Date:2021-12-27

Continue with my interim report. Finish the SWIPT-Supported D2D link sub-section:

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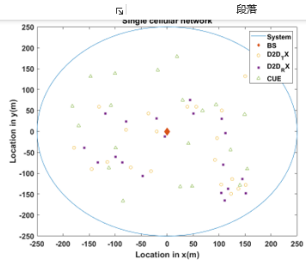
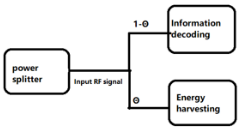


Figure 4: generated system model where communication distance is 20m

4.2.2 SWIPT-Supported D2D link

It is noted that not all the D2D links can perform SWIPT since SWIPT is supposed to operate under short distance since only when the minimum energy requirement has been reached, the EH model can be activated which is known as EH sensitivity [12]. So, to achieve the goal of maximizing EE of each SWIPT-Supported D2D link, we first need to find a way to separate all the SWIPT-Supported D2D links in the D2D link set.

There are two types of schemes for implementing SWIPT [1]: power splitting (PS) and time switching (TS). In this project, SWIPT will be implemented in power splitting mode as it has proved to perform better compared to being implemented in time switching mode [13] especially in aspect of EE and throughput. The power splitting mode model can be implemented as shown in Figure 5, the input RF signal will be divided into two parts by the power splitter, one for energy harvesting and one for information decoding where θ is the power splitting ratio.



For each SWIPT-Supported D2D link i, the throughput can be expressed as following:

$$T_i^D = log2\left(1 + \frac{(1-\theta_i)P_i^D h_i^D}{(1-\theta_i)\left(P_k^c h_{k,i} + N_0\right) + N_1}\right) \qquad (1)$$

Where θ_i is denoted as the power splitting ratio for each D2D link I, P_i^D is the transmission power for each D2D link i, P_k^c is the transmission power of CUE k, N_0 and N_1 are additive white Gaussian noise and noise power caused by RF signal, h_i^D and $h_{k,i}$ are the channel response of each D2D link i and interference link from each D2D link i to CUE k, since both of them are all multiplied by transmission power, so they be thought of as channel power gain which can be calculated as:

$$h = \frac{e^1}{d^a} \qquad (2)$$

where e^1 is the independent unit-mean exponential distribution, d is the communication distance and interference distance, a is the pass loss exponent which was set as 3 to model that of urban city [14].

In this project, the received power for the EH model when D2D receiver i is sharing resource block with CUE k can be denoted as P_i^R, it can be calculated as:

$$P_i^R = \theta_i\left(P_i^D h_i^D + P_k^c h_{k,i} + N_0\right) \qquad (3)$$

To calculate the harvested energy for each D2D link i, a piecewise linear EH model proposed in [15] will be employed as:

$$EH_i^D = \begin{cases} 0, & P_i^R \in [P_{thresold}^0, P_{thresold}^1] \\ k_j P_i^R + b_j, & P_i^R \in [P_{thresold}^j, P_{thresold}^{j+1}] \\ P_{max}^{harvested}, & P_i^R \in [P_{thresold}^L, P_{thresold}^{L+1}] \end{cases} \qquad (4)$$

Where $P_{thresold} = \{P_{thresold}^j | 1 \le j \le L+1\}$ is a set of threshold value of power segment which can be used to determine if the current D2D link i can harvest energy. k_j and b_j are the coefficient of the received power and intersect respectively in the j_{th} segment of the piecewise linear EH model. $P_{max}^{harvested}$ is the maximum harvested energy in the EH model. And as shown in function (4), when the received power is greater than $P_{thresold}^0$ and smaller than $P_{thresold}^1$, the EH model will not be activated where $P_{thresold}^1$ is the minimum received power for activating the EH model. And when the received power is within a range of certain power segment j, the harvested energy will be like a linear function. The harvested energy will reach the maximum value when the received power is greater than all the power segments. The piecewise linear EH model has proved to be more energy efficient and has lower complexity than traditional linear EH model [16] and it has proved to improve more accuracy with increasing number of power segment [17].

And to calculate the EE for each SWIPT-Supported D2D link i, the total energy consumption for each D2D link will also need to be calculated. It can be expressed as the combination of the transmission power of each D2D link i P_i^D and circuit power of D2D transmitter and receiver $P_{circuit}$ and subtract the harvested energy for each D2D link i EH_i^D :

$$EC_i^D = P_i^D + 2P_{circuit} - EH_i^D \qquad (5)$$