TFE25-462: Meeting 7

Schmidl and Cox Synchronization

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Theoretical background

Schmidl and Cox frame structure

The Schmidl and Cox synchronization algorithm is based on the following frame structure:

```
+----+---------+---------+----+--------------+----+--------------+----+--------------+
| CP |    A    |    A    | CP |    payload   | CP |    payload   | CP |    payload   |
+----+---------+---------+----+--------------+----+--------------+----+--------------+
|<------ Preamble ------>|<---------------------- N OFDM Symbols -------------------->|
```

Figure 1: Schmidl and Cox frame structure

- OFDM 0 symbols on odd subcarriers
- Gives a symmetric symbols in time domain

Schmidl and Cox synchronization algorithm - basics

- Calculate the correlation of the received signal with itself shifted by L samples $P(d) = \sum_{n=0}^{L-1} r *_{d+m} r_{d+m+L}$ calculated as

$$P(d+1) = P(d) + r *_{d-L} r_d - r *_{d-2L} r_{d-L}$$

- Recieved energy for second the second half-symbols $R(d) = \sum_{n=0}^{L-1} |r(d+m+L)|^2$ calculated as

$$R(d+1) = R(d) + |r(d)|^2 - |r(d-L)|^2$$

- Calculate the metric

$$M(d) = \frac{|P(d)|^2}{(R(d))^2}$$

where r is the received signal and $L = K/2$ with K the number of subcarriers (FFT size). So, in time domain, a symbol has a size of $CP + K = CP + 2L$ samples.

Schmidl and Cox synchronization algorithm - averaging

Moving average window of size *width*:

- The metric $M(d)$ has a plateau of size CP samples
- The metric $M(d)$ is averaged over a window of N samples

$$N(d+1) = \frac{1}{width} \cdot (N(d) + M(d) - M(d - width)))$$

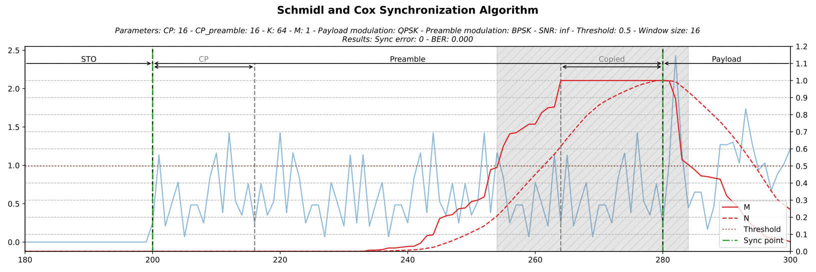
Delay introduced:

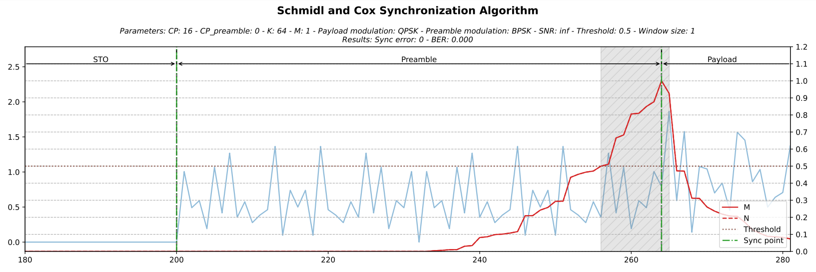
- M_delay = $K \cdot M$ (or $2L \cdot M$): introduced by computing the metric
- AVG_delay = $width/2 \cdot M$: introduced by the moving window
- MID_delay = $CP/2 \cdot M$: the peak of N indicates the middle of the cyclic prefix

where M is the oversampling factor.

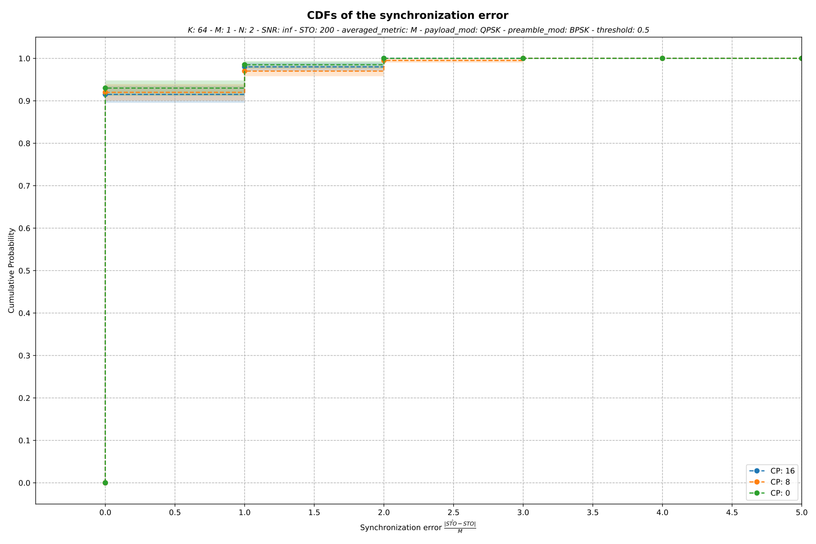
Simulation

Theoretical Simulation

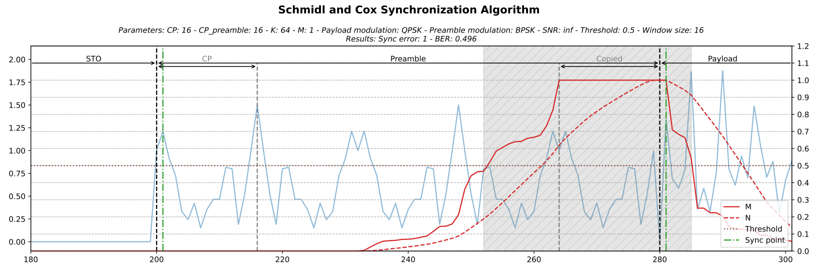




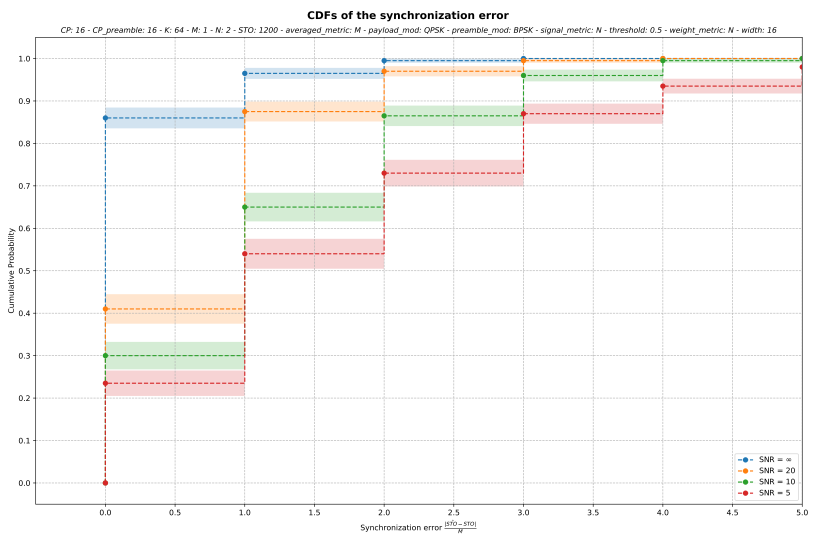
Theoretical Simulation - CDF of synchronization error



Theoretical Simulation - CDF of synchronization error



Theoretical Simulation - CDF of synchronization error



Theoretical Simulation - CDF of synchronization error