ULB

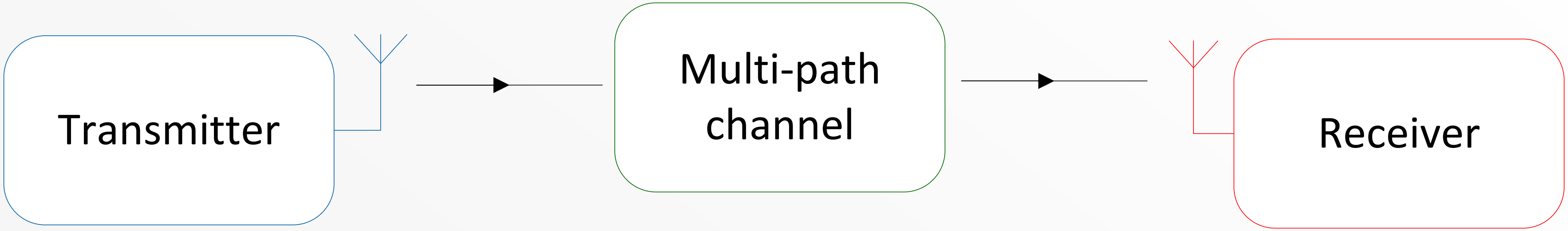
WIRELESS COMMUNICATIONS
RESEARCH GROUP

OPERA.ULB.AC.BE

Conception of a complete OFDM communication channel

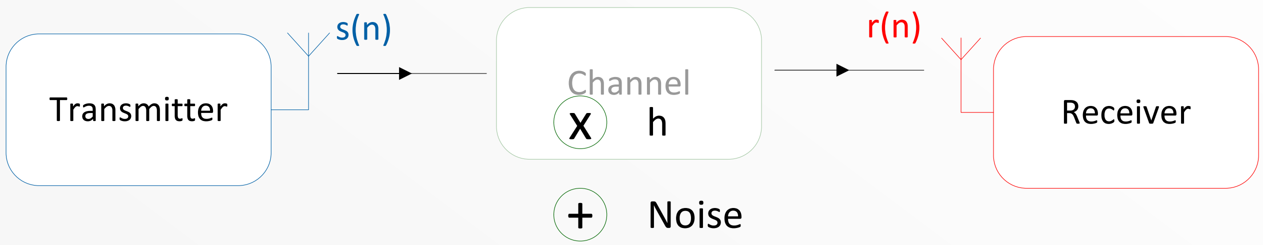
Main goal of the project

Achieve a wireless communication on a multi-path channel



Last year …

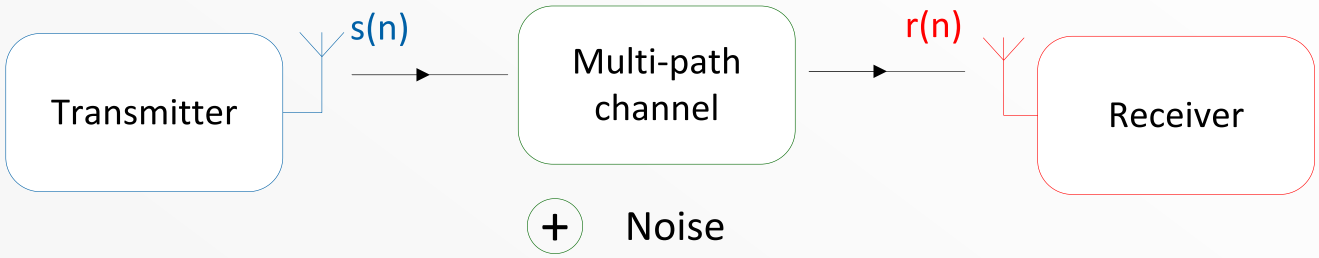
- Narrowband communication channel: Noise was the only source of degradation



- Synchronization algorithms for single carrier communications

This year …

- Wideband communication channel: Baseband channel is more complex



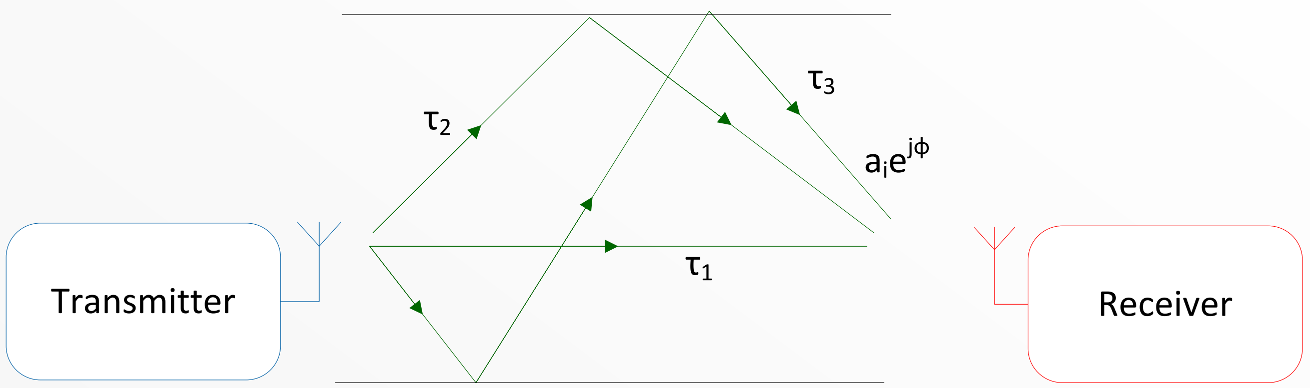
- Characterization and compensation of the channel
- Introduction to a new modulation: OFDM
- Adaptation of the synchronization algorithms

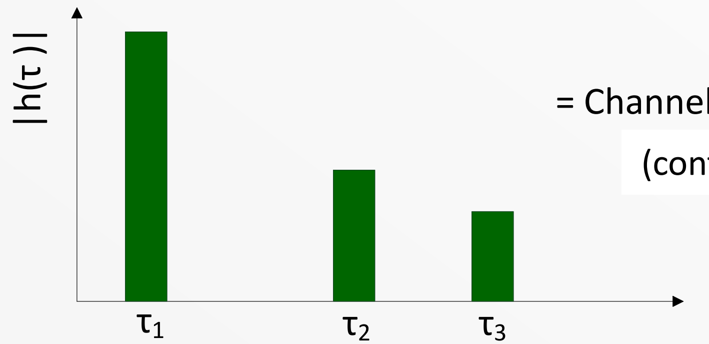
Planning

1	Transfer function, Impulse response, Power Delay Profile, Coherence bandwidth
2	SISO Channel model with a 20 MHz bandwidth: Statistical model of the narrowband and wideband channel
3	OFDM and channel equalization
4	Channel estimation
5	Time of Arrival estimation
6	CFO acquisition, compensation and tracking
7	Beamforming, SIMO channel model and Spatial Correlation
8	SIMO communication
9	Q&A
10	Evaluation

ELEC-H-422
ELEC-H-522

Multi-Path Components

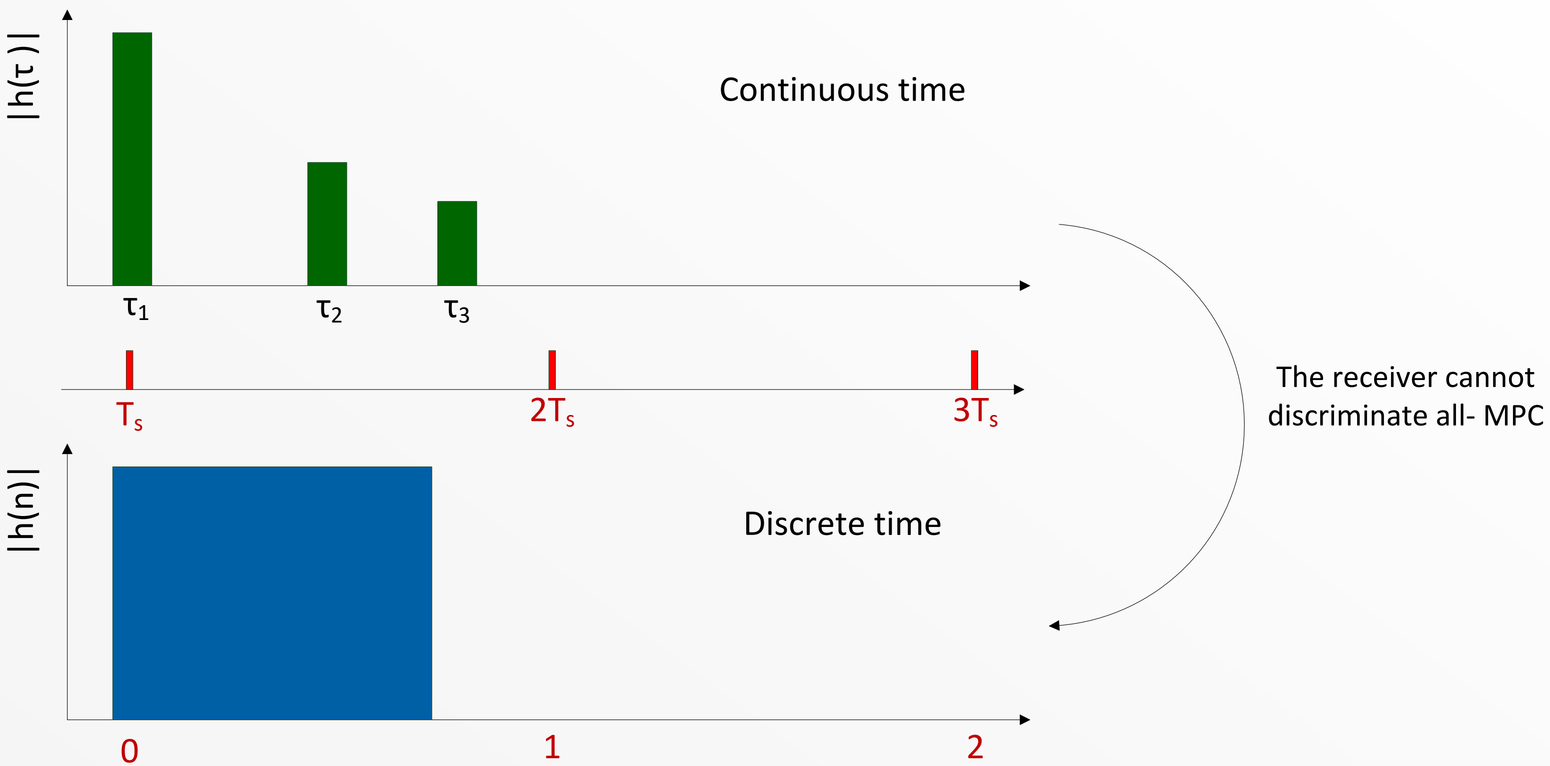




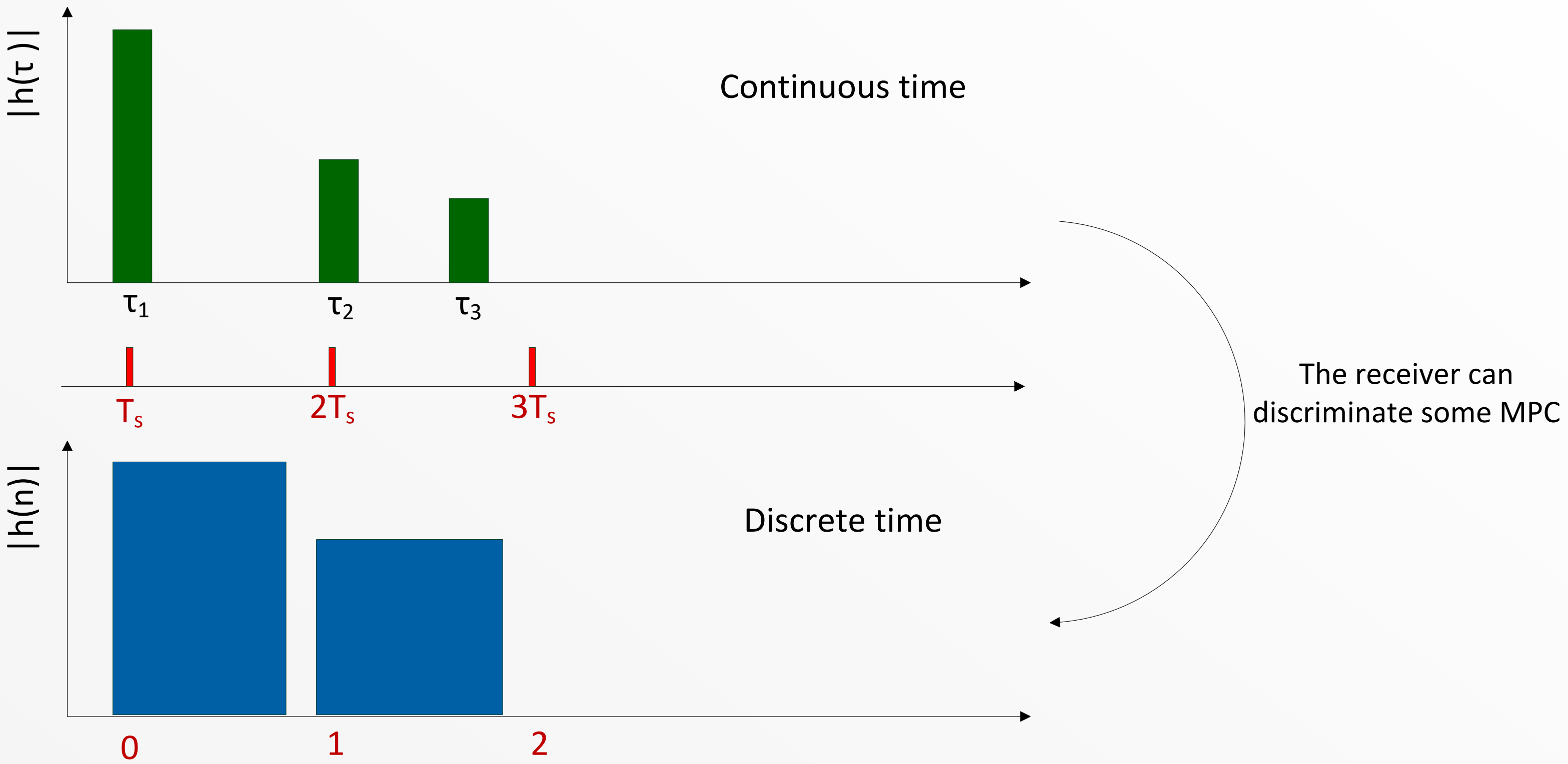
= Channel impulse response

(continuous time)

Narrowband: Sampling period $T_s > \tau_3$

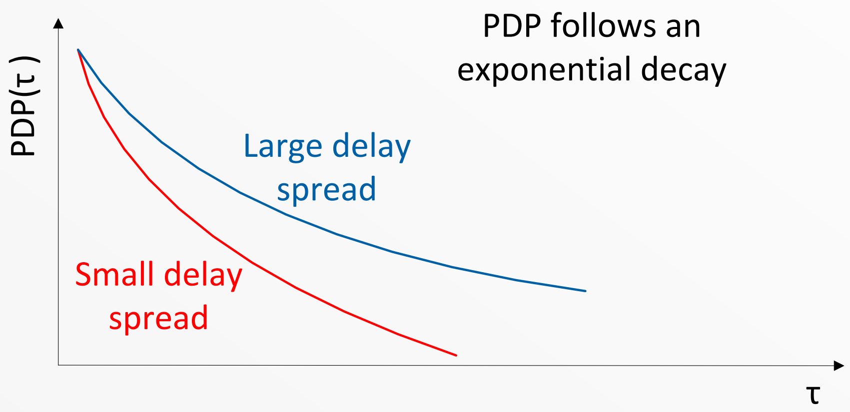


Wideband: Sampling period $T_s < \tau_3$



Power Delay Profile

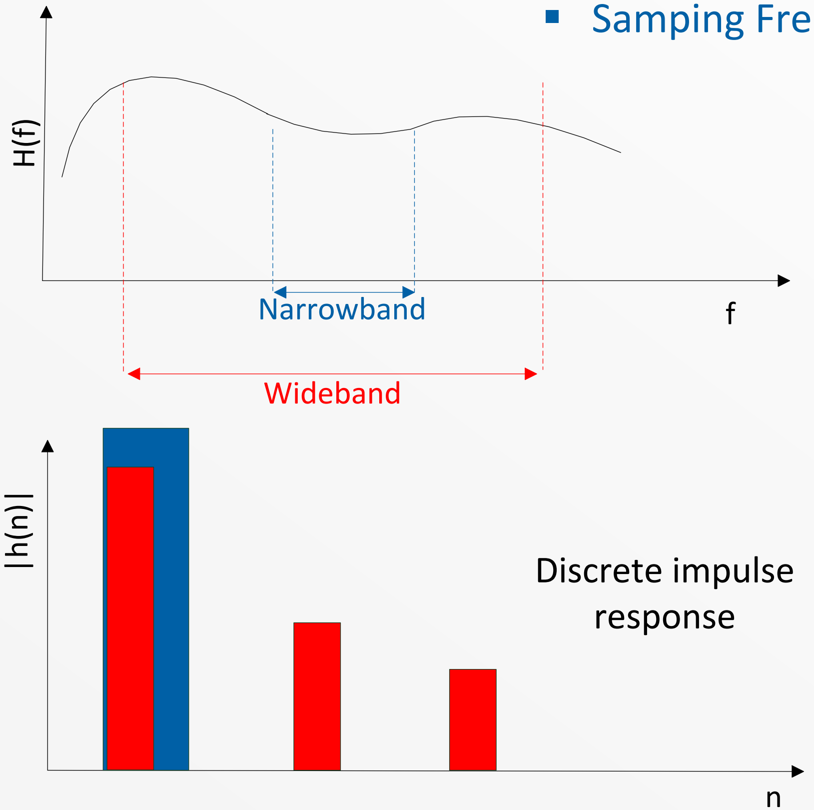
- PDP = Mean received power in function of time
- Decay of the PDP is defined by its delay spread



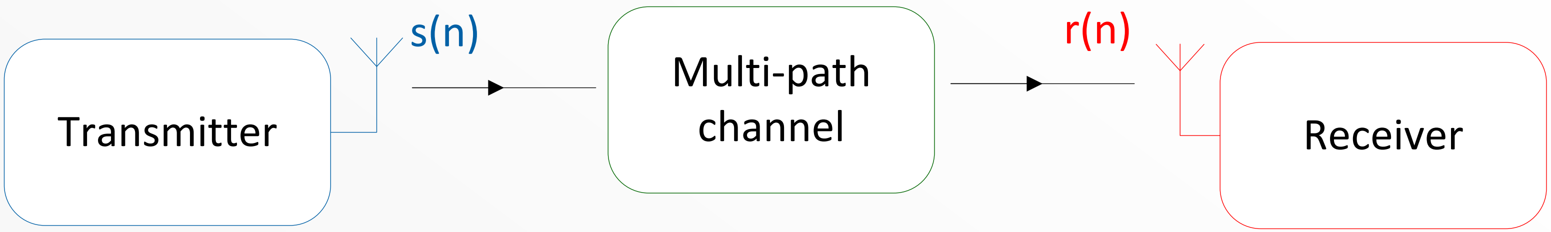
Frequency domain representation

Narrowband:
- Samping period T_s >> Delay Spread σ_s
- Samping Frequecy f_s << Coherence bandwidt Δf_c

Wideband:
- $T_s << \sigma_s$
- $f_s >> \Delta f_c$



Impact on the communication



- No memory in a narrowband channel:

$$r(n) = hs(n) + w(n)$$

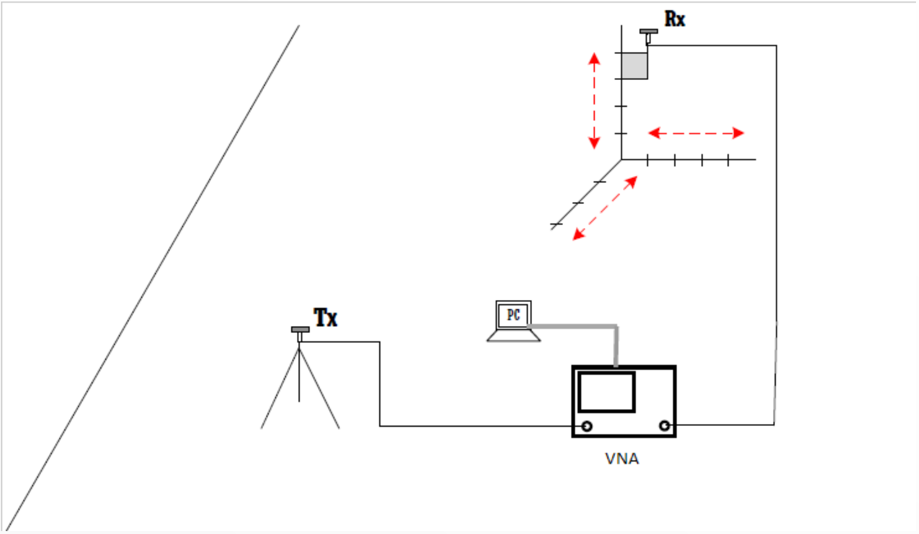
- Memory in a wideband channel:

$$r(n) = h(n) * s(n) + w(n)$$

- Interferences must be compensated on the receiver side

Experimental measurements

- Vector Network Analyzer
- 3D Positioning device
- Transmitting Antenna Tx
- Receiving antenna Rx



- For each position of Rx, a transfer function H(f) is measured

Experimental measurements

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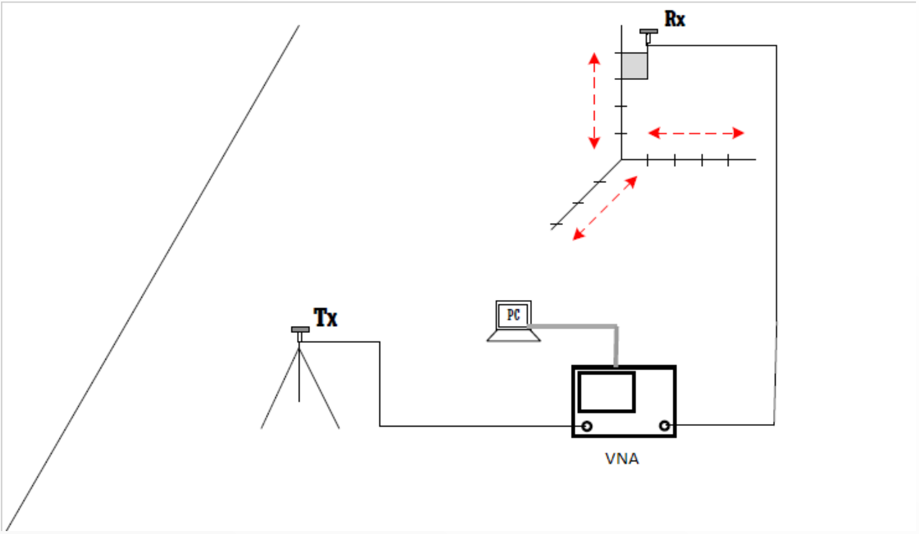
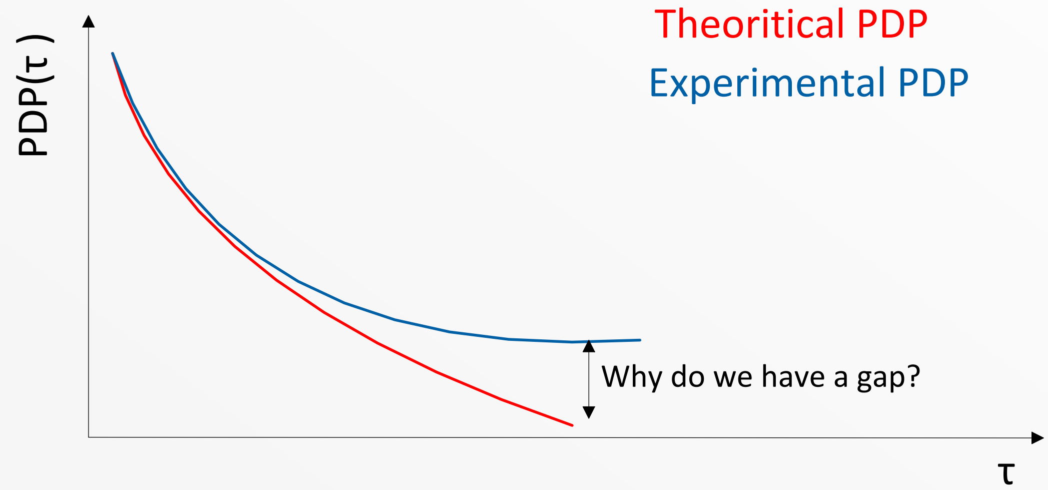


- For each position of Rx, a transfer function H(f) is measured
- Transfer function measured with a frequency sweep

Experimental measurements

- Evaluation of the PDP by averaging over the local area
  => Elimination of the effect of the small-scale fading

- $PDP(n) = \frac{1}{N}\sum_{i=1}^{N} |h_i(n)|^2$ where i is the position index



Objective

- Extract the impulse response at each position
- Evaluate the PDP, calculate its delay spread and confirm that it follows an exponential decay
- Evaluate the coherence bandwidth
- Reduce the bandwidth to 20 MHz, using a rectangular and a non-rectangular window. Interpret the impact on the impulse response, the PDP and the delay spread.