# Part II. Synchronization

## 1. Time and Frequency Synchronization

According to the model we built in Part I, for transmitting side and receiving side, both the carrier frequency and sampling rate are generated locally. As a result, there are mainly two factors concerning the synchronization of the communication:

* The carrier frequency offset (CFO) and sampling clock offset(SCO). Assuming the carrier frequency at the TX end is and sampling time is , at the receiving end, CFO and SCO would cause carrier frequency to be , and sampling time .
* Carrier phase error , and sample time shift , may also occur, since the TX and RX are physically in different places.

It could be shown that the effect of synchronization could be adapted to baseband as following model:



*figure 1 Baseband model for synchronization*

In this study, firstly, we demonstrate the impact of the synchronization errors by adding the errors to our baseband model and show the result of simulation. Then synchronization algorithms are designed and applied to improve the performance of the communication considering the effect of synchronization.

### 2. Impact of the synchronisation errors