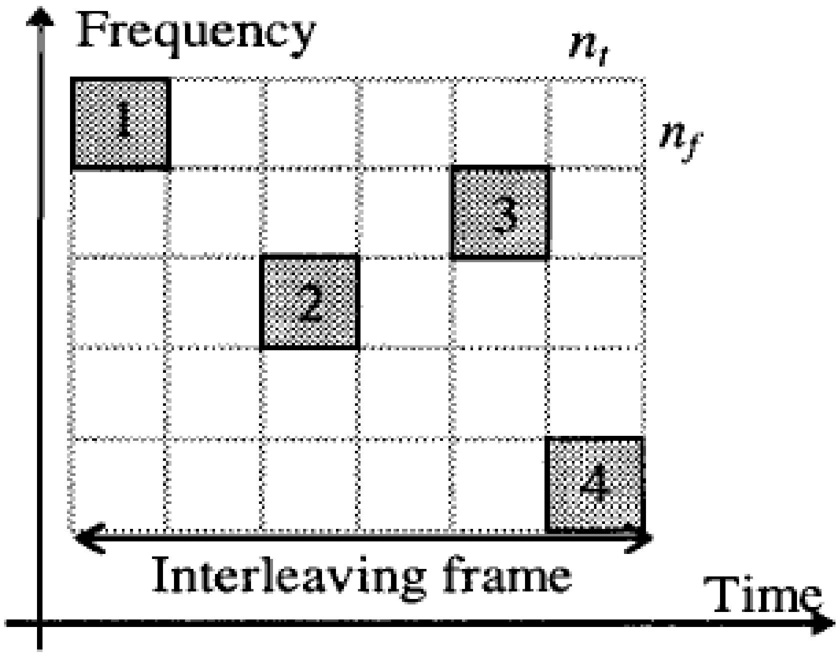


Fig.1.2 Interleaving Frame with n_k Resources [4]

The symbol data is made to be channel coded with interleaved as well as located on each resources separately. Since varying amount of bit rates can be made to available with the variation in number of resources being assigned in each interleaving frame.

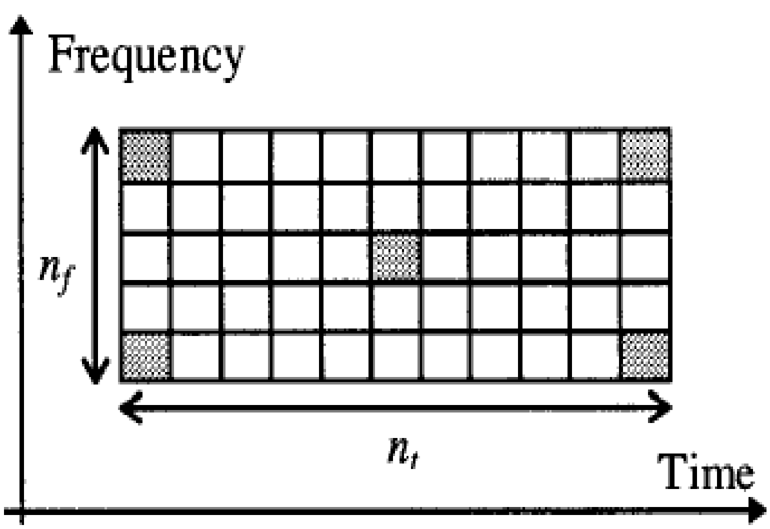


Fig.1.3. Various Pilot Symbols [4]

With the insertion of pilot symbols channel can be estimated which are fuse inside the transmission blocks. As depicted in figure 1.4, pilot symbols are shown with the gray shaded area [4]. As from the pilot symbols the channel can be estimate, in the same way data symbols are also assess with linear interpolation.

1.5 Channel Alteration and Link Modulation

The change in wireless channel was determined to be the elementary limitation on execution of any wireless system with BER is on average conquered by the most awful channel features. Due to the availability of the several propagation paths and the random movement of various mobile users the wireless channel continuously change in space, time and frequency. The principal goal of the link modification, LM was to make sure that the most proficient transmission style is always consider in spite of the used wireless channel. This can be done by dynamic alteration of the key channel parameters which are coding, modulation in addition to power used for transmitting the various channel states. The principal of water-filling theorem can be applied to this. According to which larger transmission rate must be consider when the channel is found to be in better condition [5].

1.6 Objective of the Study

- Allocate the user's with the subcarriers when they are in different cells, hence the concept of multicell arise.
- Dynamic channel allocation can be done with the proportionality of the data rate constraint are utilized in the single cell and same can be applied to the multicell.
- In multicell, to maximize the system capacity the algorithms MAX-MIN, resource allocation and the subcarrier assignment are applied over it.
- The power is also an important parameter in assigning the channels dynamically using the Water-Filling theorem.
- M.A, R.A, SNR, BER, MAX-MIN etc all form the base for the implementation of the Multicell Concept.

CHAPTER 2
REVIEW OF LITERATURE

M. Wahlqvist et al. 1997 [4] has made comparison of capacity of multiple access system based on an OFDM considering several dynamic resource allocation. In this paper, a comparison was studied for performance of different resource allocation schemes. In OFDM, FFT can work on total available bandwidth as all functions are available in all the cells. Thus, he concluded that "Multiple access system" which is based on OFDM and dynamic resource allocation together can be proved as an effective system. An investigation on mixed services, which were obtained by switching two different circuit.

Inhyoung Kim et al. 2001 [12] has studied the application of linear programming in dynamic sub-channel and also for bit allocation in multiuser OFDM. They have proved that conversion of the nonlinear optimization bugs to linear optimization including integer variables, optimal sub-carrier and allocation of bit can be obtained by *integer programming* (IP). Also a suboptimal approach was made to reduce the computation which performs channel allocation as well as bit loading separately. Results showed that performance of the suboptimal approach is optimized.

Zukang Shen et al. 2005 [7] suggested the adaptive resource allocation can be done in multiuser OFDM systems considering proportional rate constraints. In this paper, the proposed algorithm i.e. subchannel allocation was performed by assuming a uniform power distribution followed by optimal power allocation algorithm which maximizes the overall capacity but maintains the proportional fairness.

Khaled Ben Letaief et al. 2006 [5] has proposed a suboptimal algorithm with less complexity that can separate sub-channel allocation and power allocation for wireless systems. A promising technique discussed is Multiuser orthogonal frequency division multiplexing (MU-OFDM) to reach high downlink capabilities in future generation of cellular as well as WLAN systems. In this article, author has provided us an overview on recent development in MIMO and OFDM systems and some open issues within cross-layer resource allocation/adaptation are also discussed.

Bin Da et al. 2007 [8] proposed for dynamic subcarrier sharing algorithms used in uplink OFDMA Resource allocation. In this paper, Multi-antenna based Dynamic Subcarrier Sharing (MDSS) algorithms was applied for maximizing overall capacity of an uplink OFDMA (Orthogonal Frequency Division Multiple Access) system. Two MDSS algorithms were also proposed for solving this problem with less complexity in computation. Simulation results were positive for the proposed algorithms, as new methods that can adaptively allocate resources to users, enhances the system capacity and also rate fairness for different users.

Adil EL Bourichi et al. 2007 [9] proposed a combination of a low complexity and energy efficient dynamic channel allocation algorithm applicable for multiuser OFDM. Adaptive modulation shows large increase within the capacity of the wireless system and low complexity channel allocation algorithm. In this paper, it is shown that adaptive modulation have better energy efficiency for both, and better performance. The proposed algorithm was applied a single cell OFDMA system with exclusive assignment of subcarriers to users.

Vidya Kant Dwivedi et al. 2009 [10] showed shared power allocation for subcarriers used in OFDM Systems. The proposed technique needs variable amplitudes of subcarriers (VAS). The proposed method, OFDM dynamic adaptive subcarriers schemes for optimizing SNR level within sub-channels. Simulation showed the proposed algorithm has much better performance.

R. Nordin et al. 2010 [11] discussed about dynamic subcarrier allocation including ESINR Metric with conditions of correlated SM-OFDMA. The aim of this study was to minimize self-interference from dynamic subcarrier allocation (DSA) and evaluation quality of spatial sub-channel by an ESINR metric. Finally, performance of DSA-ESINR was compared with DSA based on channel gain, MGSS, and MGSS-ESINR.

Jurong Bai et al. 2011 [6] proposed that simulation of dynamic resource allocation can be applicable in OFDMA Systems. The algorithm of proportionality fairness resource allocation were studied to achieve user fairness during optimization of system capacity. Simulation showed results that algorithm discussed were well enough to keep proportional fairness and relatively small complexity.

CHAPTER 3
PRESENT WORK

3.1 Scope of the Study

In OFDM, to acquire large spectral efficiency among shared users the unfilled bandwidth is alienated into orthogonal limited band subcarriers. On every available subcarrier, the modulation techniques M-QAM / QPSK are applied for modulation of data. As for multi-user communication, the subcarrier assignment is of major concern among users and it can be achieved through channel based algorithm such as channel allocation. This channel allocation can be done through fixed channel allocation (FCA) as well as Dynamic channel allocation (DCA). Since the former requires the instruction manual for frequency planning and in which number of available channels per cell is made to be fixed inspite of what the users count and the later tends to allocation of subcarrier along with power to the present channel state and the end result was the proficient utilization of radio resources with the rise in ability of the capacity of system. However in DCA, the amount of channels can change in a cell with the increase in traffic load while the highly concentrated cells tend to borrow free channels as it is linked with neighboring cells.

DCA are of two kinds namely Rate adaptive (RA) and the Margin adaptive (MA). In RA there is a growth in overall throughput of system which is subject to power constraint to be maximum. In MA the focus is on reducing the total consumption of power which is subject to minimum rate constraint for every user. The key benefit of such new algorithm is its aptness for elevated mobility conditions where large amount of users will be available at locations which is distant from the tower of base station (BS) and thus embedded with exhausted signal-to-noise (SNR) ratio. It is suggested that the utilization of adaptive modulation was a better choice from the energy proficient point of view so that all existing user modulation level need to be altered by considering the BER and also won't increase in the value of SNR any further level. Therefore, in order to maintain the similarity in communication without any gain in the power level at the receiver node in downlink and uplink, users need to locate for inferior modulation level such as QPSK/ 16-QAM for having distant B.S.

It would be proficient if every user close to the B.S could arrange for certain level of BER without any sort of improvement in SNR. While on the other side, user's which are at distant location from the BS should increase their power level to have the same BER when larger modulation level is being used. So, all these ways are not found to be energy proficient for every mobile terminal and it generally effect the capacity of system when user's having low power could not be able to maintain the needed quality in communication even though they are provided with a channel. As in DCA, the amount of bits for transmission through the channel is determined first and after the count of subcarriers needed for this transmission is performed. With the available literature and through comparison with analysis concludes that proposed algorithm was more proficient in energy along with good optimality.

3.2 Structure of OFDM

The key principle for OFDM is to break a data stream having high-rate into amount of lesser data rate which is transmitted through different subcarriers. Due to improvement in the symbol duration of subcarriers in parallel having lesser rate, cause the demise in dispersion of time occurs with respect to multipath delay spread. An OFDM signal is found to be the summation of different subcarrier that are separately modulated through PSK or QAM whereas the symbol can be represented as:

$$s(t) = \mathrm{Re}\left\{ \sum_{i=-\frac{N_s}{2}}^{\frac{N_s}{2}-1} d_{i+N_s/2} \exp\left(j2\pi\left(f_c - \frac{i+0.5}{T}\right)(t-t_s)\right) \right\}, t_s \le t \le t_s + T \tag{3.1}$$

where,

N_s: number of subcarriers

T: symbol duration

F_c: carrier frequency

3.3 Implementation of OFDM

At transmitter side, binary form of input data is encoded through a convolutional encoder having rate ½ and this rate can be raise upto 2/3 or ¾. The binary values are changed into QAM values after interleaving. In each of the 48 data values, four pilot symbols were added which end up with a complete sum of 52 QAM values in per OFDM symbol as well as through the application of IFFT, symbol is made to modulate over 52 subcarriers. After that it is converting for the serial transmission with the addition of cyclic extension which tends to create the system robust for multipath propagation of symbols. To get the output spectrum to be narrower windowing is then applied on it. With the use of IQ modulator an OFDM signal is transformed to analog value and it is then converted further upto a frequency of 5Hz which is than amplified and transmitted over an antenna.

With some additional features, receiver do as opposite of what the transmitter has done. Firstly, it has to determine the frequency offset along with the symbol duration with the help of special symbol trainings in the opening. After it extract the cyclic extension and FFT can be applied over it to gain back the 52 QAM values for every subcarrier. Pilot subcarriers are utilizing for the phase drift along with the channel response. The QAM value obtained reverts back into binary values and lastly Viterbi decoder is used to decode data bits. Fig. 4.1 depicts the overall OFDM system.

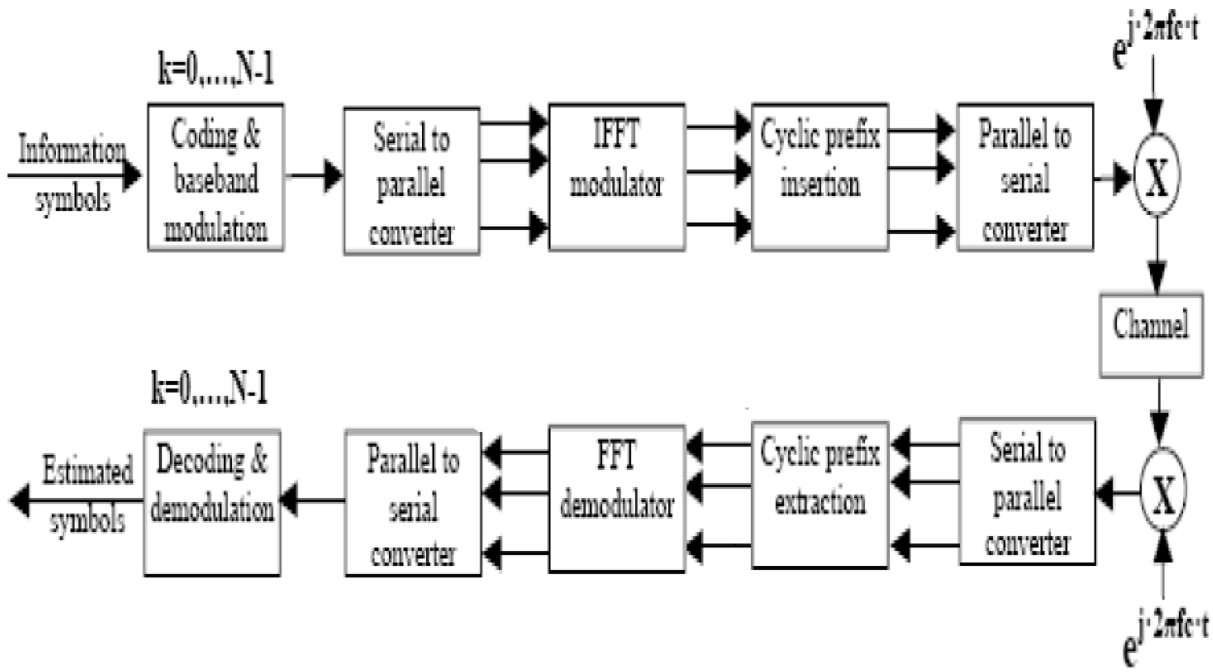


Fig.3.1 Block Architecture for an OFDM System

3.4 System Model

We take into account downlink system for OFDM having one BS serves U number of active nodes. System bandwidth 'B' is partitioned into N amount of sub-channels and every subchannel has a bandwidth given by $\Delta f = \dfrac{B}{N}$. Every user needs the minimum amount of achievable rate R_u bits in per OFDM symbol. Since channel gain of every subcarrier 'n' required by every single user u is formulated through gain matrix which can be acquired as $G = [G_{u,n}]$. It contains the causes of fading, shadowing as well as path loss. The signals modulated on subcarriers should be affected by AWGN along with zero mean as well as variance σ^2. Also σ and G completely explained about the channel and therefore it requires the good knowledge about the CSI at base station terminal.

Let assume that $p_{u,n}$ represents the transmission power while $c_{u,n}$ represent the amount of bits required for user u on the nth channel. If $p_{u,n} = 0$ (simultaneously $c_{u,n} = 0$) it state that nth channel is not linked to user u. And one user can be allocated with only single channel. Also, $c_{u,n} \in \{0, 2, ..., K\}$ where maximum amount of bits is represented with K which can be assigned on every subcarrier and also if $c_{u,n} = k$ only for even integer values and if k>0 it means on channel n there is modulation M-QAM is taken into account while $M = 2^k$.

3.5 Dynamic Channel Allocation

There are two ways in OFDM for the channel allocation of multiuser, Margin Adaptive as well as Rate Adaptive [7]. While the margin adaptive aim is to attain the least overall transmitting power with the constraints as on the BER and user's data rate. Whereas the rate adaptive function is improved every user's being free from error capacity with the constraint of full transmitting power.

3.5.1 Resource Allocation

It calculates the compulsory amount of subcarriers which all users want so as to work on a low power while maintain its overall rate values.

3.5.2 Subcarrier Assignment

In these particular users requires specific subcarrier. Since the section 4.2.1 provide sufficiently a good count of subcarriers for every user as s_u is the amount of subcarriers which are being allocated to every user 'u' having high channel gain.

3.6 Problem Formulation

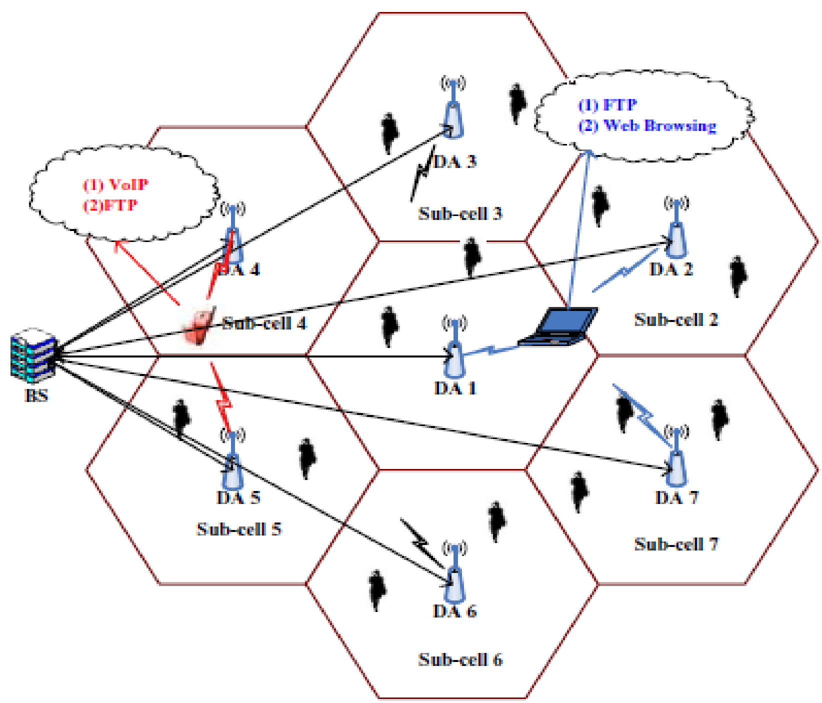


Fig. 3.2. Multicell environment per OFDM [5]

In a multicell environment the system constraints for DCA are:

- cn: Total number of cells in a multicell.
- R' (i, R(k, n)): Data rate of each user in a cell cn(i).
- r' (i, r(k, n)): Bits that the kth user was allocated on nth subcarrier in a cell cn(i).
- p' (i , p(k, n)): Power assigned to user k on subcarrier n.

Since in a single cell one subcarrier is not accessed by any other at the same time as this can be achieved by $r_{k,n}$ and $p_{k,n}$ with certain amount of unchanging power given by:

$$\sum_{k=1}^{K}\sum_{n=1}^{N} p_{k,n} = P_{total} \tag{3.2}$$

We propose multicell based OFDMA DCA for multiuser which solves the channel allocation problem for multiuser when the mobile operator region changes from one cell to another. Thus it provides the flexibility in DCA with no much cost overhead. The power constraint is important which makes the subcarrier allocation more flexible for each user in a multicell and also it helps to determine whether the channel is allocate or not to a specific user

3.7 Research Methodology

OFDM system modeled for DCA having number of spectral properties i.e. channel condition as well as power pattern for proficient and consistent transfer of data from source node to destination node.

3.7.1 Spectral Competence

The regular capacity factors which are traffic capacity or may be information capacity can be determined through this Spectral Competence. Therefore, mean reuse can be determined as [4]

$$G' = (T_{load})^{-1} \tag{3.3}$$

Where traffic load of the system denoted as T_{load} , it means comparative quantity of each resources available in a system are presently taken by traffic of the system.

Spectral efficiency of the system, S [4]

$$S = N_{tot}(\frac{R}{G * B}) \tag{3.4}$$

3.7.2 Margin Adaptive

It shrinks complete power of transmission needed for data transfer having rate $\{R_1,....R_k\}$.

$$\min_{C_{k,n},P_{k,n}} P_T = \min_{C_{k,n},P_{k,n}} \sum_{k=1}^{K} \left(\sum_{n=1}^{N} \left(\frac{f_k(c_{k,n})}{\alpha_{k,n}} \right) \times p_{k,n} \right) \tag{3.5}$$

Is subject to $$R_k = \sum_{n=1}^{N} \left(c_{k,n} \cdot p_{k,n} \right) \tag{3.6}$$

Where complete power needed for transmission is denoted by P_T.

Since user k having subcarrier n is allocated with power which can be formulated as [6]:

$$P_{k,n} = f_k \times \left(\frac{c_{k,n}}{\alpha_{k,n}^2} \right) \tag{3.7}$$

3.7.3 Rate Adaptive

It extends the minimum of user's performance which focus to constraint of power along with the complete communication power is available limited [6].

$$\max_{C_{k,n} p_{k,n}} \min_k R_k = \max_{C_{k,n} p_{k,n}} \left(\min_k \left(\sum_{n=1}^{N} \left(c_{k,n} \cdot p_{k,n} \right) \right) \right) \tag{3.8}$$

Subject to $$\sum_{k=1}^{K} \sum_{n=1}^{N} \left(\frac{f_k(c_{k,n})}{\alpha_{k,n}^2} \right) \cdot p_{k,n} \leq P_T \tag{3.9}$$

3.7.4 Signal to Noise Ratio (SNR)

The k[th] user for the u[th] subcarrier with AWGN power and SNR for this is denoted with σ_u^2 and formulated as [5]:

$$SNR(\varepsilon, \sigma_u^2) \geq \frac{\gamma[\sin c^2(\pi\varepsilon)]}{1 + \gamma \left[0.5947 \cdot (\sin(\pi \cdot \varepsilon))^2 + \left\{ \left(\frac{\sigma_u^2}{2N} \right) \cdot \sin c^2(\pi \cdot \varepsilon) \left(\sum_{r=1}^{N} \left(\sin^2 \left(\frac{\pi\gamma}{N} \right) \right)^{-1} \right) \right\} \right]} \tag{3.10}$$

3.7.5 Bit Error Rate (BER)

It is defined for AWGN with the QAM is [5]:

$$BER = \frac{1}{2} \cdot erfc(\sqrt{SNR}) \tag{3.11}$$

3.7.6 Water Filling Theorem

Under a definite power constraint the complete data transmission rate for a random channel is enhanced through transferring extra power in a situation when attenuation as well as noise being smaller. In view of water-filling criteria the optimal power transmission for a subchannel 'n' is [5]:

$$P_n = \begin{cases} \left(\lambda - \frac{1}{\Upsilon_n} \right), if\, \Upsilon \geq \frac{1}{\Upsilon_n} \\ 0, otherwise \end{cases} \tag{3.12}$$

3.7.7 Channel Complexity Algorithm

In order to acquire less complexity based solution the following two methods are needed:

- Initial subcarriers were first compute and afterwards few users get their allocation of subcarriers end to nothing while some other get the increment in assigned number of subcarriers.
- In Subcarrier assignments, particular sub-carriers are allocating to particular terminals with correspond to the number of bits as well as power on every bit.

3.7.8 DCA Algorithm

The algorithm takes the proportionality rate of each user and it can be defined in several steps [6]:

- The number of subcarrier required by each user can be determined by slackening of proportional rate constraint.

- According to channel allocation scheme every user get the rough proportionality.
- After that, to maximize the system capacity there is need of complete power allocation.
- Power can be made available to each user with the allocated subcarrier.
- LINEAR algorithm gives importance to the user having the minimum ration of R_k to φ_k. So that it can select another subcarrier and it is known as MAX algorithm.
- And if it gives priority to the user found with minimal data rate when the subcarrier is allocating to them and providing fairness to the user which is slower. Thus it is known to be MIN algorithm

The above steps are defined for single cell based DCA in a OFDMA system and it is also worked for multicell having same functionality but with efficient in channel allocation process for multiuser diversity in a multicell with the MAX and MIN algorithm

3.8 Experimental Work

In Section 3.8.1, the flow chart describes how the amount of bit errors for a unit time occurs while transmitting stream of data bits in a channel of OFDM dynamically. In Section 3.8.2, the Flow chart shows how the DCA has been achieved by using proportionality rate constraint for a Single cell in a OFDM. Finally in Section 3.8.3, the Flow chart describes the DCA in multicell environment for multiuser with increase in the system capacity as number of user's per unit time can be raised through MAX-MIN, proportionality rate constraint and also subcarrier assignment.

3.8.1 Flow Chart of BER

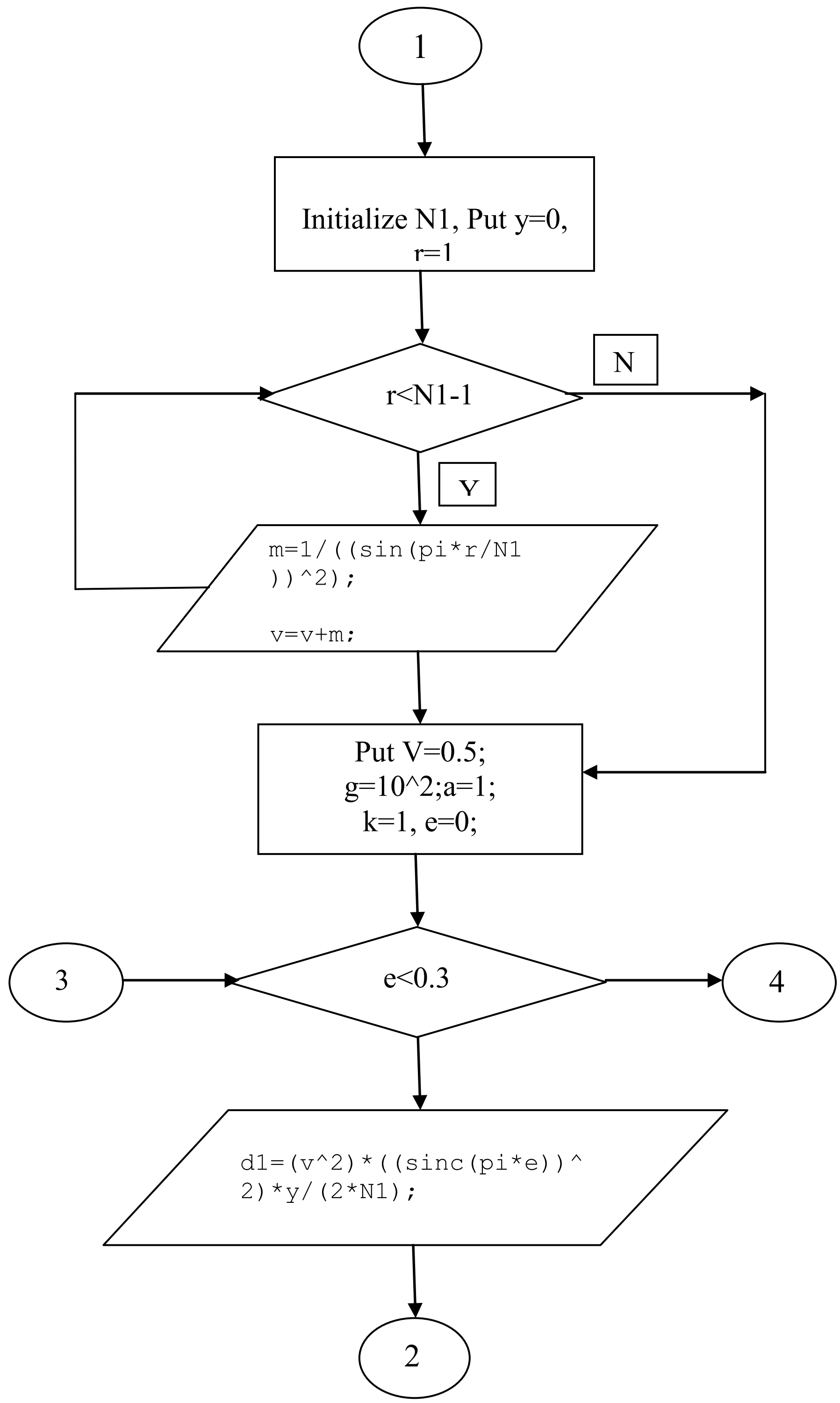
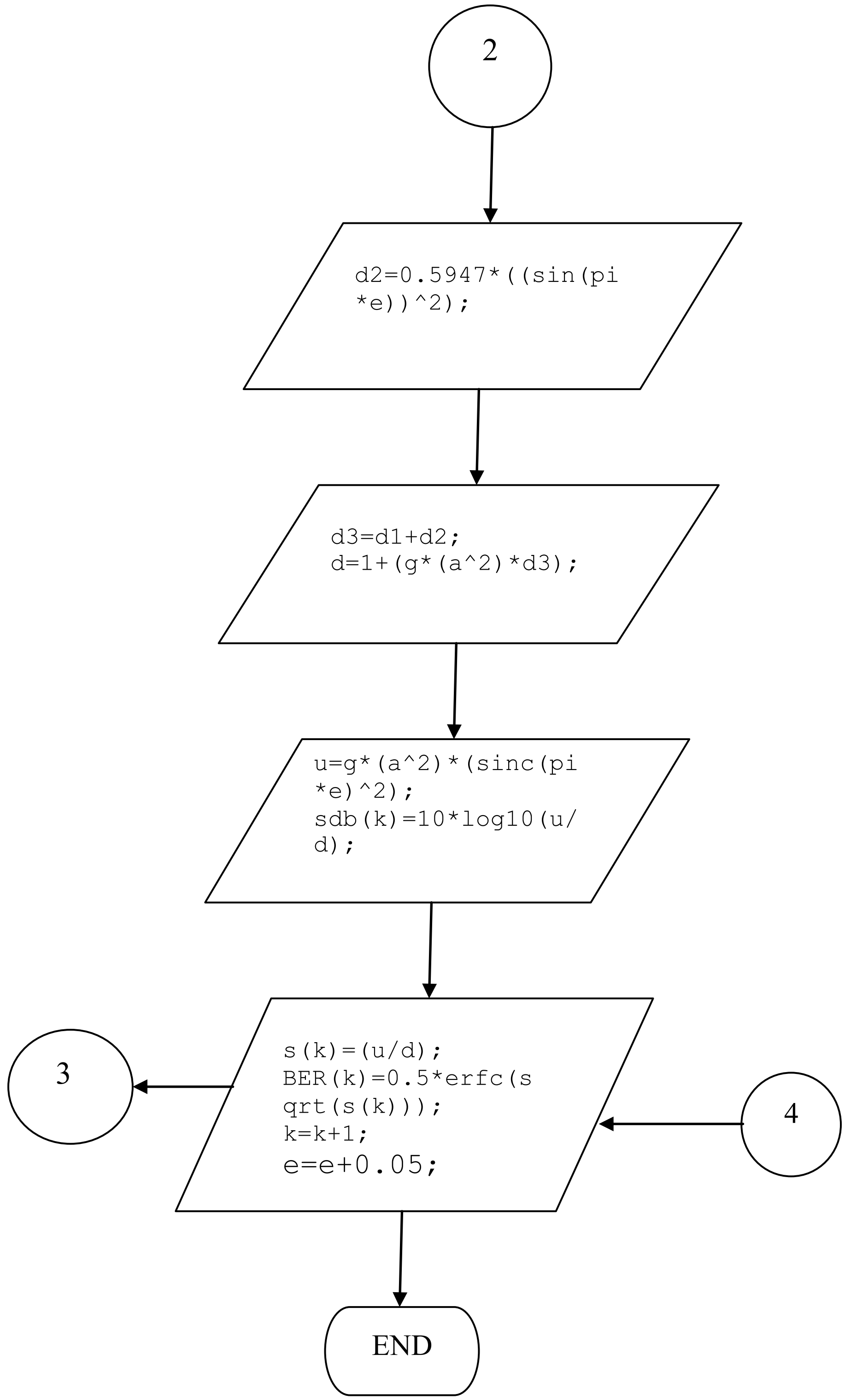


Fig. 3.3. Program flowchart for BER


2
d2=0.5947*((sin(pi
*e))^2);
d3=d1+d2;
d=1+(g*(a^2)*d3);
u=g*(a^2)*(sinc(pi
*e)^2);
sdb(k)=10*log10(u/
d);
3
s(k)=(u/d);
BER(k)=0.5*erfc(s
qrt(s(k)));
k=k+1;
e=e+0.05;
4
END

3.8.2 Flow Chart of DCA for Single Cell

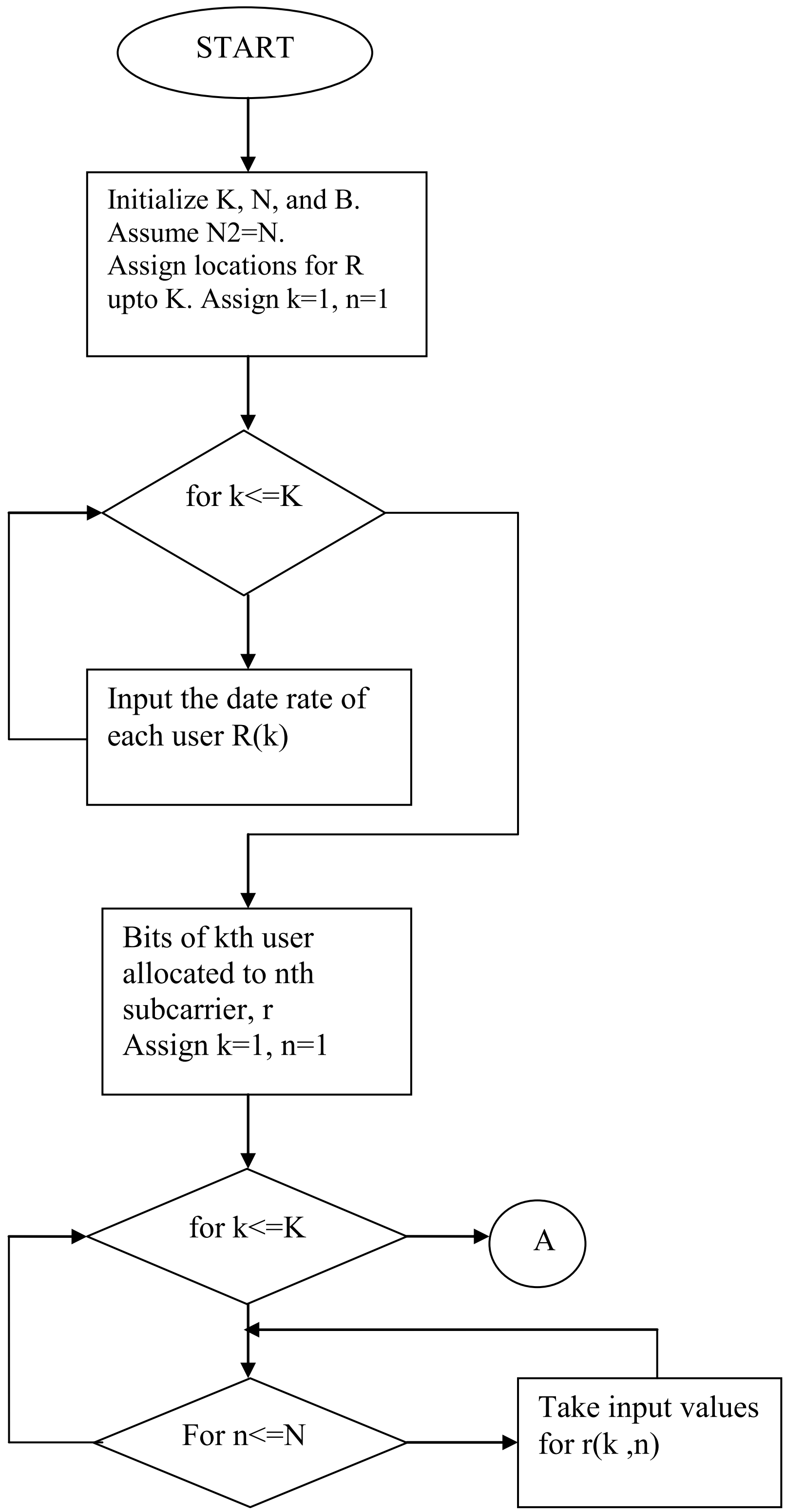
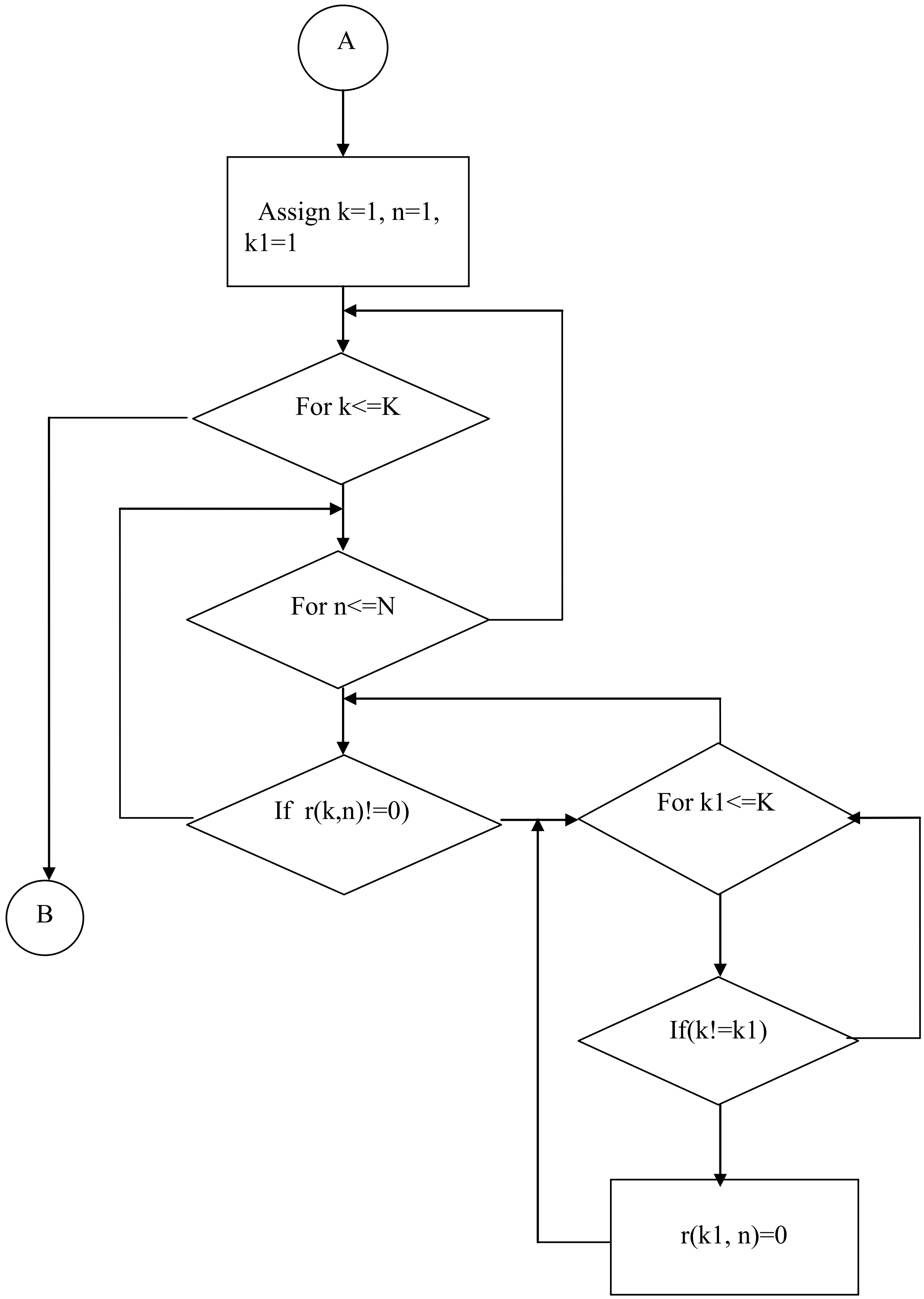
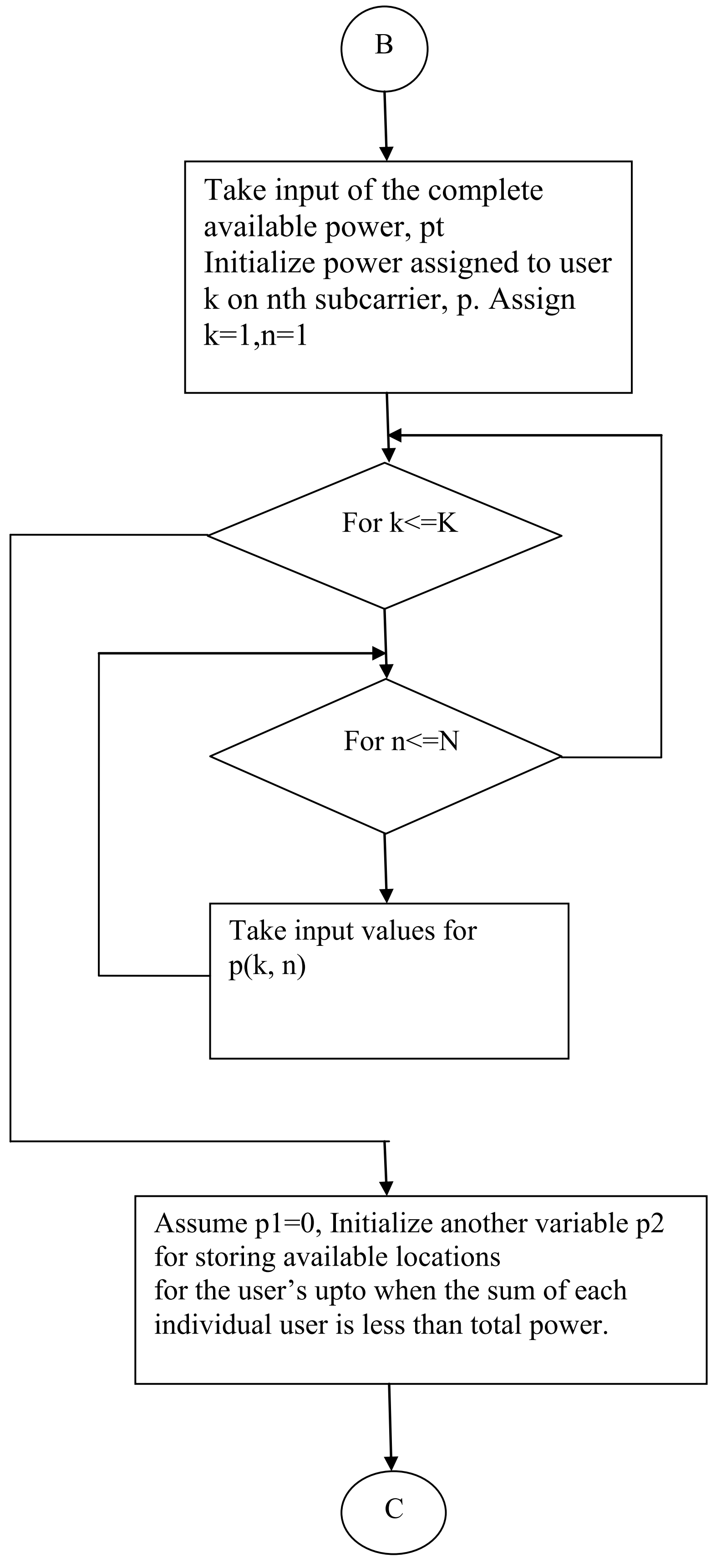
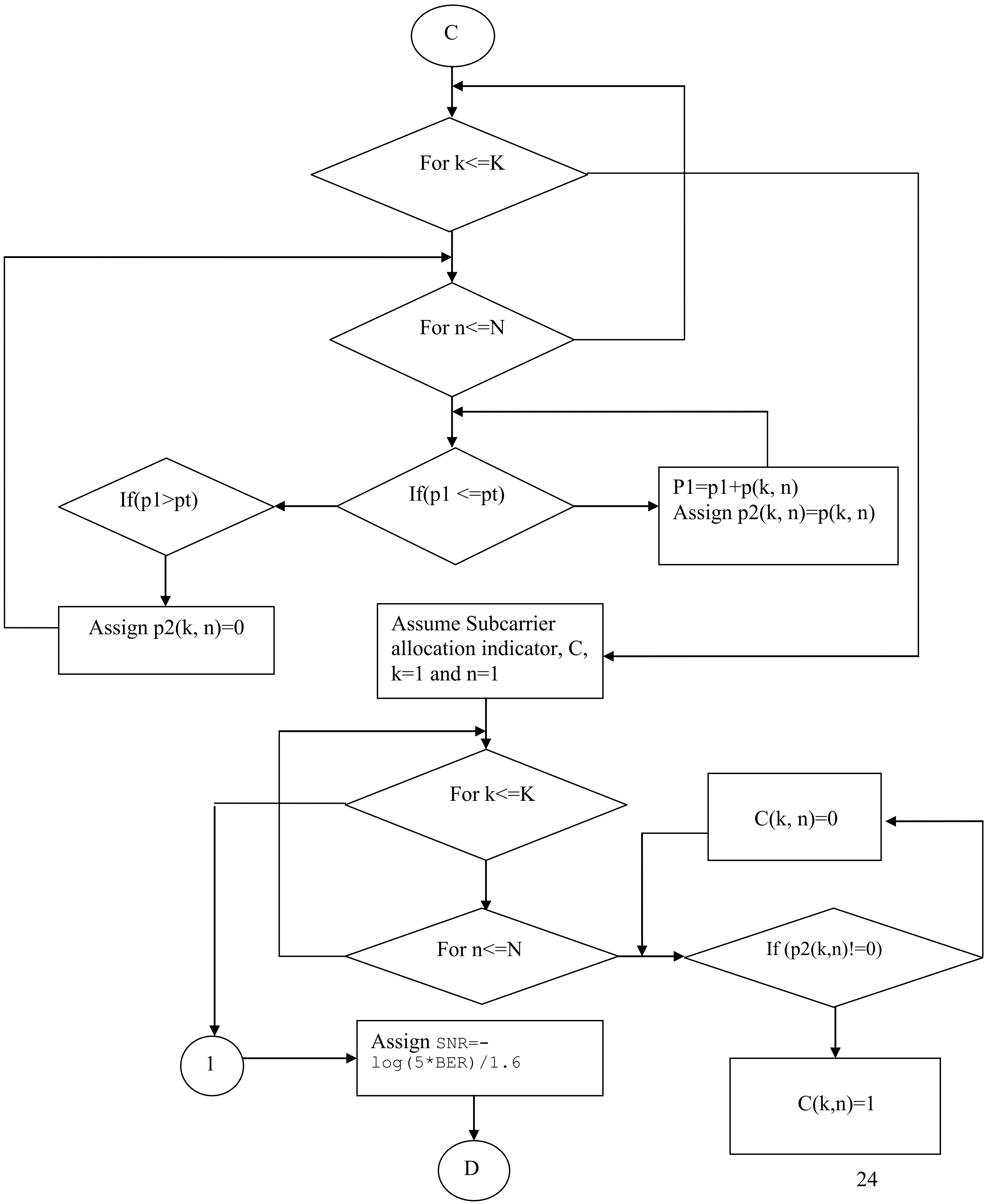


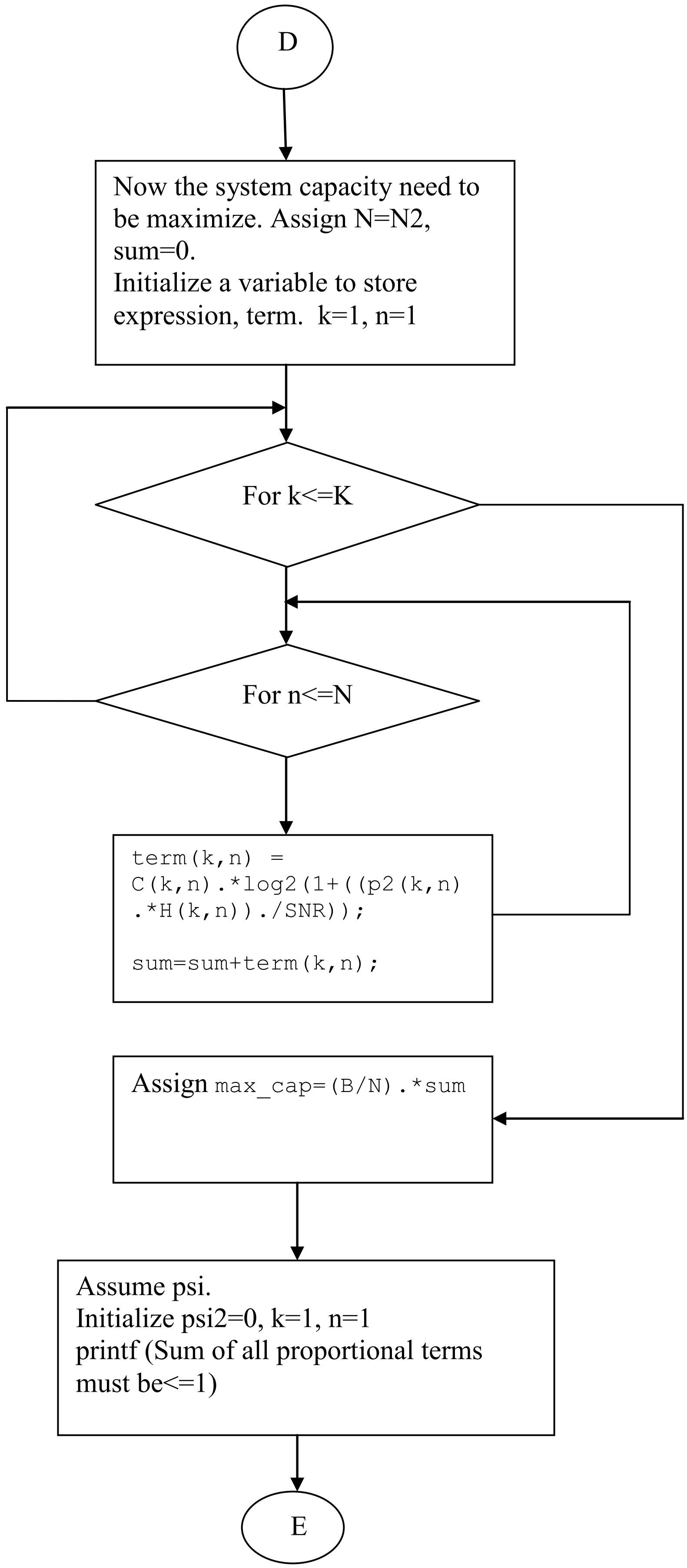
Fig. 3.4. Program flowchart for Single Cell DCA

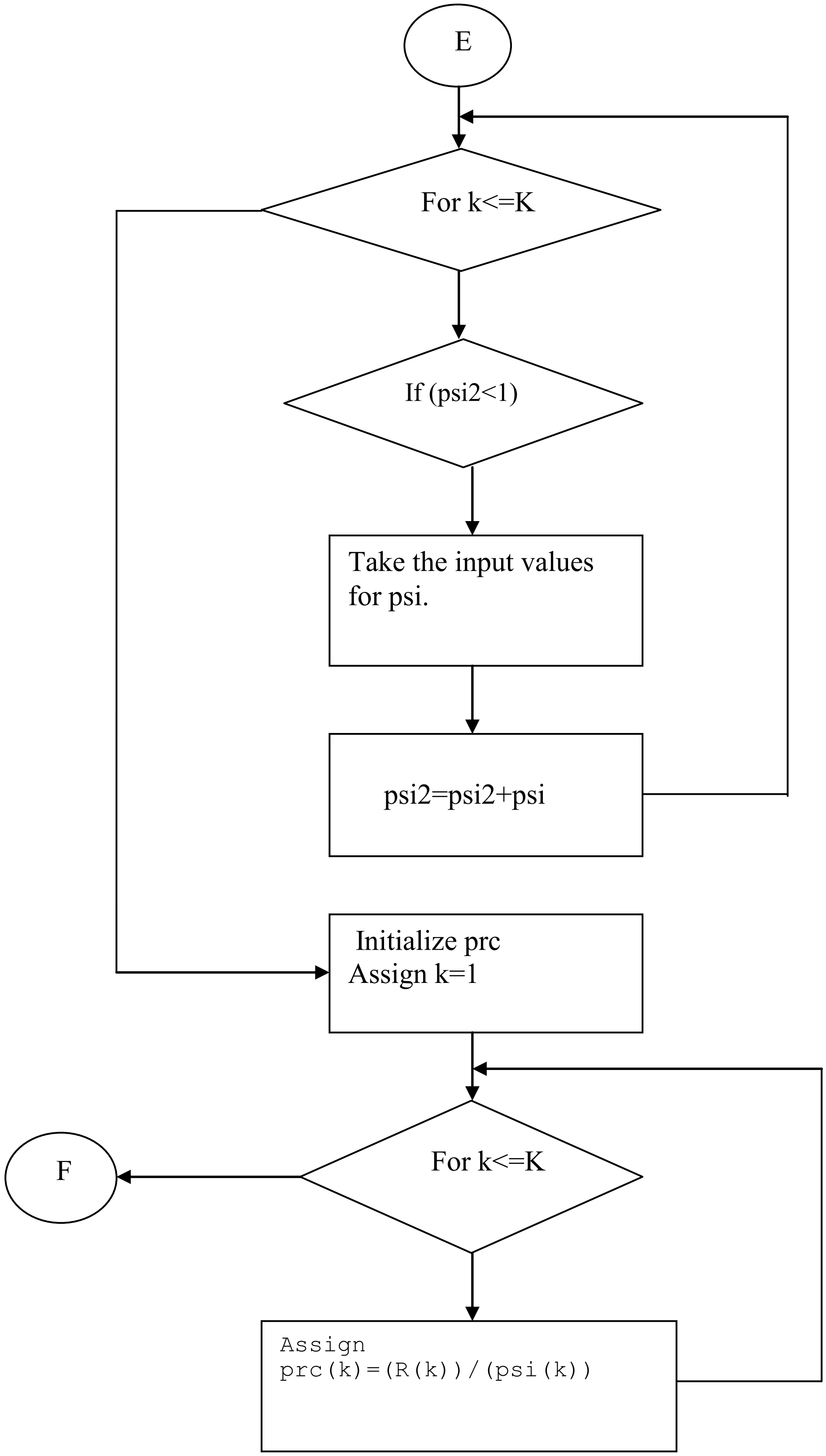

A
Assign k=1, n=1, k1=1
For k<=K
For n<=N
If r(k,n)!=0)
For k1<=K
If(k!=k1)
r(k1, n)=0
B

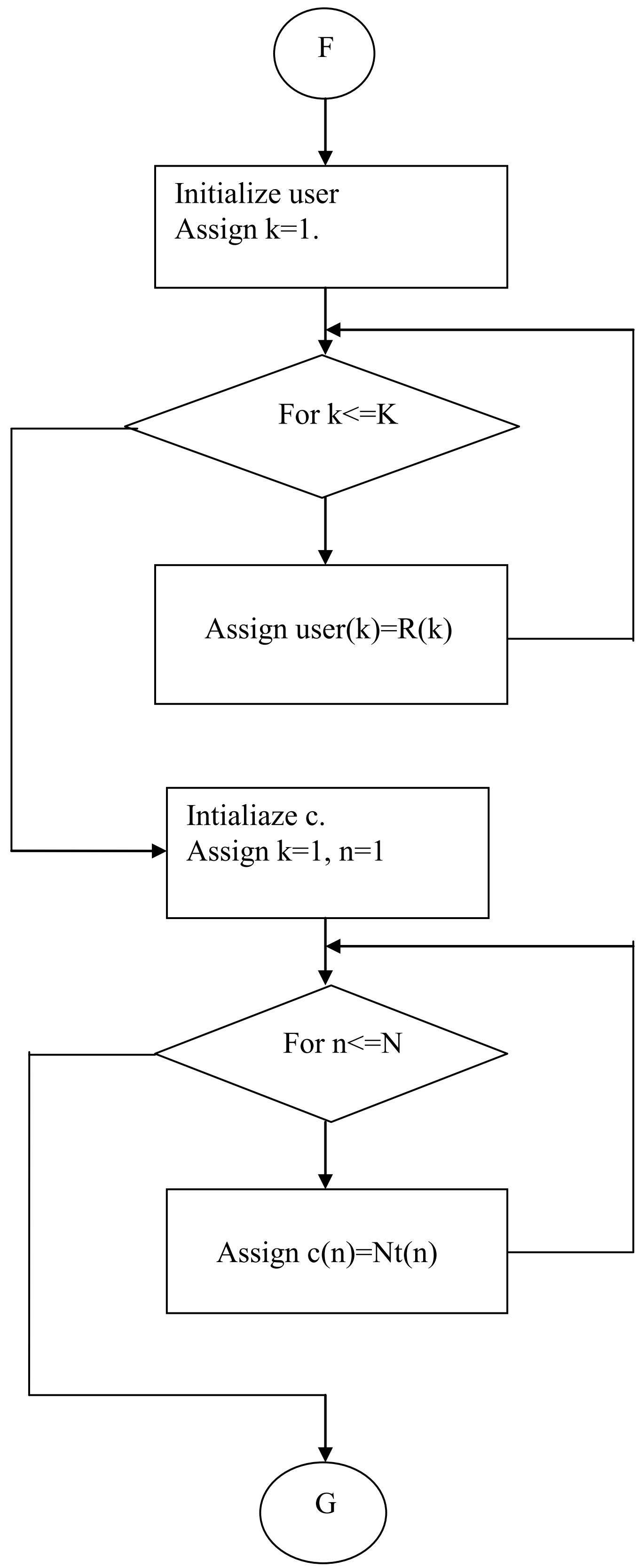


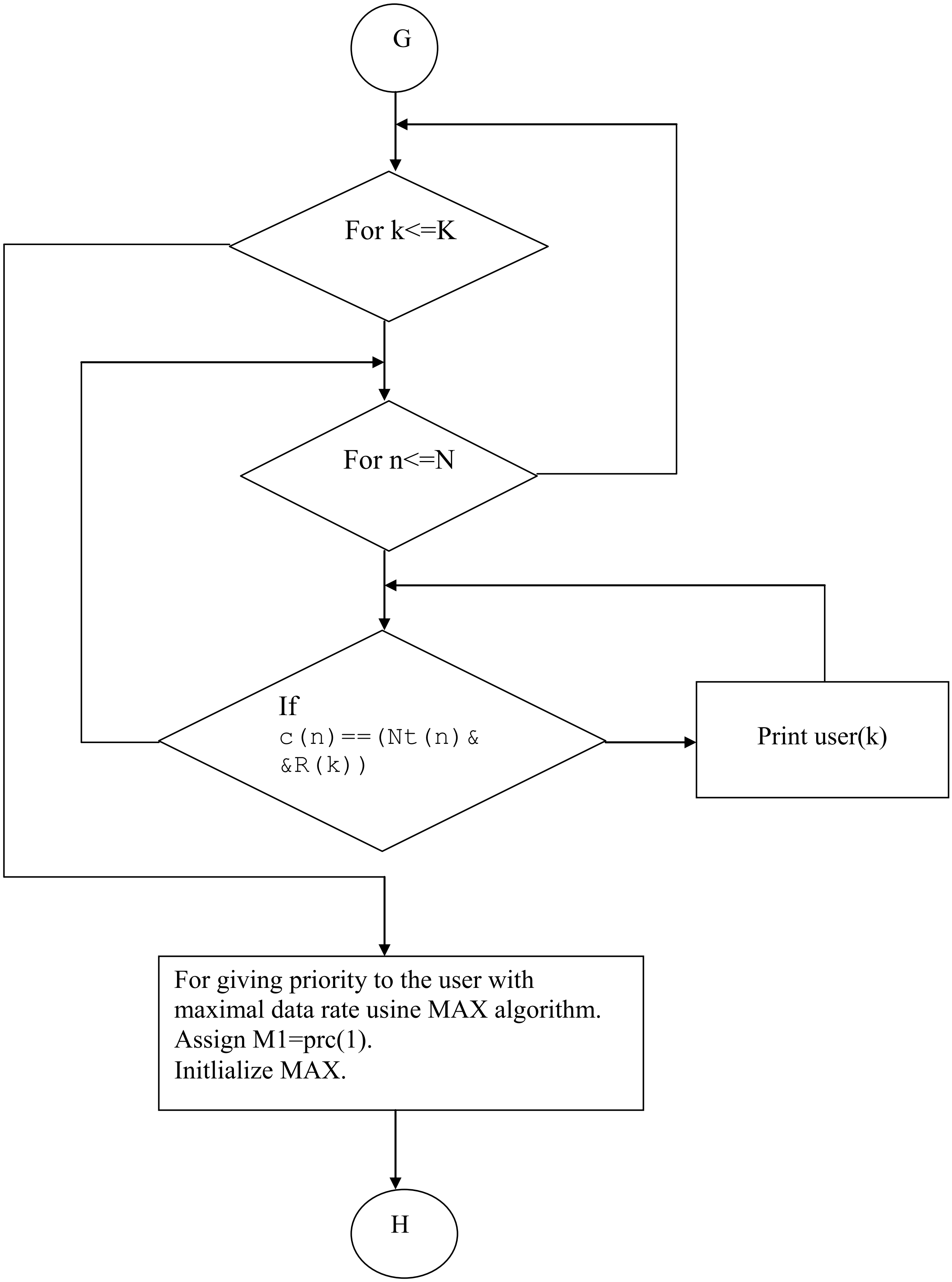
B
Take input of the complete available power, pt
Initialize power assigned to user k on nth subcarrier, p. Assign k=1,n=1
For k<=K
For n<=N
Take input values for p(k, n)
Assume p1=0, Initialize another variable p2 for storing available locations
for the user's upto when the sum of each individual user is less than total power.
C

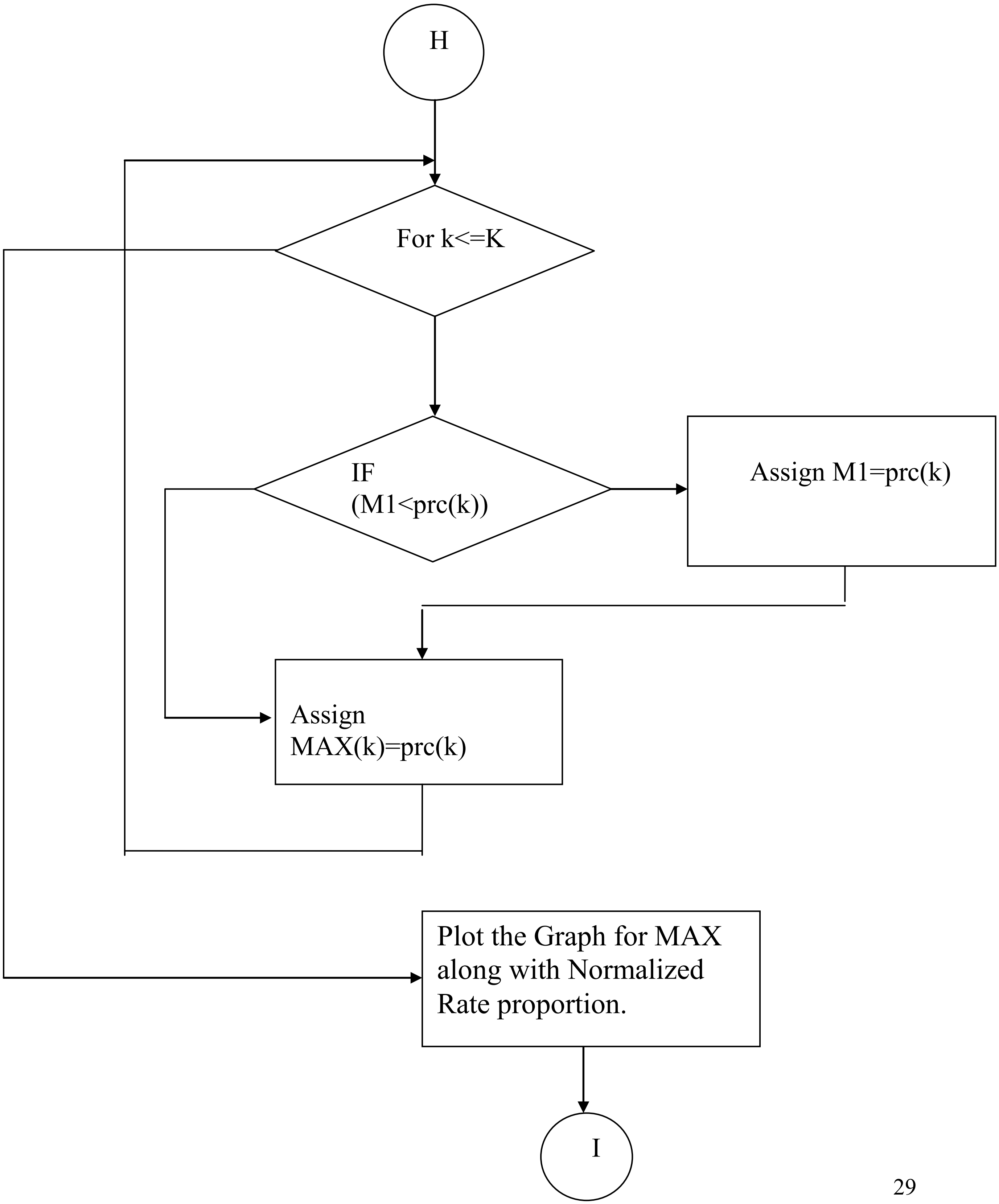

C
For k<=K
For n<=N
If(p1>pt)
If(p1 <=pt)
P1=p1+p(k, n)
Assign p2(k, n)=p(k, n)
Assign p2(k, n)=0
Assume Subcarrier allocation indicator, C, k=1 and n=1
For k<=K
C(k, n)=0
For n<=N
If (p2(k,n)!=0)
1
Assign SNR=-log(5*BER)/1.6
C(k,n)=1
D


D
Now the system capacity need to be maximize. Assign N=N2, sum=0.
Initialize a variable to store expression, term. k=1, n=1
For k<=K
For n<=N
term(k,n) = C(k,n).*log2(1+((p2(k,n).*H(k,n))./SNR));
sum=sum+term(k,n);
Assign max_cap=(B/N).*sum
Assume psi.
Initialize psi2=0, k=1, n=1
printf (Sum of all proportional terms must be<=1)
E

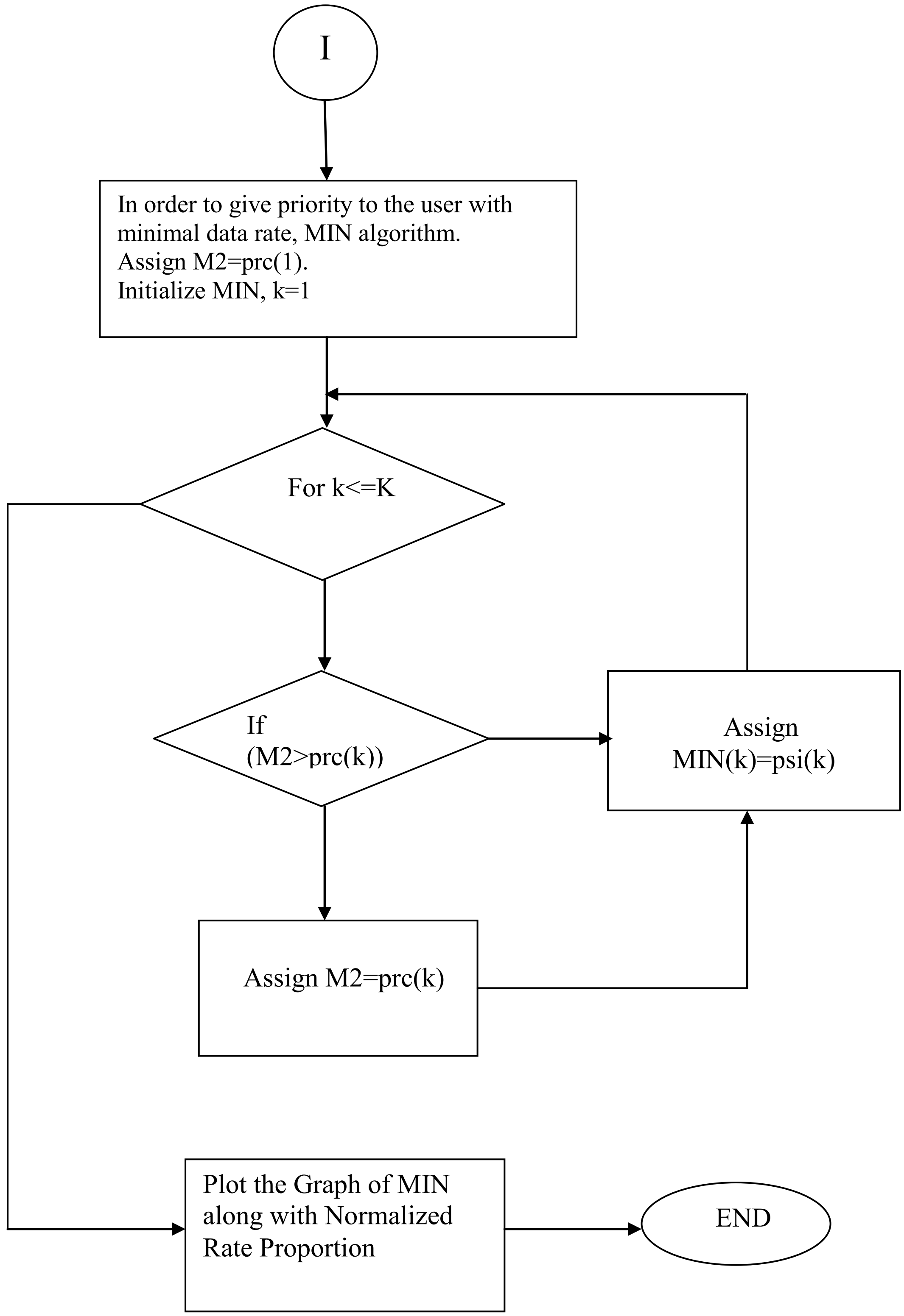

E
For k<=K
If (psi2<1)
Take the input values for psi.
psi2=psi2+psi
Initialize prc
Assign k=1
F
For k<=K
Assign
prc(k)=(R(k))/(psi(k))


F
Initialize user
Assign k=1.
For k<=K
Assign user(k)=R(k)
Intialiaze c.
Assign k=1, n=1
For n<=N
Assign c(n)=Nt(n)
G


G
For k<=K
For n<=N
If
c(n)==(Nt(n)&
&R(k))
Print user(k)
For giving priority to the user with
maximal data rate usine MAX algorithm.
Assign M1=prc(1).
Initlialize MAX.
H



H
For k<=K
IF
(M1<prc(k))
Assign M1=prc(k)
Assign
MAX(k)=prc(k)
Plot the Graph for MAX
along with Normalized
Rate proportion.
I


I
In order to give priority to the user with minimal data rate, MIN algorithm.
Assign M2=prc(1).
Initialize MIN, k=1
For k<=K
If (M2>prc(k))
Assign MIN(k)=psi(k)
Assign M2=prc(k)
Plot the Graph of MIN along with Normalized Rate Proportion
END

3.8.3 Flow Chart of DCA for Multi-Cell

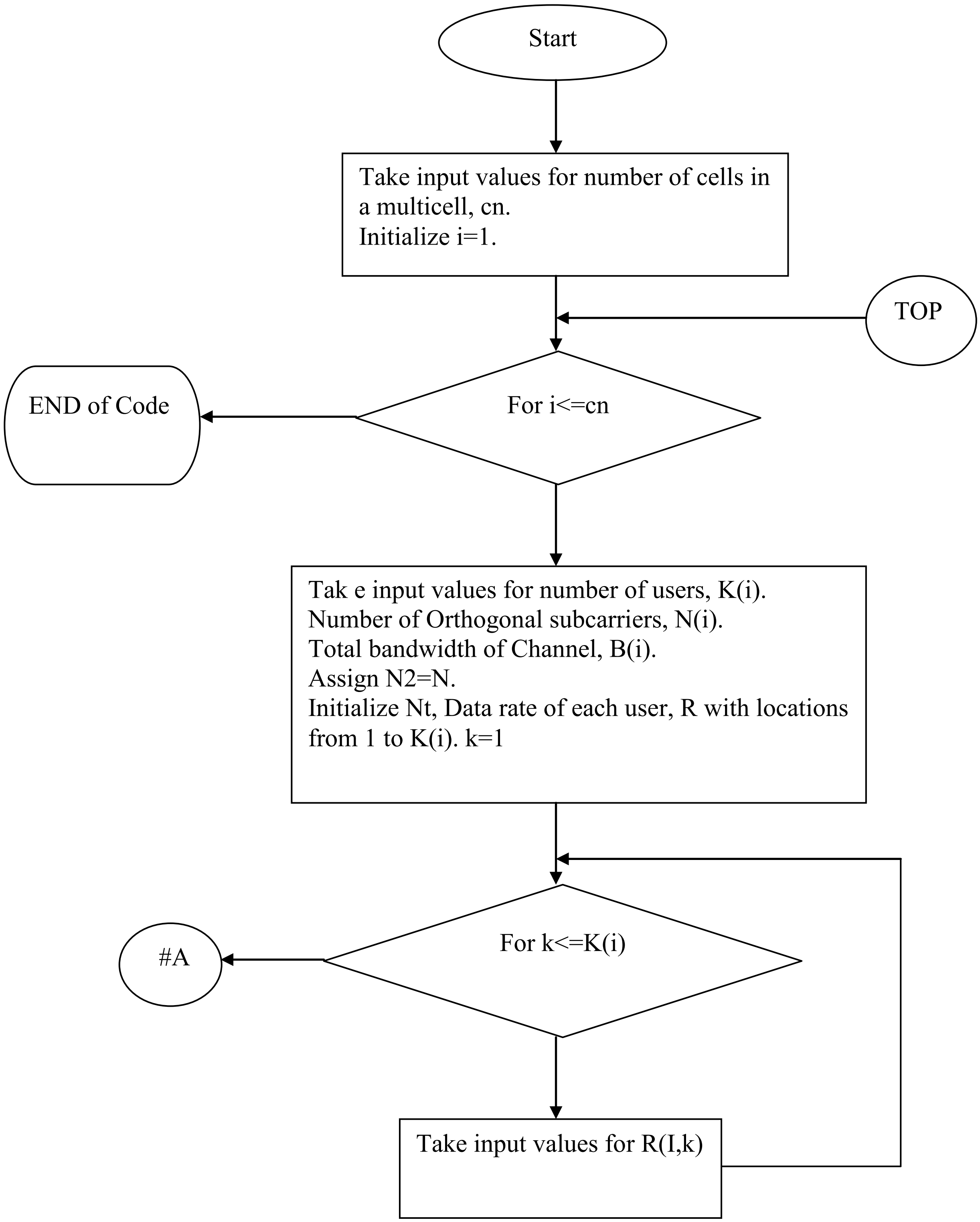
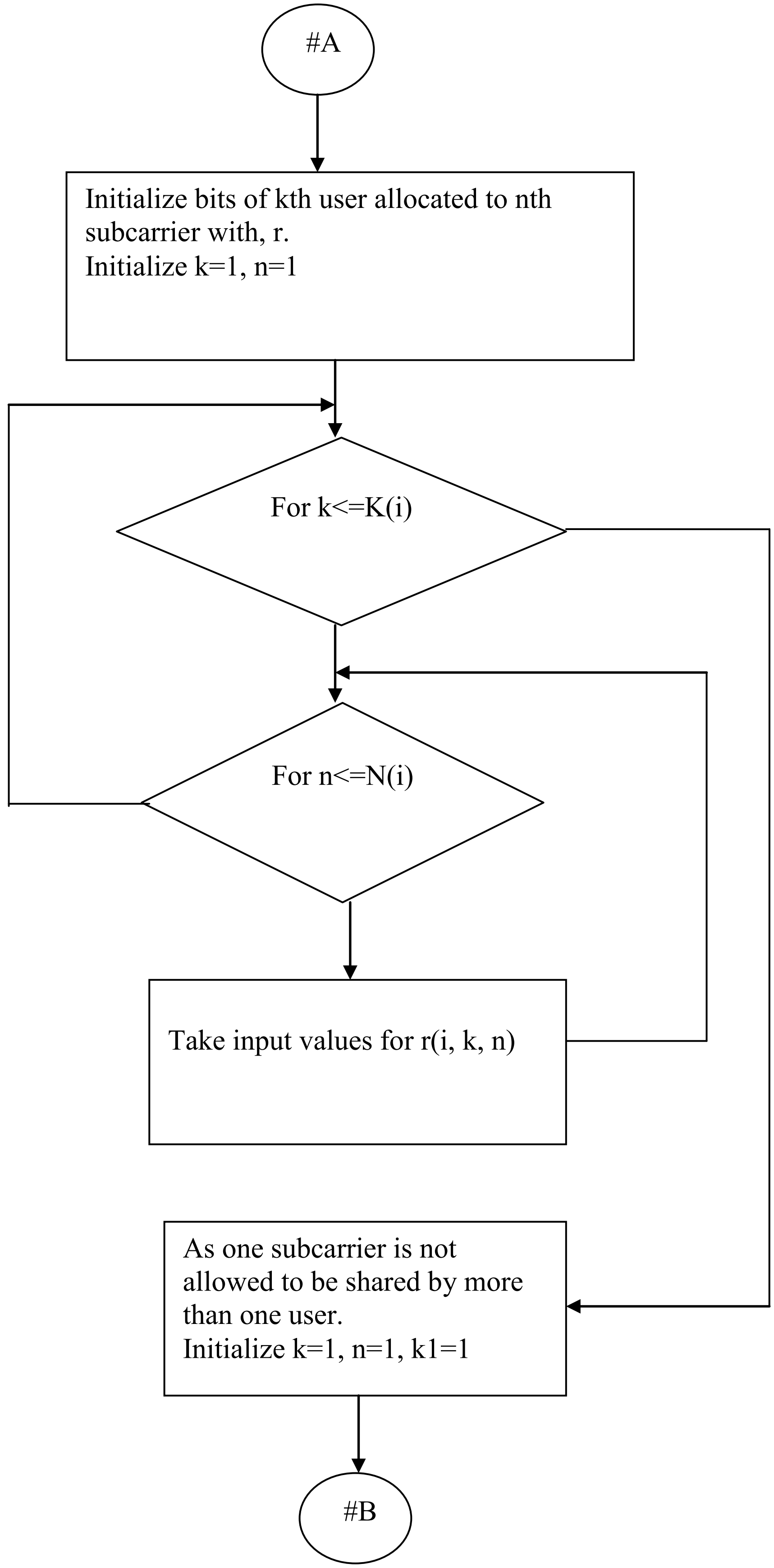
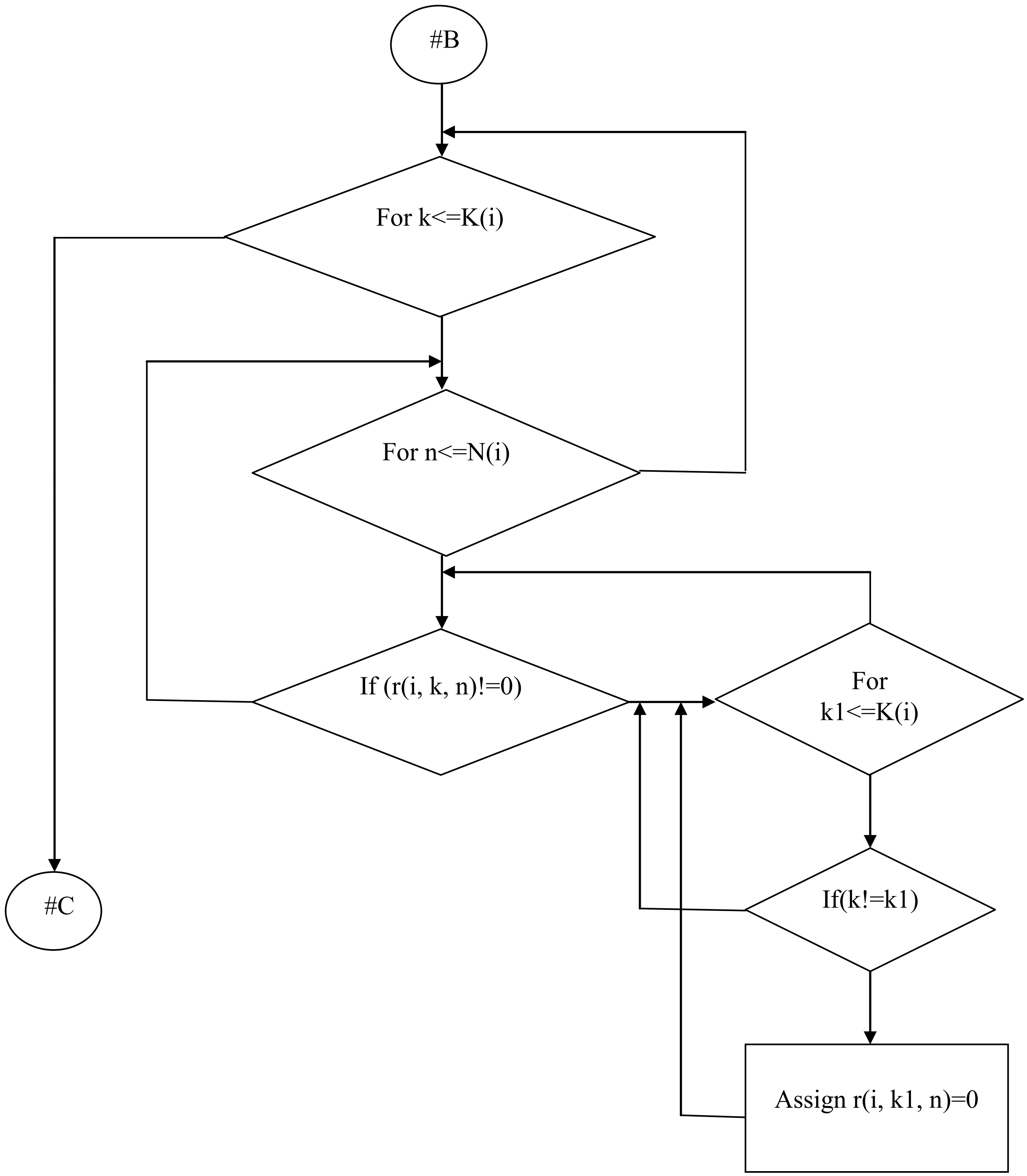
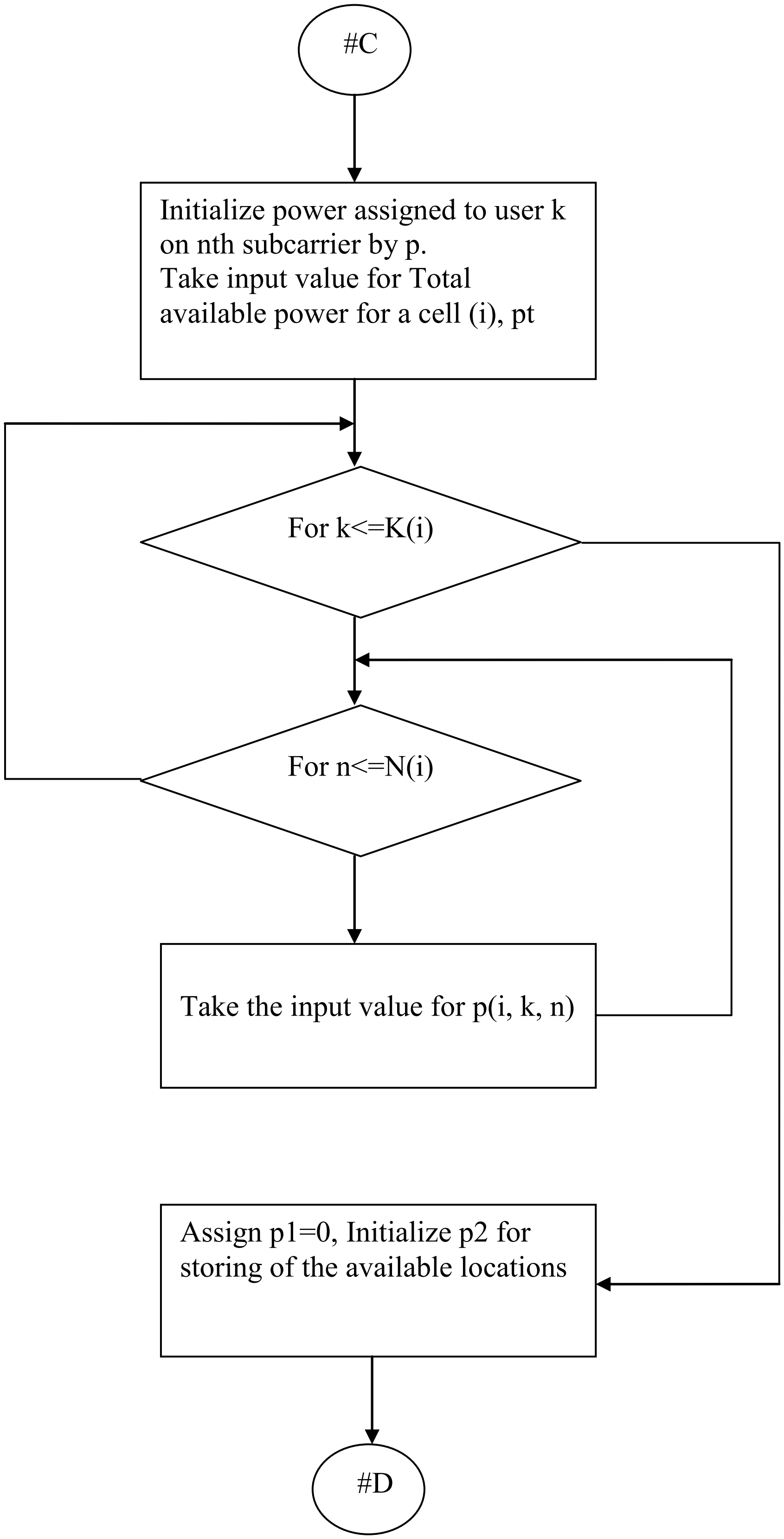


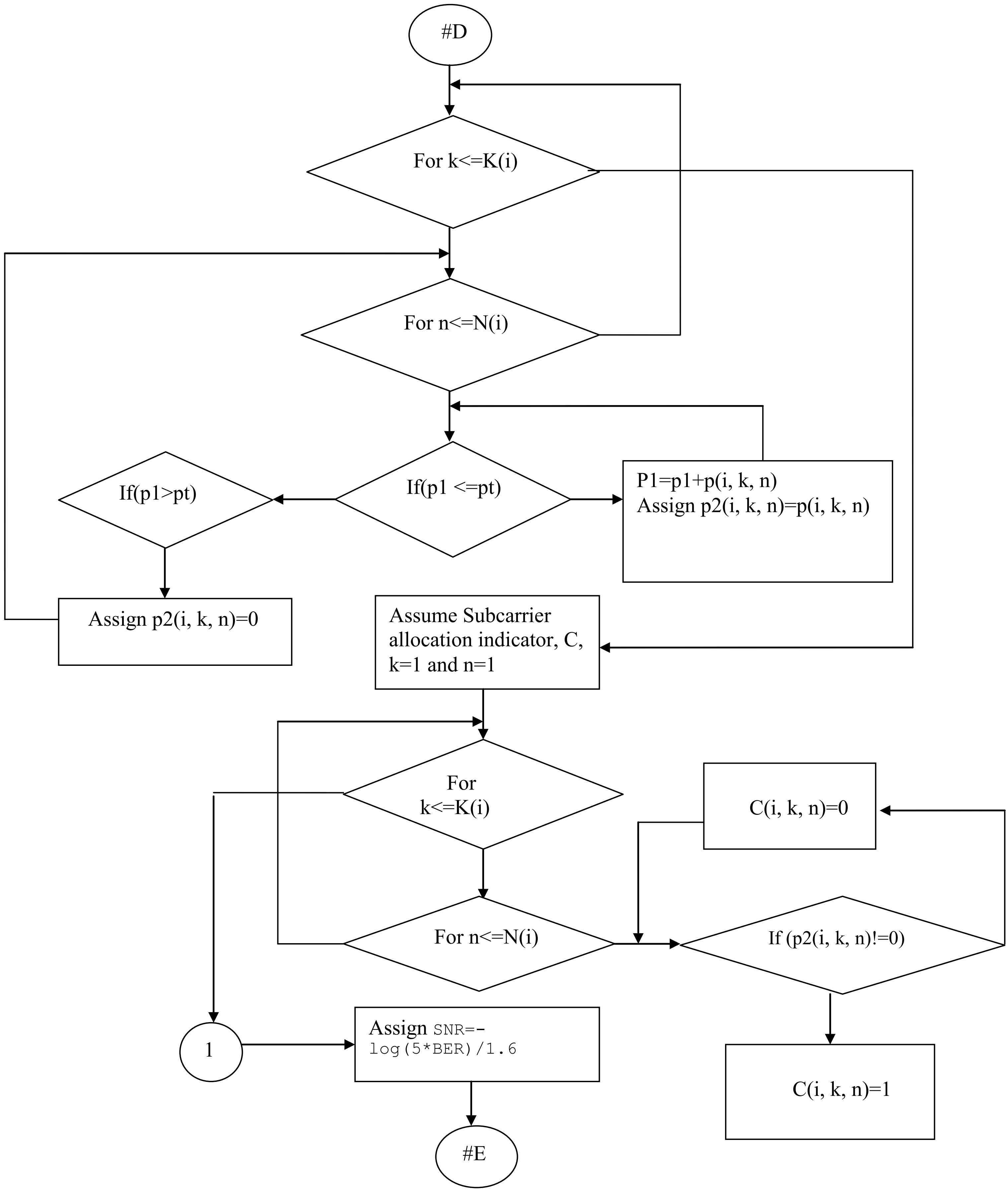
Fig. 3.5. Program flowchart for Multi Cell DCA

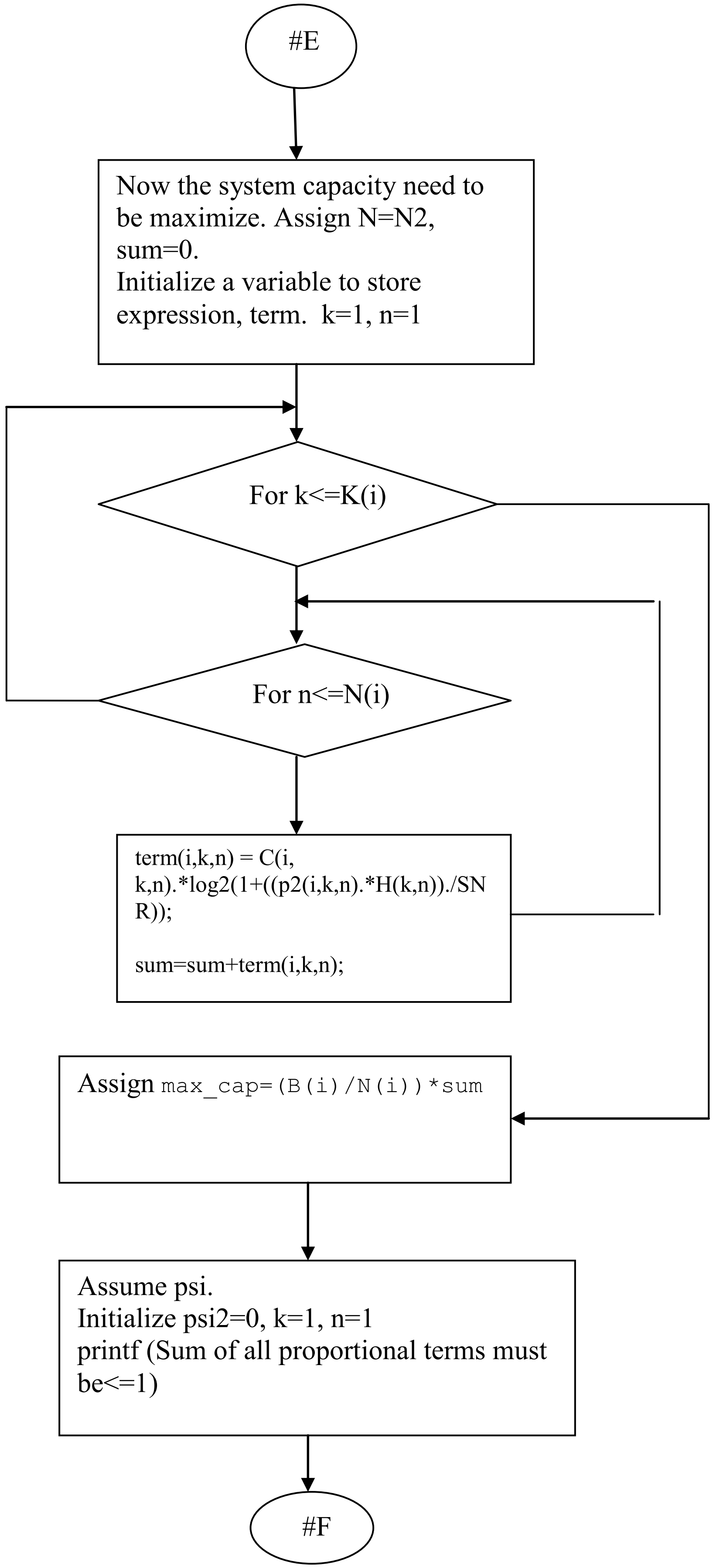

#A
Initialize bits of kth user allocated to nth subcarrier with, r.
Initialize k=1, n=1
For k<=K(i)
For n<=N(i)
Take input values for r(i, k, n)
As one subcarrier is not allowed to be shared by more than one user.
Initialize k=1, n=1, k1=1
#B

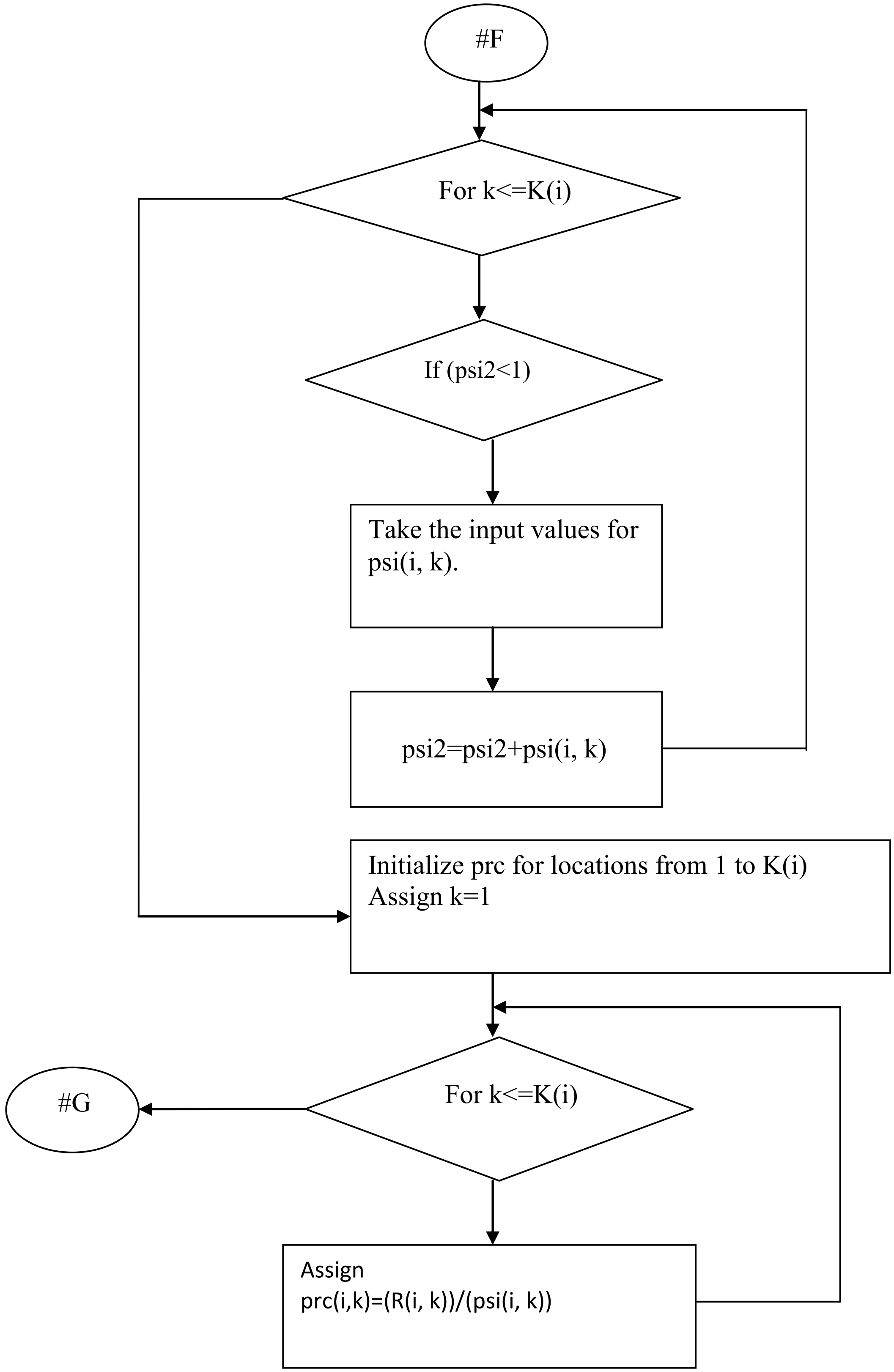


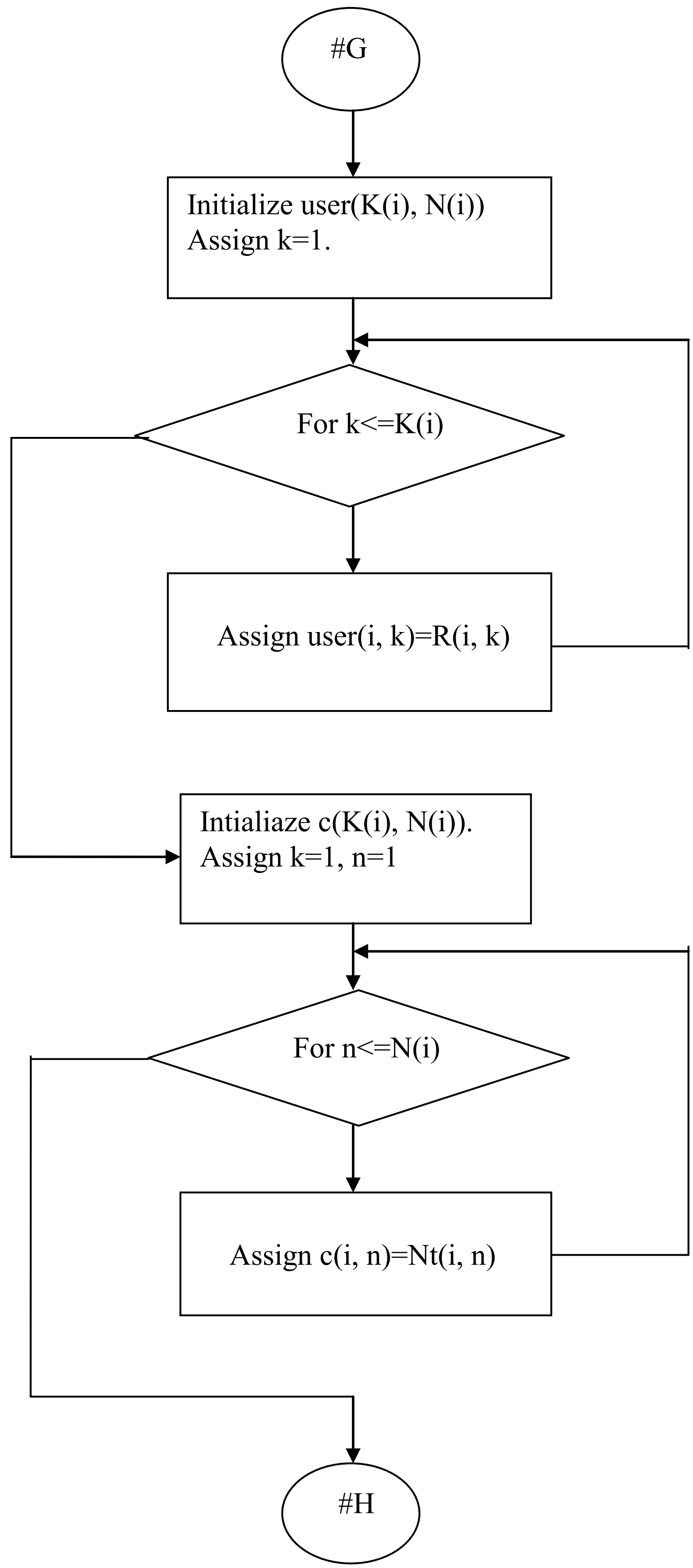
#B
For k<=K(i)
For n<=N(i)
If (r(i, k, n)!=0)
For
k1<=K(i)
If(k!=k1)
Assign r(i, k1, n)=0
#C

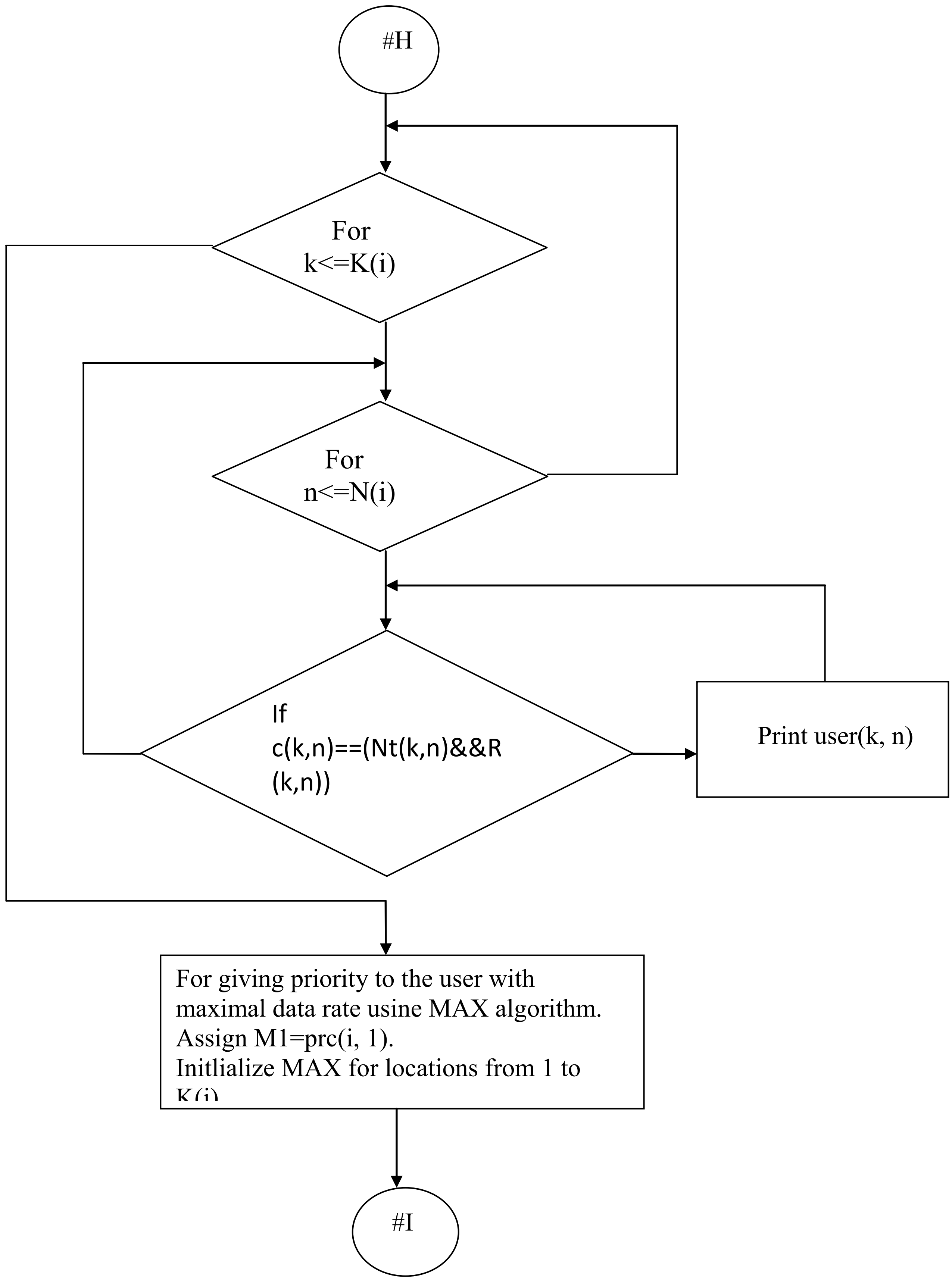

#C
Initialize power assigned to user k on nth subcarrier by p.
Take input value for Total available power for a cell (i), pt
For k<=K(i)
For n<=N(i)
Take the input value for p(i, k, n)
Assign p1=0, Initialize p2 for storing of the available locations
#D

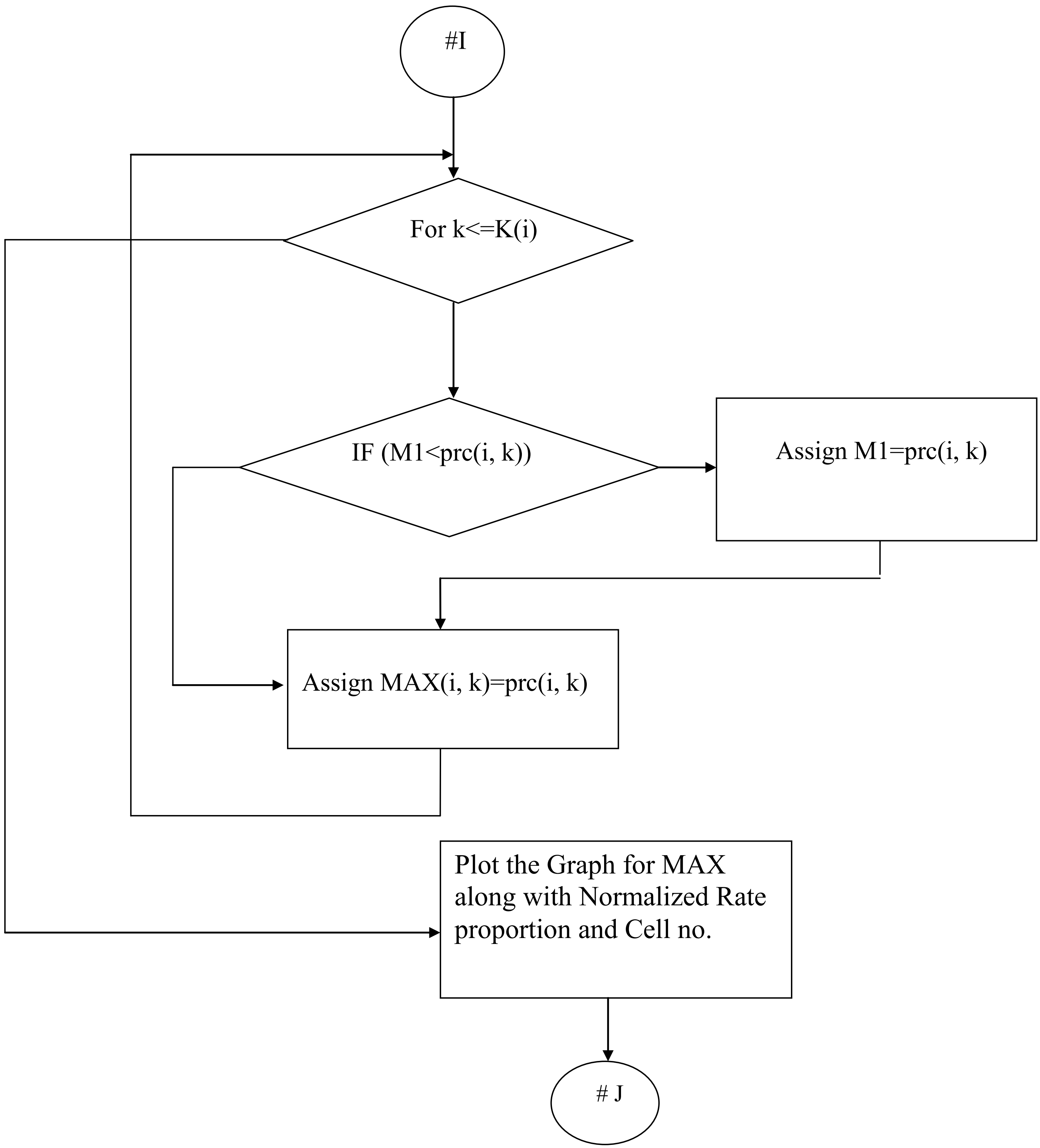

#D
For k<=K(i)
For n<=N(i)
If(p1>pt)
If(p1 <=pt)
P1=p1+p(i, k, n)
Assign p2(i, k, n)=p(i, k, n)
Assign p2(i, k, n)=0
Assume Subcarrier allocation indicator, C, k=1 and n=1
For k<=K(i)
C(i, k, n)=0
For n<=N(i)
If (p2(i, k, n)!=0)
1
Assign SNR=-log(5*BER)/1.6
C(i, k, n)=1
#E

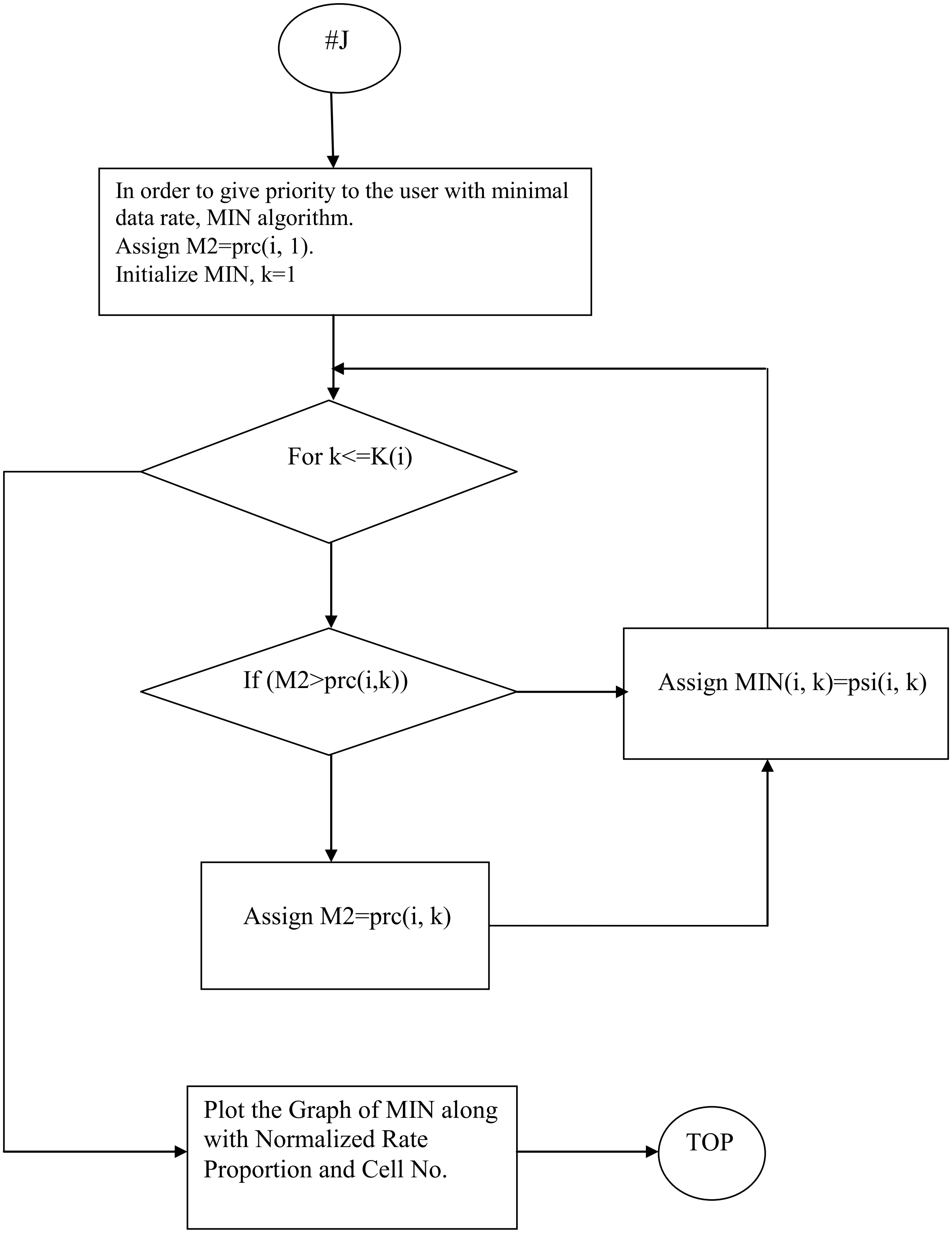

#E
Now the system capacity need to be maximize. Assign N=N2, sum=0.
Initialize a variable to store expression, term. k=1, n=1
For k<=K(i)
For n<=N(i)
term(i,k,n) = C(i, k,n).*log2(1+((p2(i,k,n).*H(k,n))./SNR));
sum=sum+term(i,k,n);
Assign max_cap=(B(i)/N(i))*sum
Assume psi.
Initialize psi2=0, k=1, n=1
printf (Sum of all proportional terms must be<=1)
#F


#F
For k<=K(i)
If (psi2<1)
Take the input values for psi(i, k).
psi2=psi2+psi(i, k)
Initialize prc for locations from 1 to K(i)
Assign k=1
For k<=K(i)
#G
Assign
prc(i,k)=(R(i, k))/(psi(i, k))


#G
Initialize user(K(i), N(i))
Assign k=1.
For k<=K(i)
Assign user(i, k)=R(i, k)
Intialiaze c(K(i), N(i)).
Assign k=1, n=1
For n<=N(i)
Assign c(i, n)=Nt(i, n)
#H


#H
For
k<=K(i)
For
n<=N(i)
If
c(k,n)==(Nt(k,n)&&R
(k,n))
Print user(k, n)
For giving priority to the user with
maximal data rate usine MAX algorithm.
Assign M1=prc(i, 1).
Initlialize MAX for locations from 1 to
#I


#I
For k<=K(i)
IF (M1<prc(i, k))
Assign M1=prc(i, k)
Assign MAX(i, k)=prc(i, k)
Plot the Graph for MAX along with Normalized Rate proportion and Cell no.
J


#J
In order to give priority to the user with minimal data rate, MIN algorithm.
Assign M2=prc(i, 1).
Initialize MIN, k=1
For k<=K(i)
If (M2>prc(i,k))
Assign MIN(i, k)=psi(i, k)
Assign M2=prc(i, k)
Plot the Graph of MIN along with Normalized Rate Proportion and Cell No.
TOP

CHAPTER 4
RESULT AND DISCUSSION

4.1 MATLAB Result

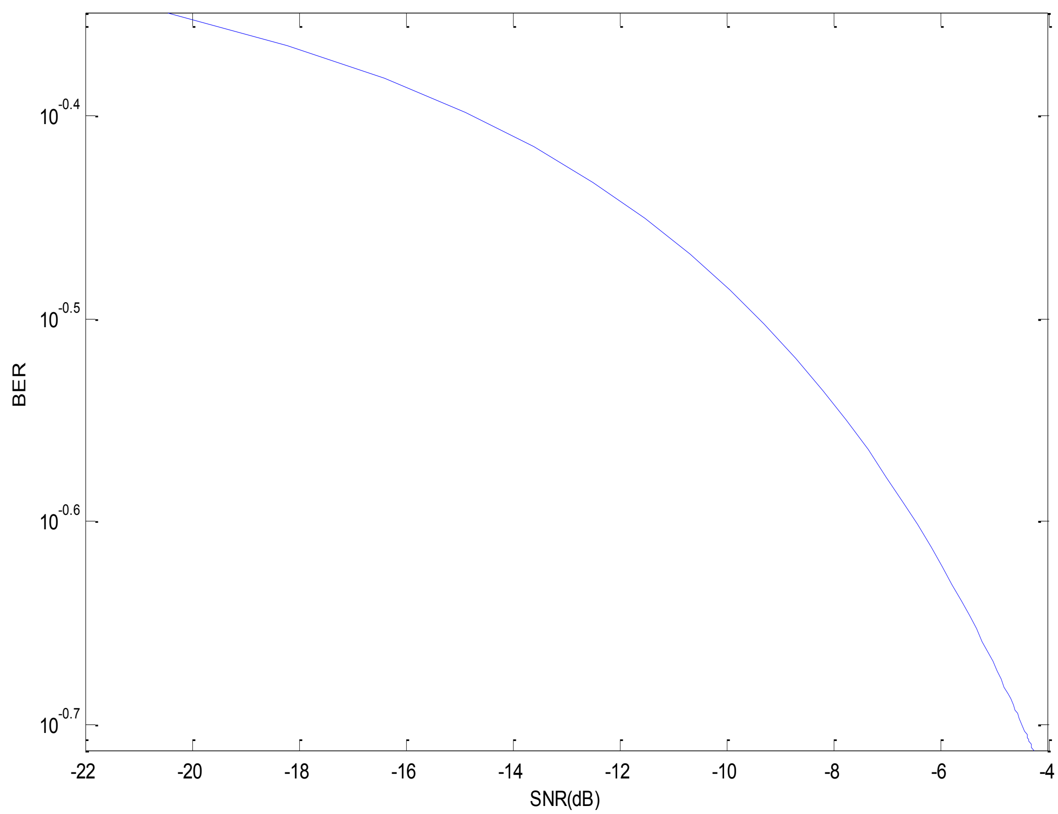


Fig.4.1 Plot of BER vs. SNR

In fig. 4.1, the graph between BER and SNR shows that the increasing SNR decreases the BER, which can cause less number of bit errors per unit time. In fig. 4.2 and 4.3, graph between BER and SNR on the basis of varying phase noise as the phase noise is decrease SNR decreases for a particular data bits in a channel. In fig. 4.4, the plot shows the number of samples in a channel and the normalized frequency w.r.t magnitude of the samples in a channel of OFDM respectively. In fig. 4.5 the 3-D plot of the Fig. 4.1 shows the BER vs SNR

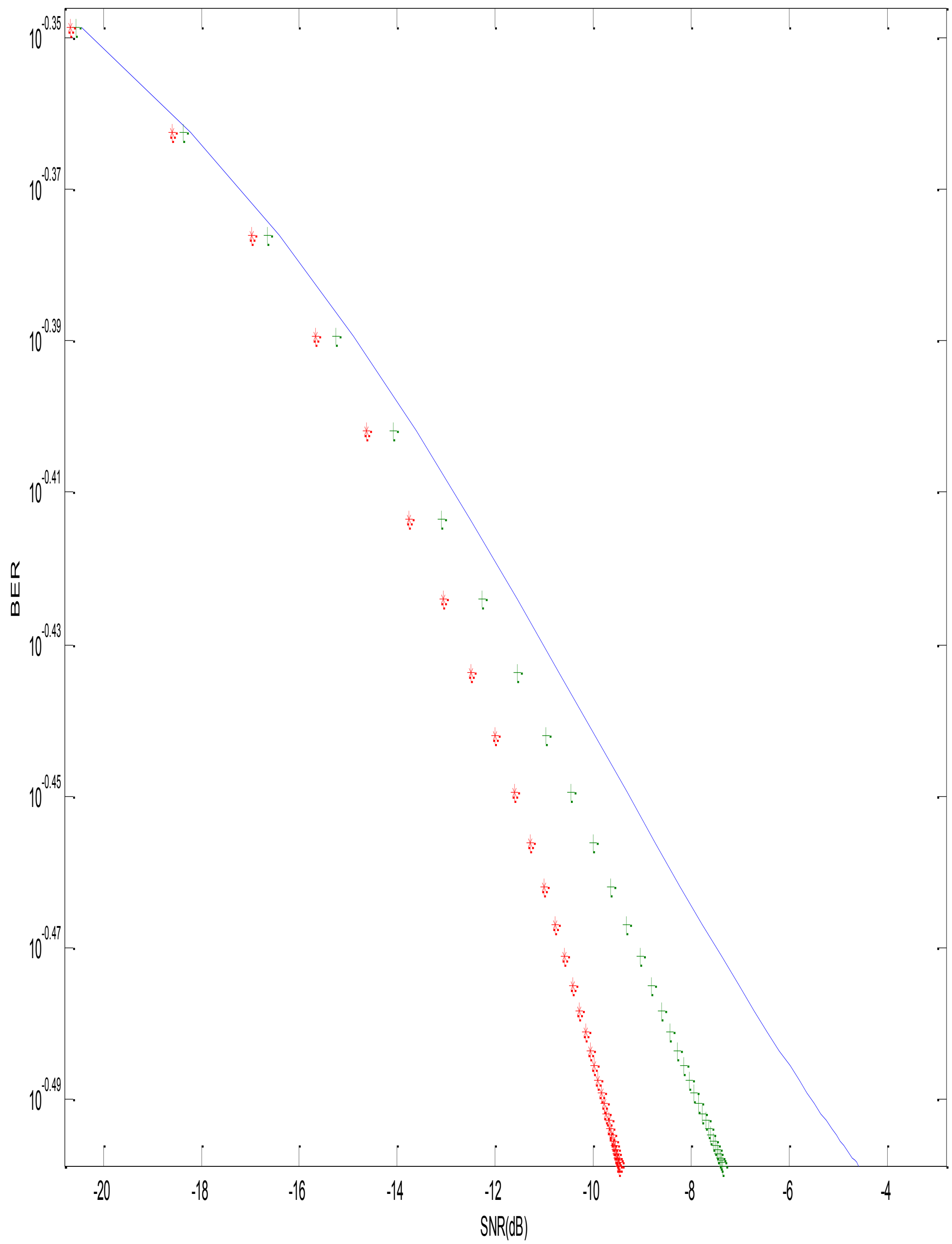


Fig.4.2 Plot of BER vs. SNR for the variable Phase noise

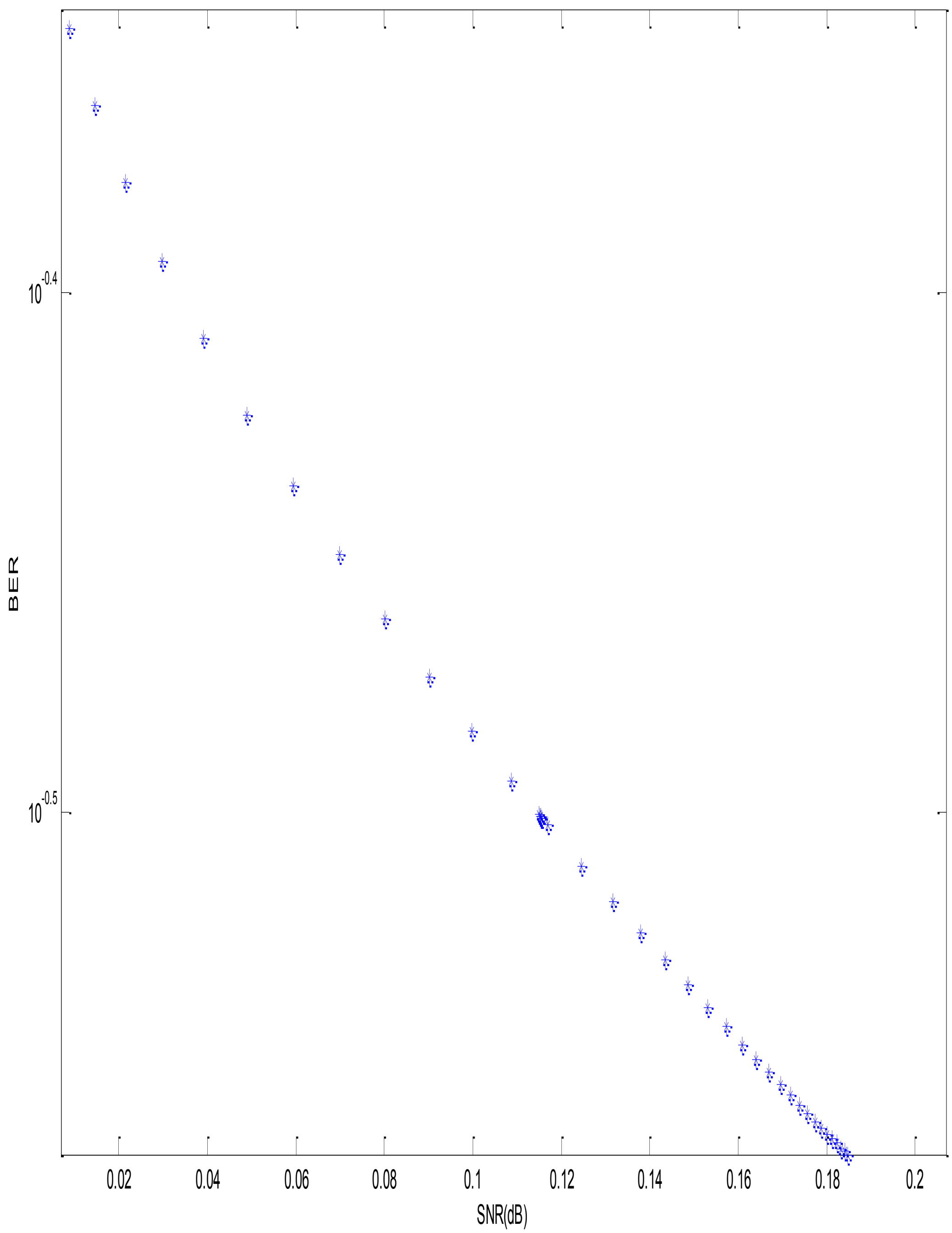


Fig.4.3 Plot of BER vs. SNR for a single phase noise

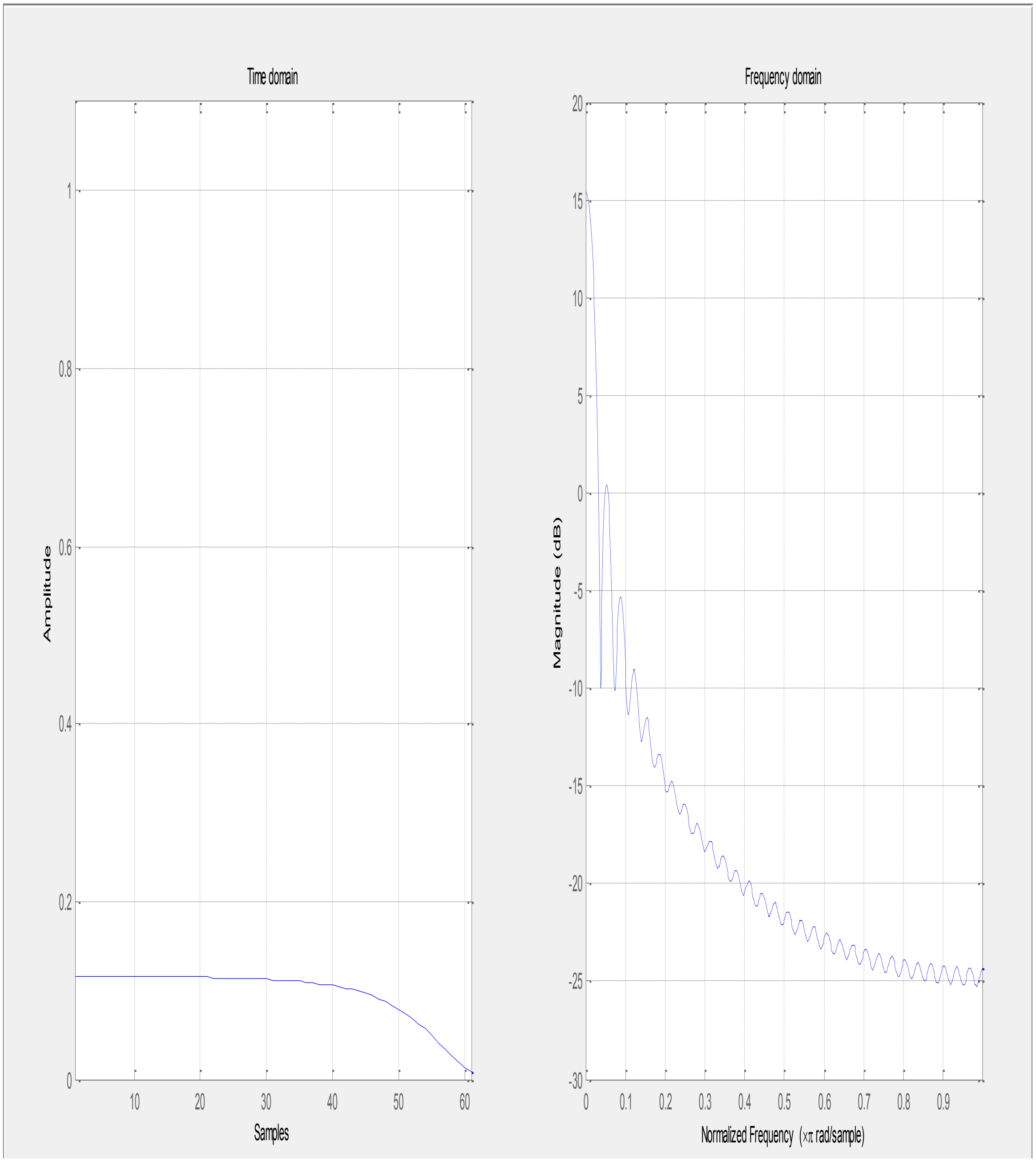


Fig.4.4 Plot of Time and frequency signal in a channel

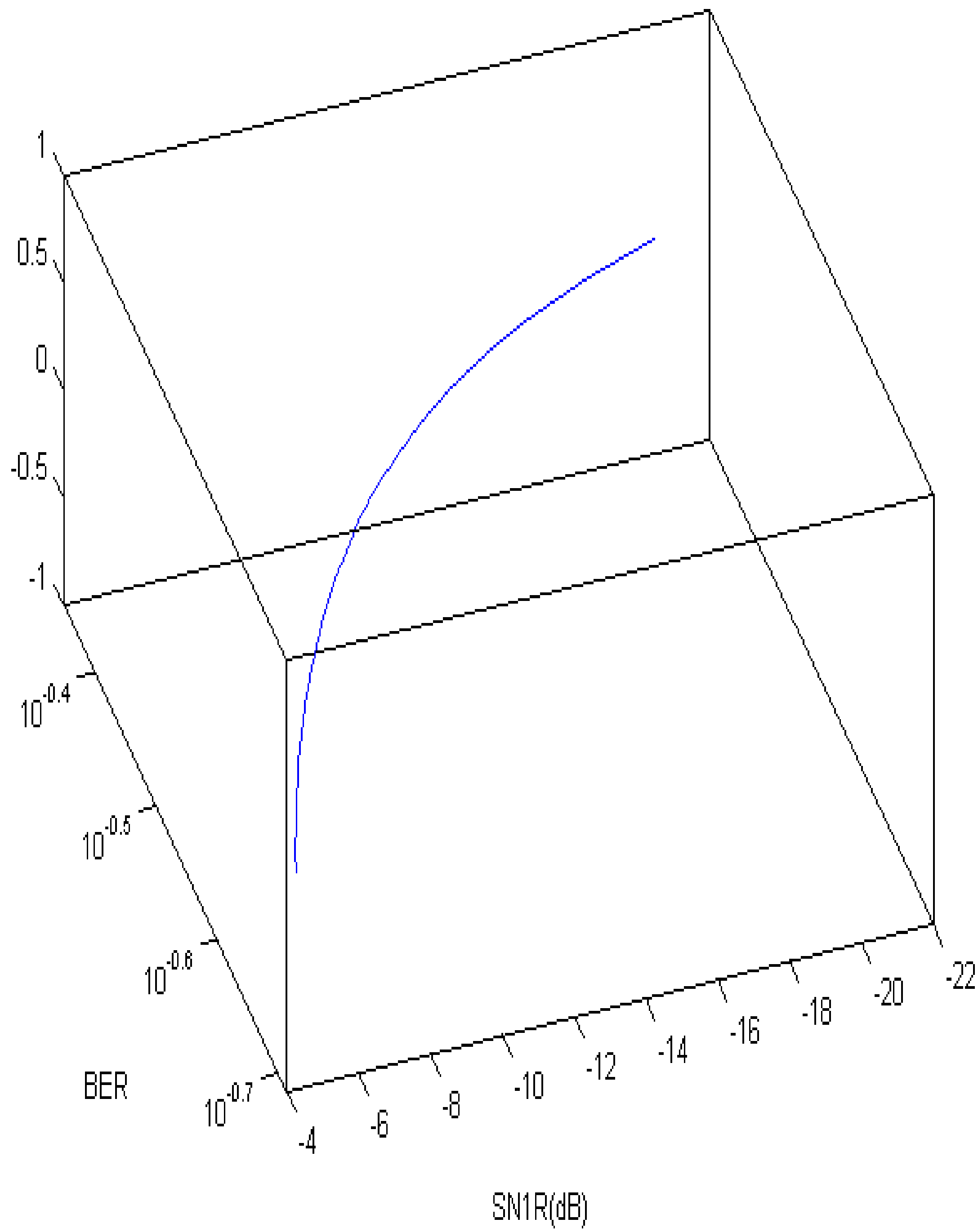


Fig.4.5 Plot of BER vs. SNR for a Single channel DCA in 3-D

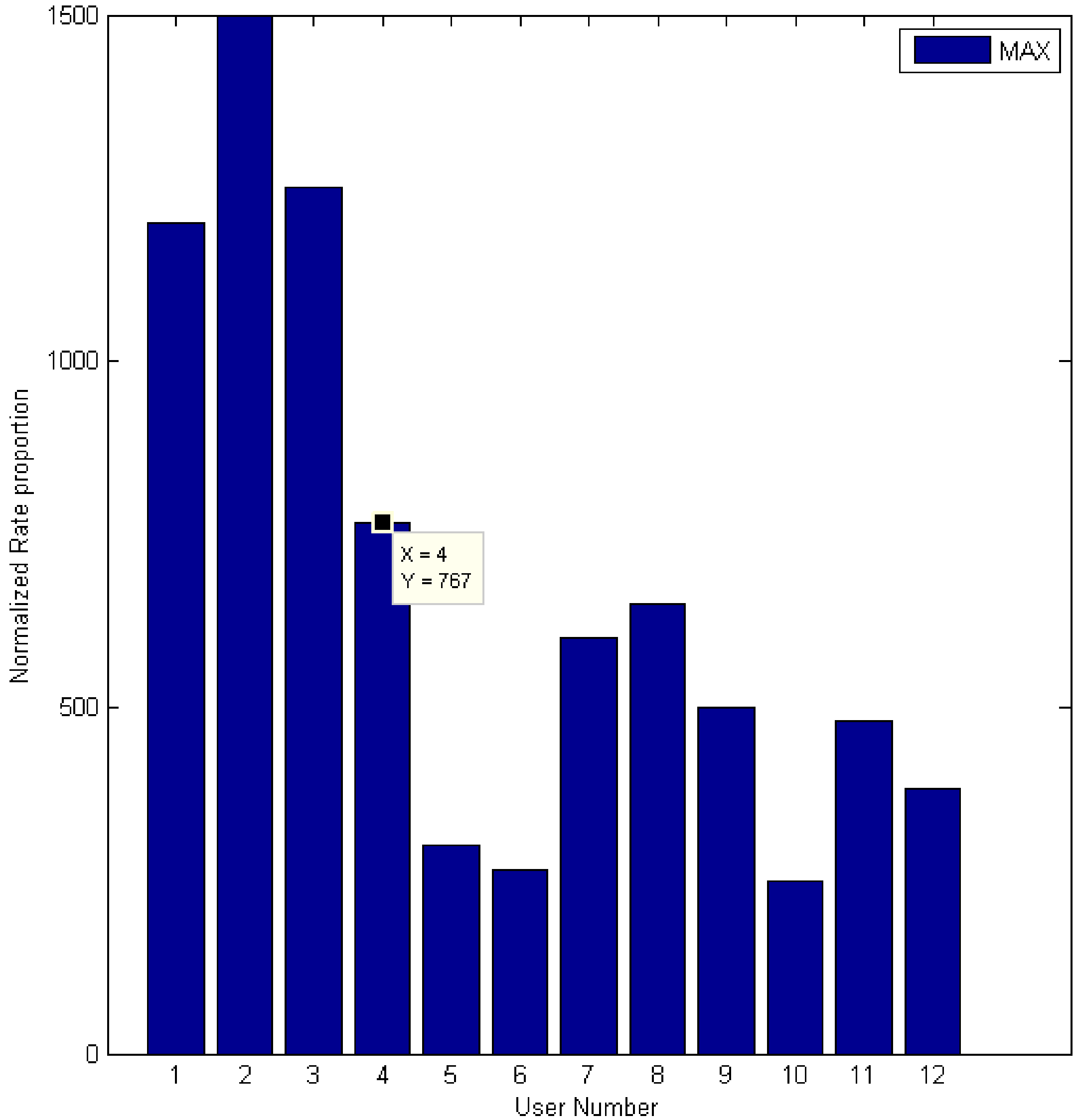


Fig.4.6 Plot of K=12 with their Normalized rate proportion for MAX values in a Single cell DCA

Since Fig. 4.6 shows the channel allocation according to the rate proportionality constraint in single cell DCA for single cell using the MAX algorithm for upto 12 users whereas Fig. 4.7 shows the same but by using MIN algorithm and shows that MIN has higher capacity as compared to the MAX algorithm based values.

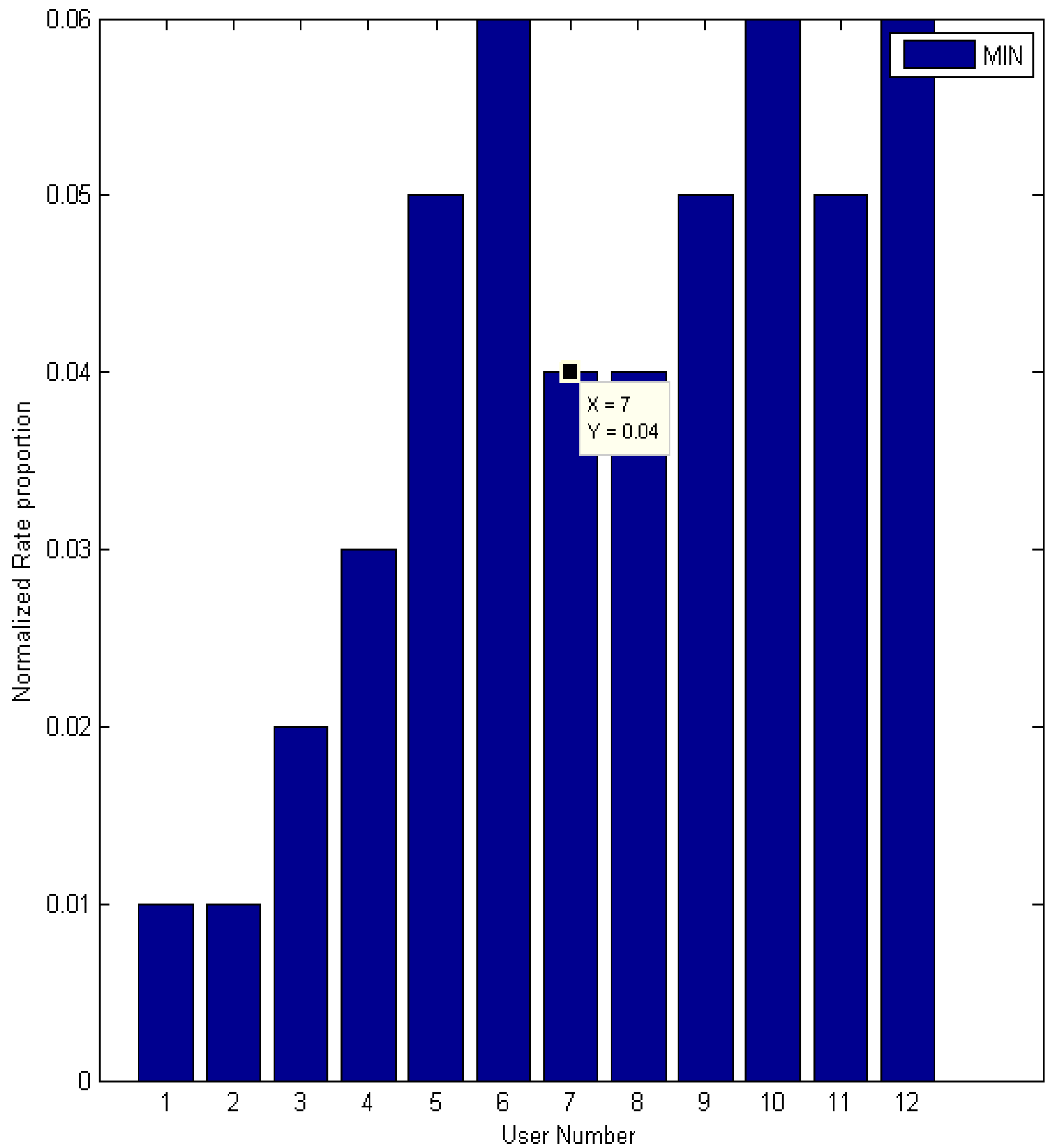


Fig.4.7 Plot of K=12 with their Normalized rate proportion for MIN values in a Single cell DCA

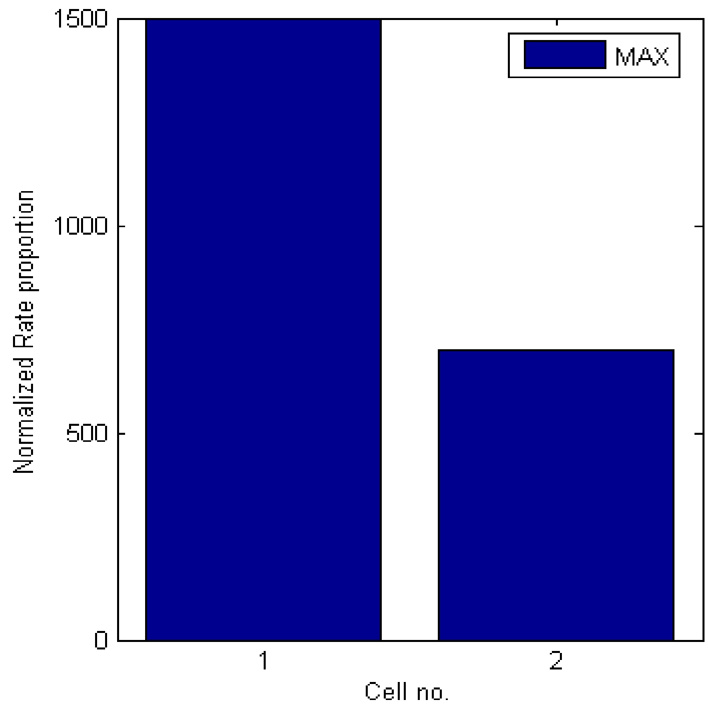


Fig. 4.8 Plot of K=2 with their Normalized rate proportion for MAX values in a multicell channel DCA

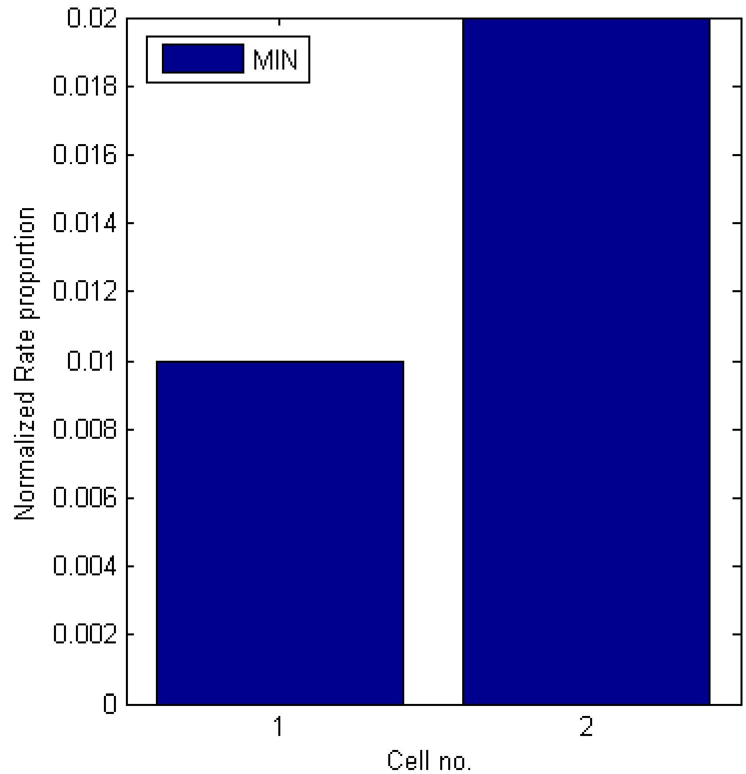


Fig. 4.9 Plot of K=2, N=2 with their Normalized rate proportion for MIN values in a multicell channel DCA

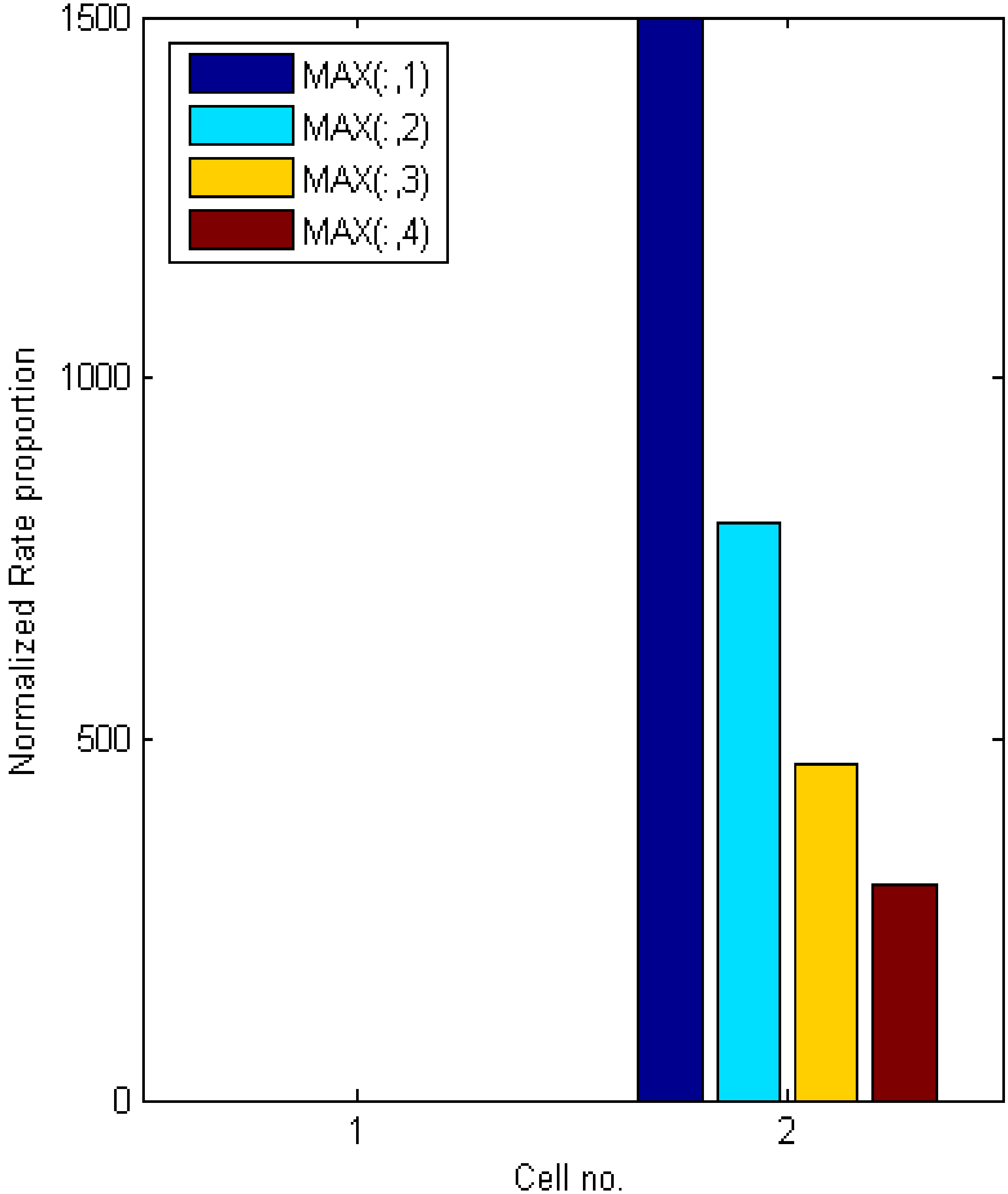


Fig. 4.10 Plot of K=4, N=3 with their Normalized rate proportion for MAX values in a multicell channel DCA

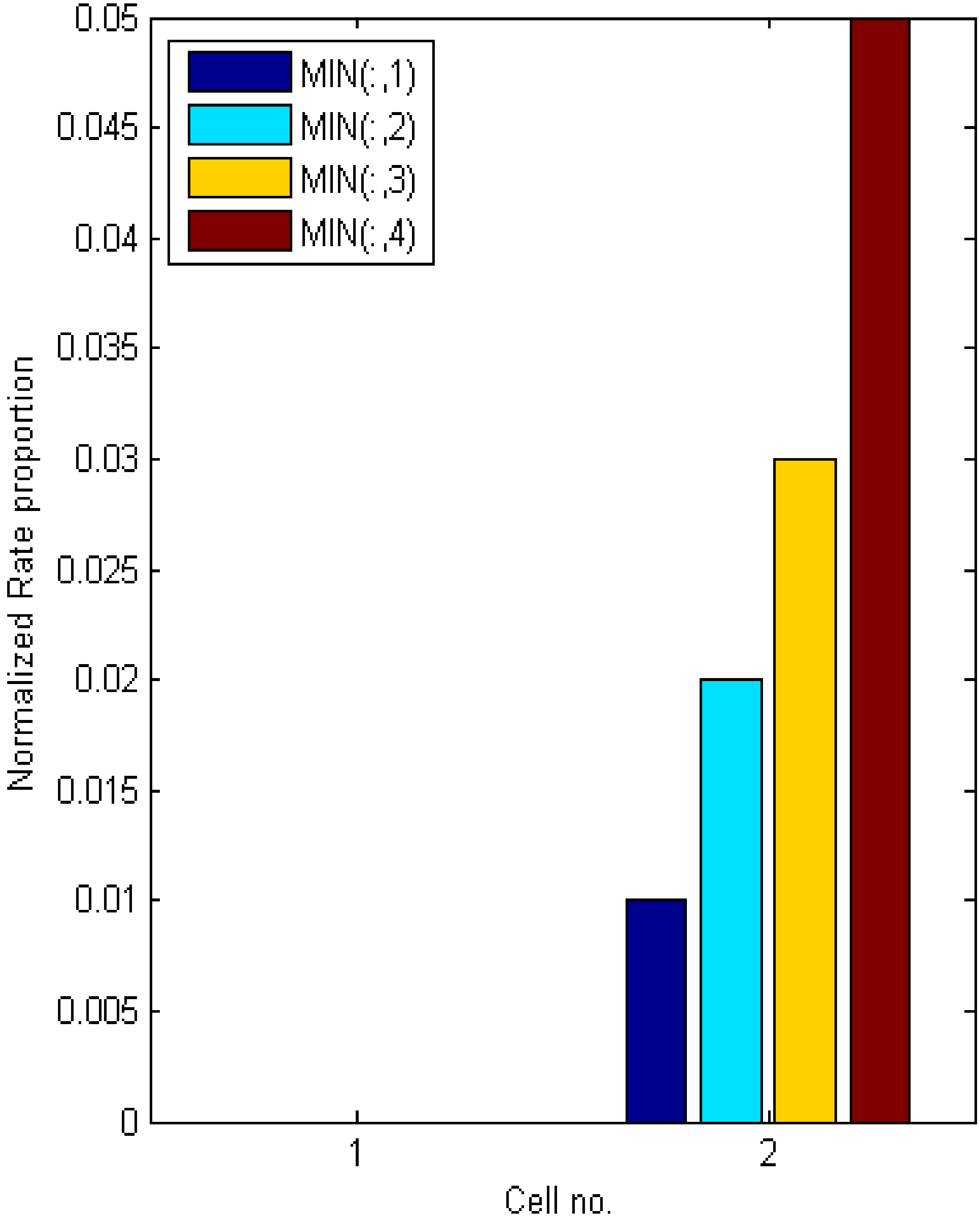


Fig.4.11 Plot of K=4, N=3 with their Normalized rate proportion for MIN values in a multicell channel DCA

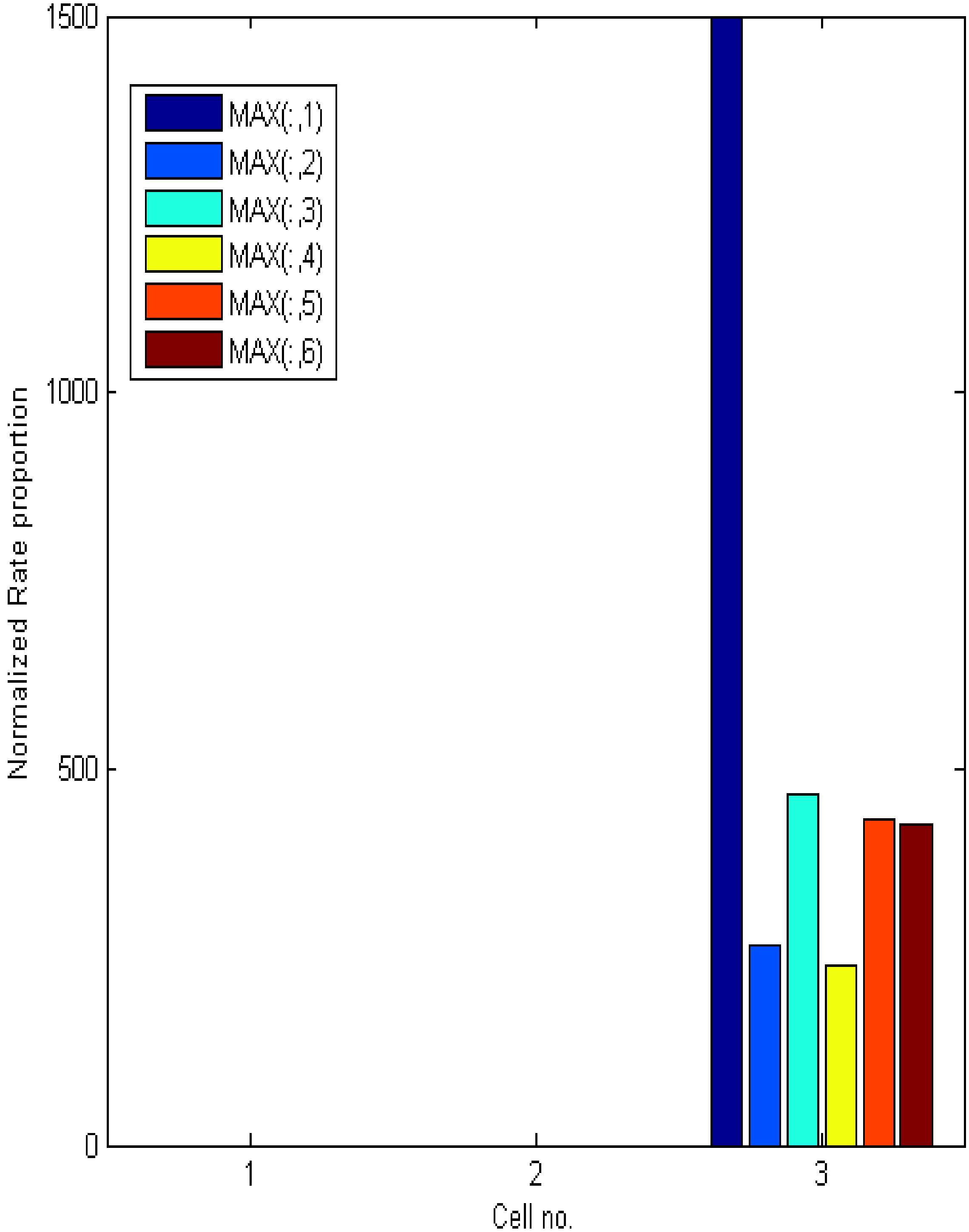


Fig.4.12 Plot of K=6, N=4 with their Normalized rate proportion for MAX values in a multicell channel DCA

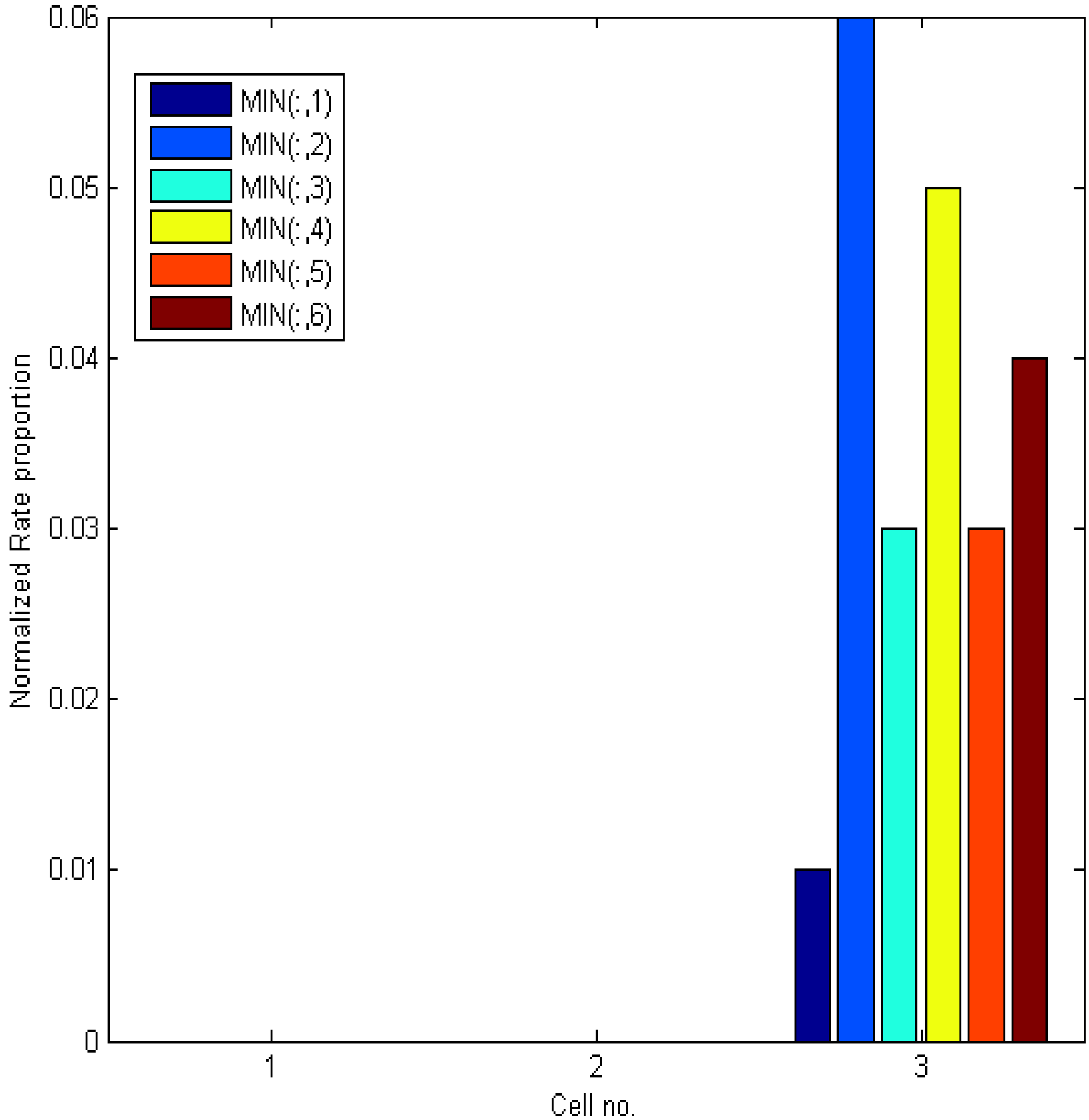


Fig.4.13 Plot of K=6, N=4 with their Normalized rate proportion for MIN values in a multicell channel

Fig. 4.8, 4.10 and 4.12 shows the MAX values for Multicell as the cell number ranges 1, 2 and 3 with the system capacity lesser than the MIN values for Fig. 4.9, 4.11 and 4.13 for the same cell number respectively. Thus the multicell has been achieved for channel allocation with the increase in system capacity.

CHAPTER 5
CONCLUSION

5.1 Conclusion

Most OFDM systems use a fixed modulation scheme over all carriers for simplicity. However each carrier in a multiuser OFDM system can potentially have a different modulation scheme depending on the channel conditions. Any coherent or differential, phase or amplitude modulation scheme can be used including BPSK, QPSK, 8PSK, 16QAM, 64QAM… Each modulation scheme provides a trade-off between spectral efficiency and the bit error rate. The spectral efficiency can be maximized by choosing the highest modulation scheme that will give an acceptable Bit Error Rate (BER).

The future mixture of services will put different demands on the networks than the traditional approach. As the performance results of the system shows much better behavior with dynamic resource allocation schemes than the traditional fixed planning approach, this issue seems to be of great importance for the next generation mobile communication systems. It means that every user has the possibility to allocate as many resources as needed for the moment, making the technique suitable for using together with dynamic resource allocation.

Dynamic resource allocation considerably improves resource utilization efficiency by exploiting multiuser diversity gain as well as system dynamics in various domains. As the subscriber population and service demand continue to expand, the advantages of dynamic resource allocation will be increasingly important in future broadband and ubiquitous wireless communications systems. This report has attempted to give an overview of dynamic multiuser resource allocation.

A low complexity algorithm for minimizing total power consumption in a multiuser OFDM system with constraints on averaged total power consumption. Comparison of SNR vs BER was presented and in addition to that PSD of the system while allocating the channel dynamically was also being presented. The proposed algorithm is particularly suitable for high mobility scenarios because it allows users far from the base station to maintain the required quality of communication without much power expenditure.

The proposed algorithm was tested for the case of a multi cell OFDMA system with exclusive assignment of subcarriers to users.

5.2 Future Work

Thus algorithm with pseudo codes makes it possible for subcarrier allocation in a multicell. Future work can be the enhancement in efficiency when the mobile operator bandwidth may overlap for a DA in a multicell based OFDMA.

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