The average network throughput $\mathcal{C}$ is a function of both subcarrier and power allocation variables. The sum rate maximization problem is formulated as follows using the standard Shannon capacity formula, $\mathcal{C}_{n,k,l} = \log_2(1+\gamma_{n,k,l})$, where $\mathcal{C}_{n,k,l}$ and $\gamma_{n,k,l}$ represent the throughput and SINR of the k^{th} user at n^{th} subcarrier in cell l, respectively:

$$\underset{p_{n,k,l},\alpha_{n,k,l}}{\text{maximize}} \quad \sum_{l=1}^{L}\sum_{k=1}^{K}\sum_{n=1}^{N}\alpha_{n,k,l}\log_2\left(1+\frac{p_{n,k,l}h_{n,k,l}}{\sigma^2+I_{n,l}}\right) \tag{1}$$

$$\text{subject to} \quad \sum_{n=1}^{N} p_{n,k,l} \leq \mathrm{P}_{k,\max}, \quad \forall k, \forall l \tag{2}$$

$$\sum_{k=1}^{K}\alpha_{n,k,l} = 1, \quad \forall n, \forall l \tag{3}$$

$$\alpha_{n,k,l} \in \{0,1\}, \quad \forall n, \forall l, \forall k \tag{4}$$

In (1), $I_{n,l} = \sum_{j=1,j\neq l}^{L}\sum_{k=1}^{K}\alpha_{n,k,j}p_{n,k,j}g_{n,k,jl}$ represents the cumulative interference at n^{th} subcarrier in cell l from the users in all other cells, $p_{n,k,l}$ denotes the power transmitted by k^{th} user at the n^{th} subcarrier in cell l, $\alpha_{n,k,l}$ represents the allocation of k^{th} user at the n^{th} subcarrier in cell l and $h_{n,k,l}$ is the channel gain of k^{th} user at the n^{th} subcarrier in cell l. Constraint (2) implies that the power spent by k^{th} user on its allocated subcarriers cannot exceed the maximum available power, $P_{k_{\max}}$. For each cell, we collect the power allocation variables $p_{n,k,l}$ in a vector $\mathbf{p}_{n,l} = [p_{n,1,l}, p_{n,2,l}, ..., p_{n,K,l}]$ and then stack all the vectors in a power matrix $\mathbf{P}_l$ of cell l where $\mathbf{P}_l \in \mathbb{R}^{N\times K}$. Constraint (3) restricts the allocation of each subcarrier to only one user. The channel gains $h_{n,k,l}$ and binary allocation variables $\alpha_{n,k,l}$ are stacked up similarly in the matrices $\mathbf{H}_l$ and $\mathbf{A}_l$, respectively, where $\mathbf{A}_l, \mathbf{H}_l \in \mathbb{R}^{N\times K}$. Moreover, we define $g_{n,k,lj}$ as the interfering gain from the k^{th} user in cell l to cell j, $\forall j \neq l$ at n^{th} subcarrier. We collect these interfering gains into a vector $\mathbf{g}_{n,lj} = [g_{n,1,lj}, g_{n,2,lj}...., g_{n,K,lj}]$ and then stack all the vectors in a matrix $\mathbf{G}_{lj} \in \mathbb{R}^{N\times K}$.