Analyzing CDMA System through MATLAB

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ABSTRACT

CDMA is an example of multiple access, which is where several transmitters can send information simultaneously over a single communication channel. This allows several users to share a band of frequencies (see bandwidth). To permit this to be achieved without undue interference between the users CDMA employs spread-spectrum technology and a special coding scheme (where each transmitter is assigned a code). CDMA technology is one of potential candidates for the physical layer of 4G mobile systems with the aim of improving cell capacity, multipath immunity, and flexibility. In this work the performance of CDMA system has been analyzed and thus showing its efficient performance.

II. THEORETICAL ANALYSIS

One of the most important concepts required in order to understand spread spectrum techniques is the idea of process gain. The process gain of a system indicates the gain or signal to noise improvement exhibited by a spread spectrum system by the nature of the spreading and despreading process. The process gain of a system is equal to the ratio of the spread spectrum bandwidth used, to the original information bandwidth. Thus, the process gain can be written as:

\[ G_p = \frac{BW_{RF}}{BW_{info}} \]

Where \( BW_{RF} \) is the transmitted bandwidth after the data is spread, and \( BW_{info} \) is the bandwidth of the information data being sent. The data to be transmitted is spread before transmission by modulating the data using a PN code. This broadens the spectrum and the process gain is 125 as the spread spectrum bandwidth is 125 times greater the data bandwidth. The received signal consists of the required signal, plus background noise, and any interference from other CDMA users or radio sources. The received signal is recovered by multiplying the signal by the original spreading code. This process causes the wanted received signal to be despread back to the original transmitted data. However, all other signals that are uncorrelated to the PN spreading code become more spread. The wanted signal is then filtered removing the wide spread interference and noise signals.

III. SIMULATED MODEL

The model used for the simulations of the CDMA forward link is shown in Figure 1.

The forward link of the CDMA system modeled uses orthogonal Walsh codes to separate the users. Each user is randomly allocated a Walsh code to spread the data to be transmitted. The transmitted signals from all the users are combined together, then passed through a radio channel model. This allows for clipping of the signal, adding multipath interference, and adding white Gaussian noise to the signal. The receiver uses the same
Walsh code that was used by the transmitter to demodulate the signal and recover the data. After the received signal has been disspread using the Walsh code, it is sub-sampled back down to the original data rate. This is done by using an integrate-and-dump filter, followed by a comparator to decide whether the data was a 1 or a 0. The received data is then compared with the original data transmitted to calculate the bit error rate (BER). The RMS amplitude error is also worked out. The signal level after it has been demodulated and filtered is compared with the expected amplitude of the signal based on the transmitted data. The RMS amplitude error directly relates to the bit error rate, so is a useful measurement to make. The reverse link of the CDMA link was simulated in a very similar way to the forward link except that orthogonal Walsh codes are not used. As shown earlier it is extremely difficult to use orthogonal codes effectively in a reverse link from the mobiles to the base station, because of the difficulty in synchronizing the system accurately enough. Because of this simply long pseudo random codes were used instead of the Walsh codes.

IV. SIMULATION RESULT

The reverse links of a CDMA system, from the mobiles to the base station, use non-orthogonal codes, which are pseudo random noise codes (PN codes). This leads to the signals from each user interfering with each other. The signals transmitted by each user are uncorrelated with each other as each user uses a unique pseudo random sequence code, resulting in the signal appearing a noise to other users.

The BER for the reverse link of a CDMA system, increases by increasing the number of users in the same cell. Figure 2 shows the BER expected base and the number of users. This result, is taken for an isolated cell with assuming no interference from neighboring cells, avoiding multipath effects and no channel noise. Any of these effects can affect the BER. From Figure 2 it is clear that the BER becomes significantly large if the number of users is greater than 8 users. This represents only 12.5% of the total user capacity of 80 users. By using forward error correction the maximum number of users in the cell can be increased. It is clear from the result obtained from Figure 2 that the inter-user interference in the reverse link is the weak point in the CDMA system. It is this interference that limits the cell capacity to approximately 8-12 users.

CDMA is inherently willing to accept multipath delay spread signals as any signal that is delayed by more than one chip time becomes uncorrelated to the PN code used to decode the signal. This simply appears as noise results in the multipath. This noise causes an increase in the amount of interference seen by each user subjected to the multipath and thus the received BER increases.

Figure 3 shows the effect of delay spread on the reverse link of a CDMA system. It can be seen that the BER is essentially flat for delay spreads of greater than one chip time (0.8 µsec), which is to be expected as the reflected signal becomes uncorrelated.

Figure 4 shows how the multipath power leads to an increase in the effective number of users in the cell. This simulation was performed for a fixed number of users in the CDMA link. A multipath signal of 10 samples in delay (to ensure that it is uncorrelated) was then added. It was found it increases the amplitude of the reflected signal, so did the Bit Error Rate (BER).

V. CONCLUSION

Thus it is concluded that the CDMA system is one of the effective and efficient technologies is used in wireless communication and is inherently tolerant to multipath delay spread signals.
REFERENCES


