Final Evaluation

LELEC2103

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Outline

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Frame detection & frequency offset correction : what for?

- Goal of frame detection : locate the beginning of the frame despite the signal suffering an unknown delay
- Goal of frequency offset correction : even small Δf at Tx and Rx $\Rightarrow$ distortions that need to be corrected

We will (again) use *training sequences* to do these operations

Frame detection by correlation

Idea : use a training sequence with strong *autocorrelation* properties

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Narrowband vs wideband channels

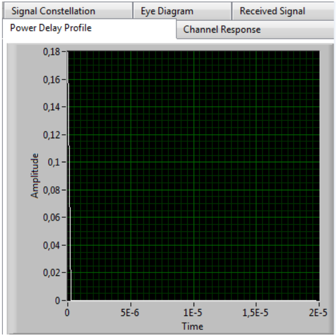
To use a narrowband channel we take:

- Sample rate: $4 MSample/s$
- Oversampling factor: 20
- Bandwidth: $0,1 MHz$

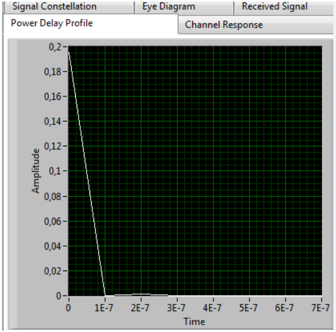
To use a wideband channel we take:

- Sample rate: $20 MSample/s$
- Oversampling factor: 4
- Bandwidth: $2.5 MHz$

Power delay



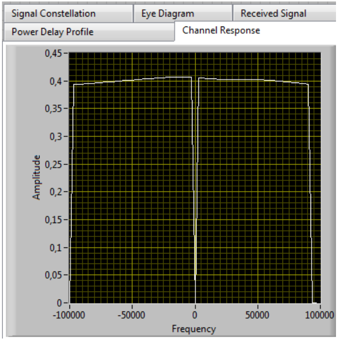
(a) Narrowband channel



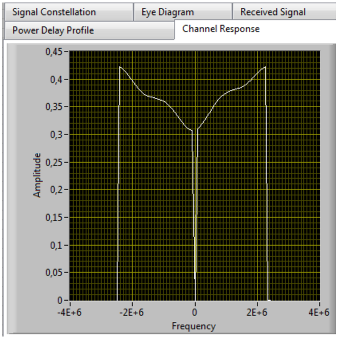
(b) Wideband channel

Figure: Power delay

Channel frequency response



(a) Narrowband channel



(b) Wideband channel

Figure: Channel frequency response

Narrowband vs wideband channels

We can observe that:

- A Narrowband channel is flat because $L_h = 0$

$$H[k] = \sum_{l=0}^{L_h} e^{-j2\pi kl/N} = h[0]e^{-j2\pi kl/N} = h[0] \forall k$$

- A Wideband channel is frequency selective because $L_h > 0$.

$$k_1 = 0 \quad and \quad k_2 = N/2$$

$$H[k_1] = \sum_{l=0} L_h h[l] \quad and \quad H[k_2] = \sum_{l=0} L_h (-1)^l h[l]$$

$$H[k_1] \neq H[k_2]$$

Outline

Frame detection & Frequency Offset Correction
- Objectives and method
- Practical results

OFDM
- Narrowband vs wideband channels
- OFDM overview
- Sensitivity to frequency offset
- Parameters of a OFDM modulation

OFDM overview

We want to transfer $\{s[n]\}_{n=0}^{N-1}$ where N is the number of subcarriers. We transfer in time domain:

$$\begin{aligned} w[n] &= iDFT(s[m]) \\ &= \frac{1}{N}\sum_{m=0}^{N-1} s[m]e^{j2\pi\frac{m(n-L_c)}{N}} \quad n = 0, \ldots, N + L_c - 1 \end{aligned}$$

Due to channel response we receive signal:

$$\bar{y}[n] = \sum_{l=0}^{L} h[l]w[n-l] + v[n]$$

His DFT gives:

$$\begin{aligned} \overline{Y}[k] &= DFT[\bar{y}[n]] \\ &= H[k]s[k] + V[k] \end{aligned}$$

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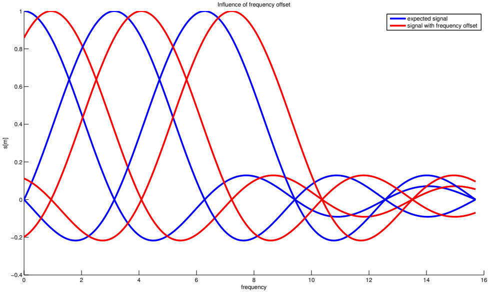
Frequency offset influence



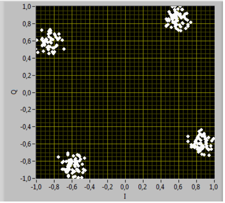


Figure: Influence of frequency offset in OFDM

Number of subcarriers influence

What happen when the number of subcarriers grows ?

- There is more subcarriers for a certain bandwidth
- Less resistant against frequency offset

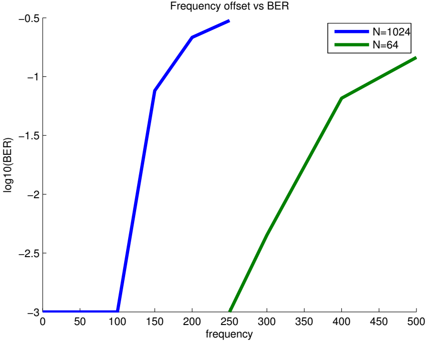


Figure: BER vs frequency offset for different subcarriers

Outline

Parameters of a OFDM modulation

We can choose at least 3 parameters for a OFDM modulation:

- Increasing the number of subcarriers:
  - Make the channel less frequency selective
  - Increase OFDM frequency offset sensibility
- Increasing the bandwith
  - Make the channel more frequency selective
  - Decrease OFDM frequency offset sensibility
- The length of the cyclic prefix
  - Avoid ICI
  - Should be at least greater then L_h