POLYTECH.MONS

Modeling and design of heterogeneous systems

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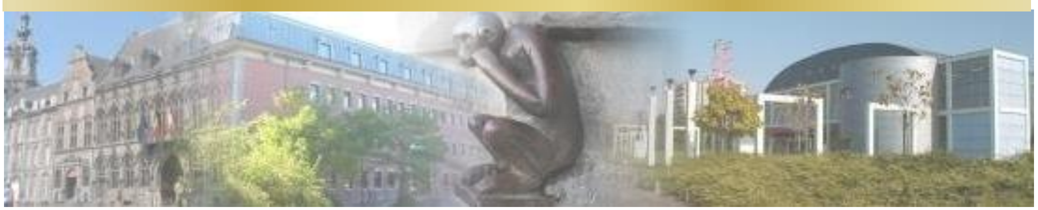
EuroDocInfo 09



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Service Electronique et Microélectronique
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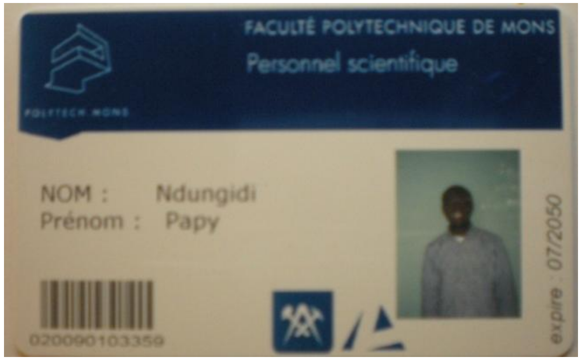
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Introduction

- The user asks for devices containing the most possible functionalities, consuming less possible energy and at very low cost.
- The industry reflect these demands on engineers.
- The complexity of these devices requires collaboration between heterogeneous teams and work environments.

Introduction

- Uses modeling.
  - Through the modeling of its wireless communication system, the Kysoh company increased the range of the transmitter - receiver of Tux of 75%.

- To reinforce the Top- Down methodology of design by allowing parallelism.
- Provide **tools** that facilitate the work of engineers.

Outline

- ❑ Introduction
- ❑ Presentation of our toolbox
- ❑ Examples of use of the toolbox
- ❑ Summary, Future work

Presentation of our toolbox

- Designed in Simulink/Matlab, the blockset covers the following areas:
  - RF
  - Baseband
  - Analog
  - Digital.
- It includes configurable blocks, modeling the components of RF communication chain with major imperfections (noise and nonlinearity) to generate a specification.

Presentation of our toolbox

- This toolbox () models the physical layer of the majority of Wireless Personal Area Network (WPAN).
- Moreover, the blockset contains tools making possible to check that the parameters of blocks respect a given standard.

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Examples of use of the toolbox

IEEE 802.15.4

Low power consumption, low cost and low data rate.

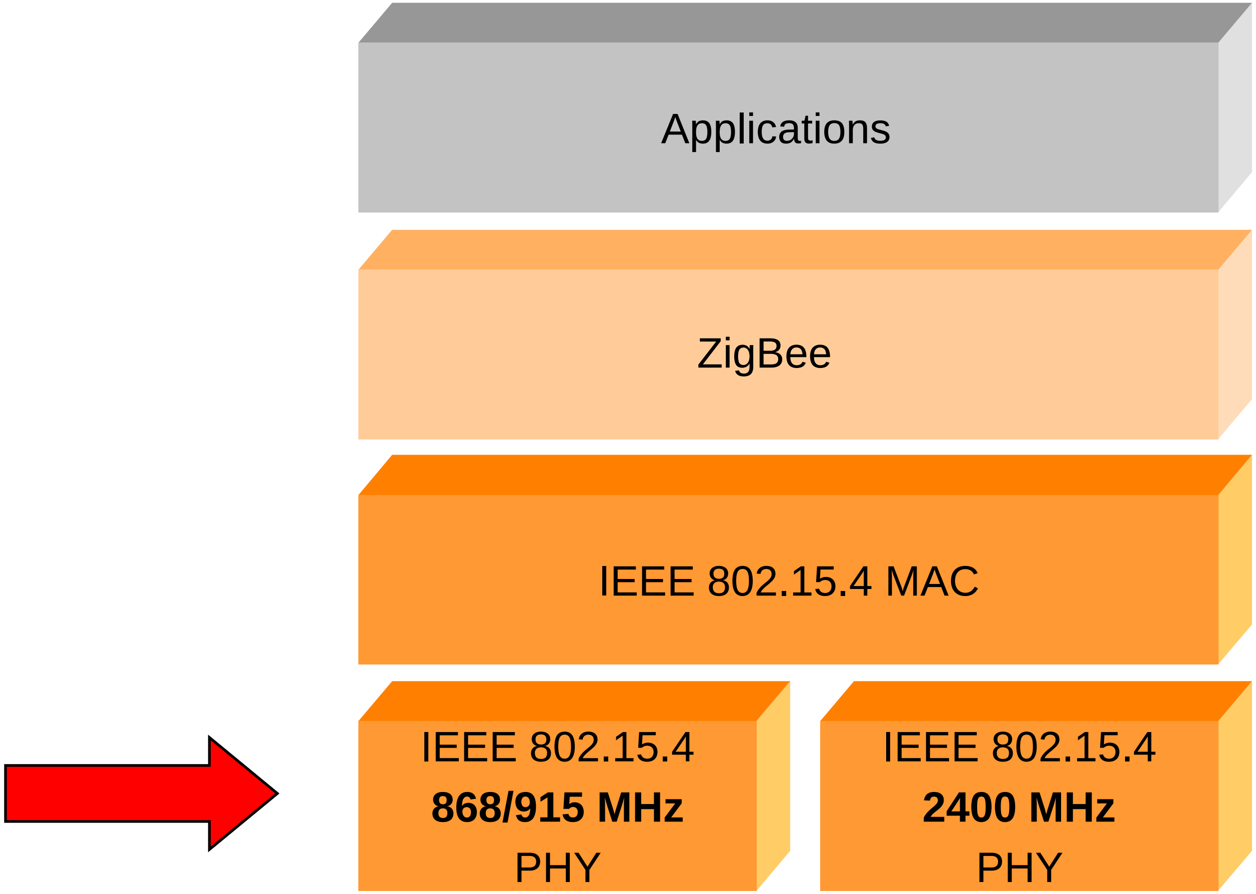
Dedicated to short range operation.

Easy to implement and with reliable data transfer.

Simple and flexible.

Band	Frequency Band	Bit rate	Symbol Rate	Modulatio n	Chip rate
868 MHz 1 channel	868-868.6 MHz	20 kb/s	20 Ksymbols/s	BPSK	300 Kchips/s
915 MHz 10 channels	902-928 MHz	40 kb/s	40 Ksymbols/s	BPSK	600 Kchips/s
2.4 GHz 16 channels	2.4-2.4835 GHz	250 kb/s	62.5 Ksymbols/s	OQPSK	2 Mchips/s

Zigbee Architecture



- User-defined

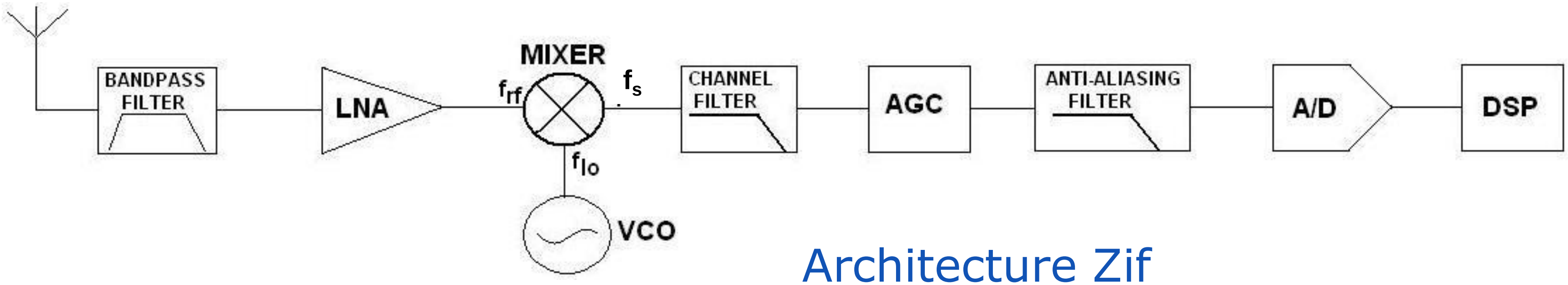
- Network Routing
- Address translation
- Packet Segmentation
- Profiles

- Channel acquisition
- Contention management
- NIC address
- Error Correction

- Packet generation
- Packet reception
- Data transparency
- Power management

Example 1 : architectural exploration

Is to choose the blocks that will form the chain of communication and their locations



Architecture Zif

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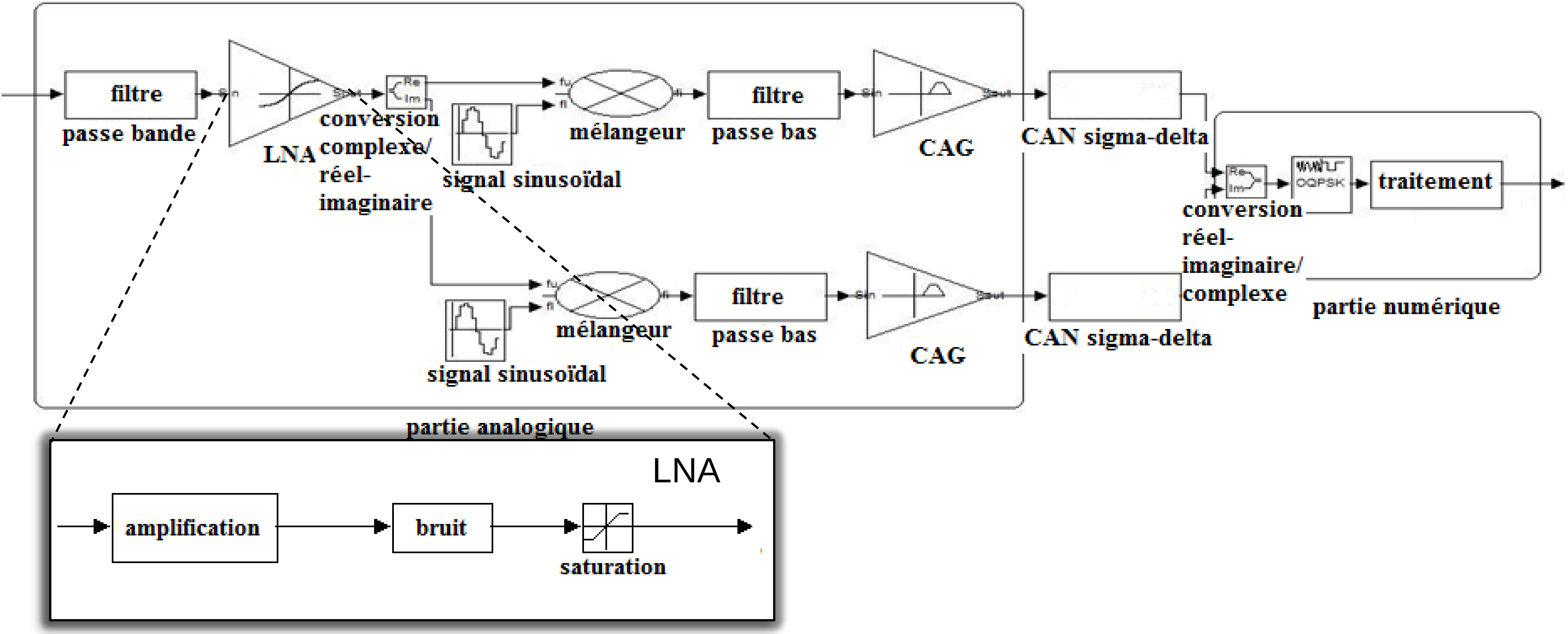
Modeling of an RF receiver



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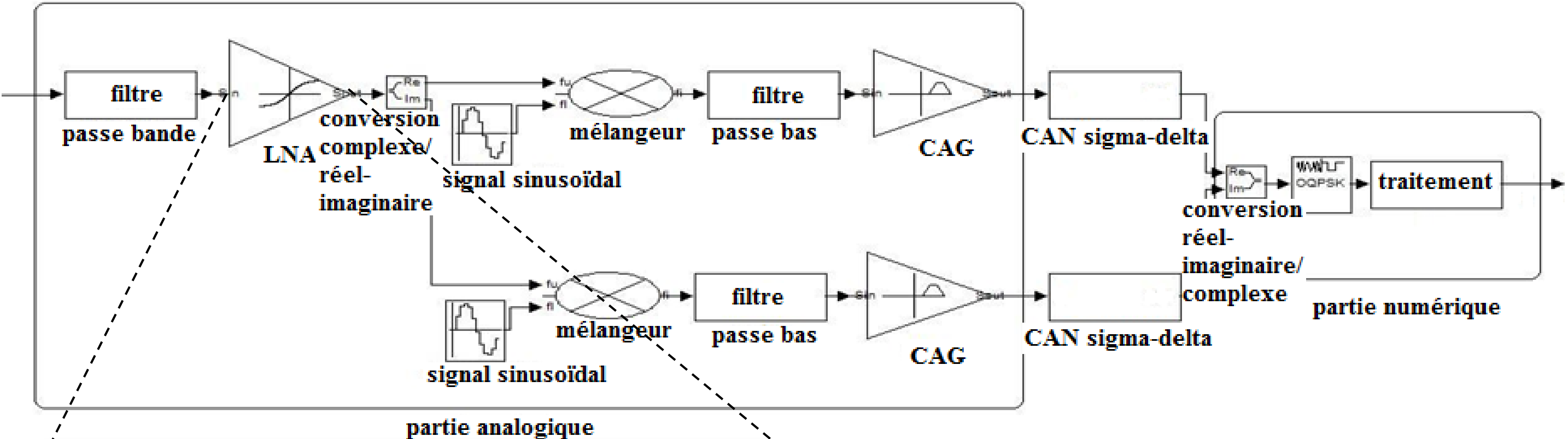
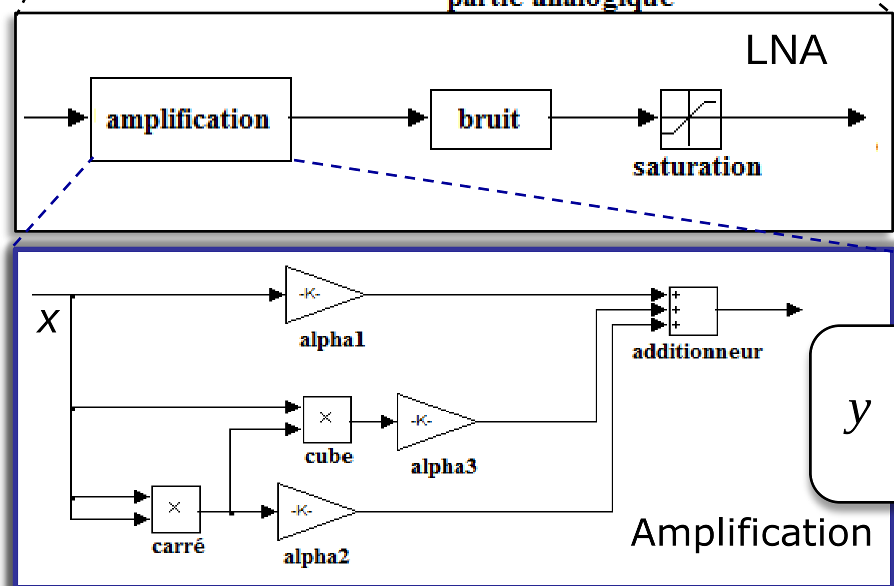
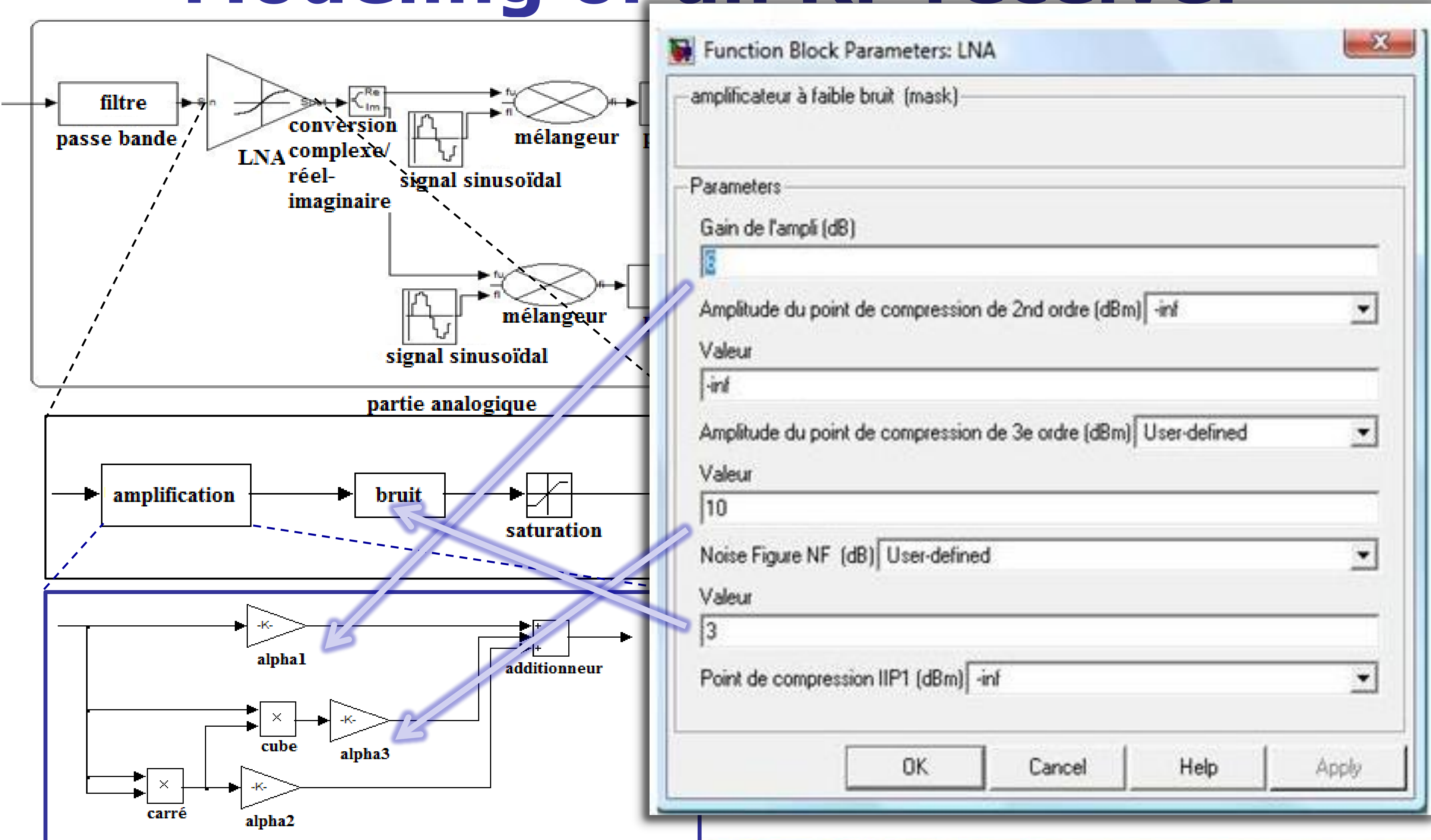
Modeling of an RF receiver





$$y(t) = \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t)$$

Modeling of an RF receiver



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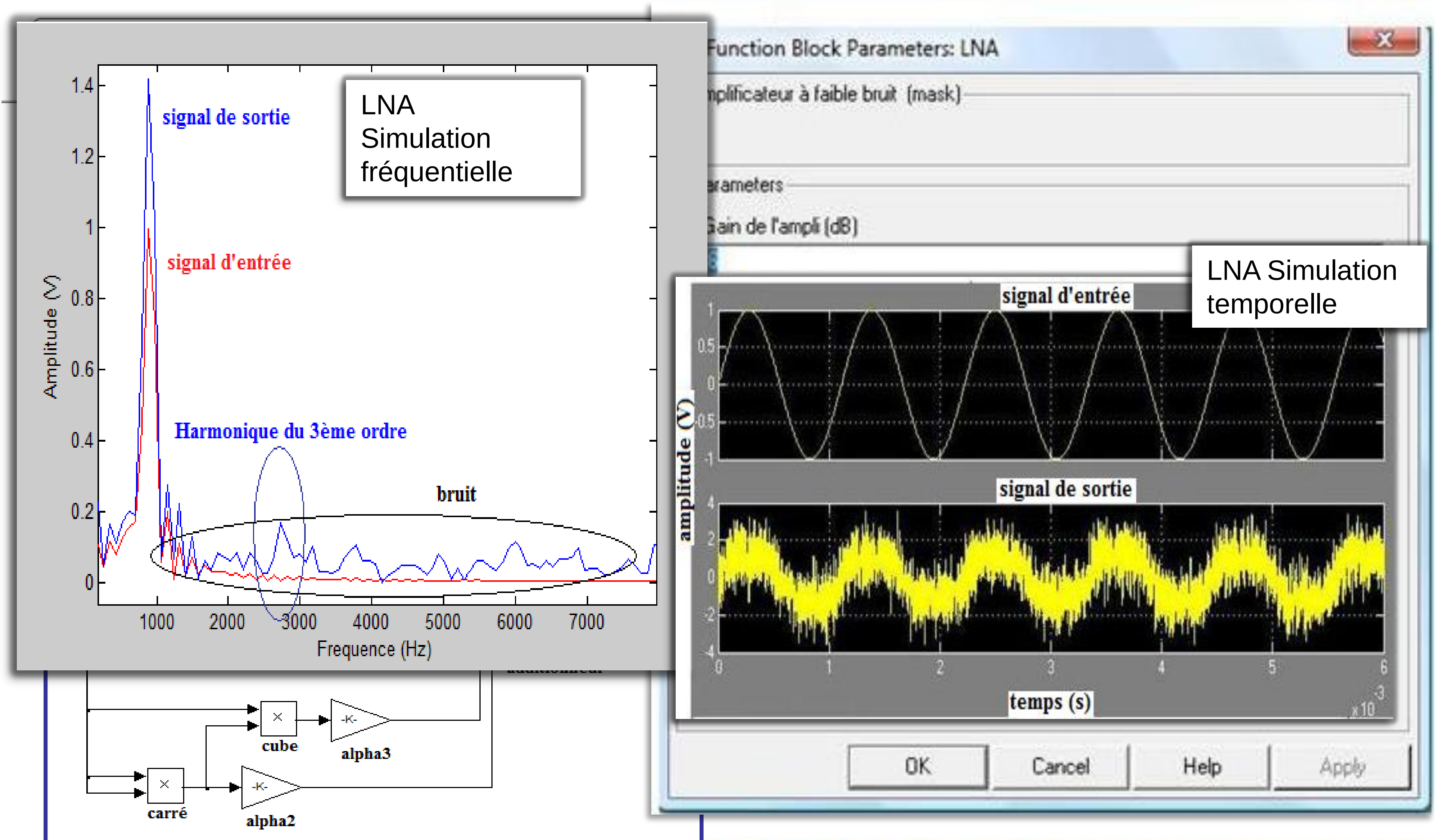
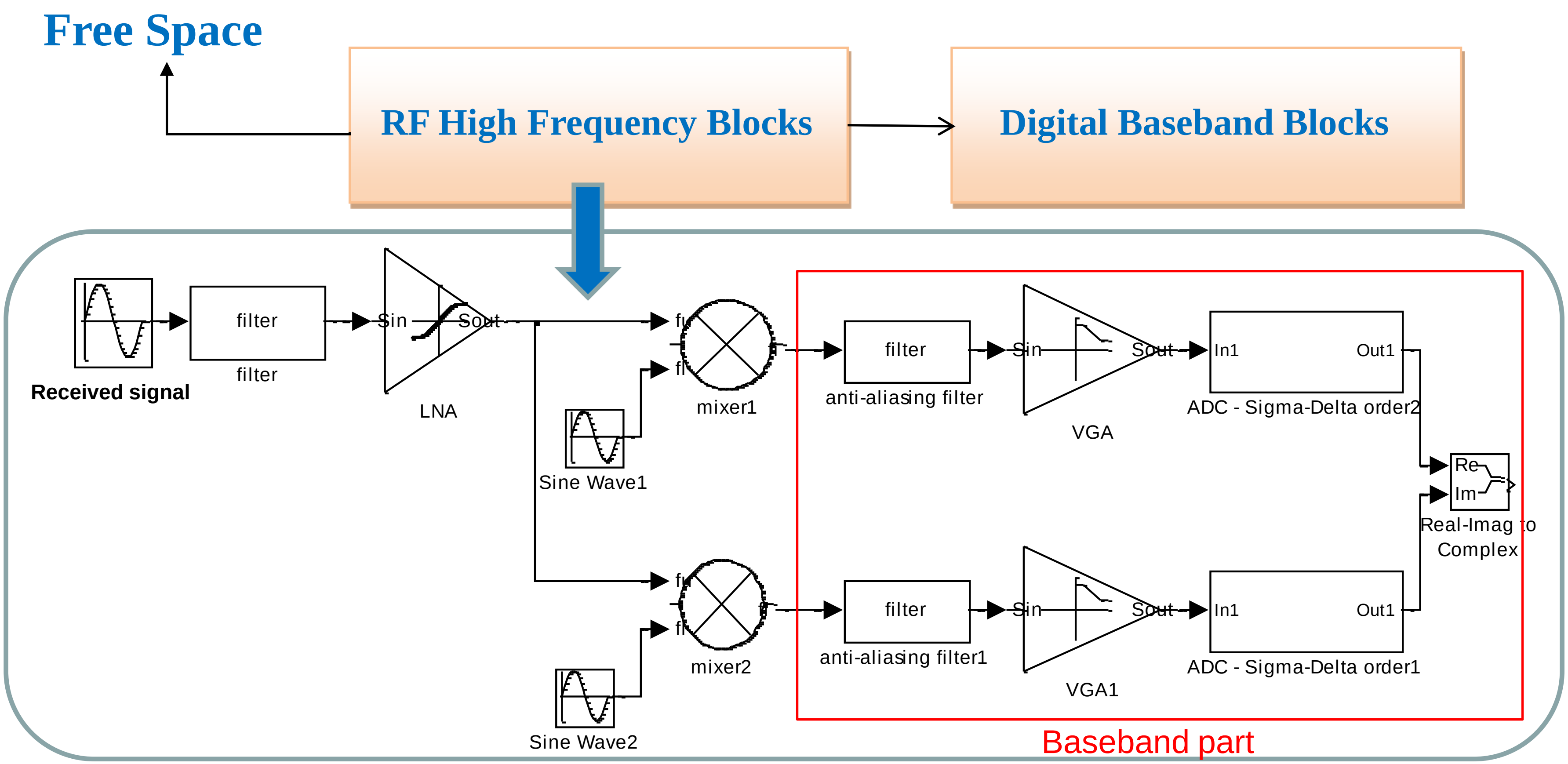
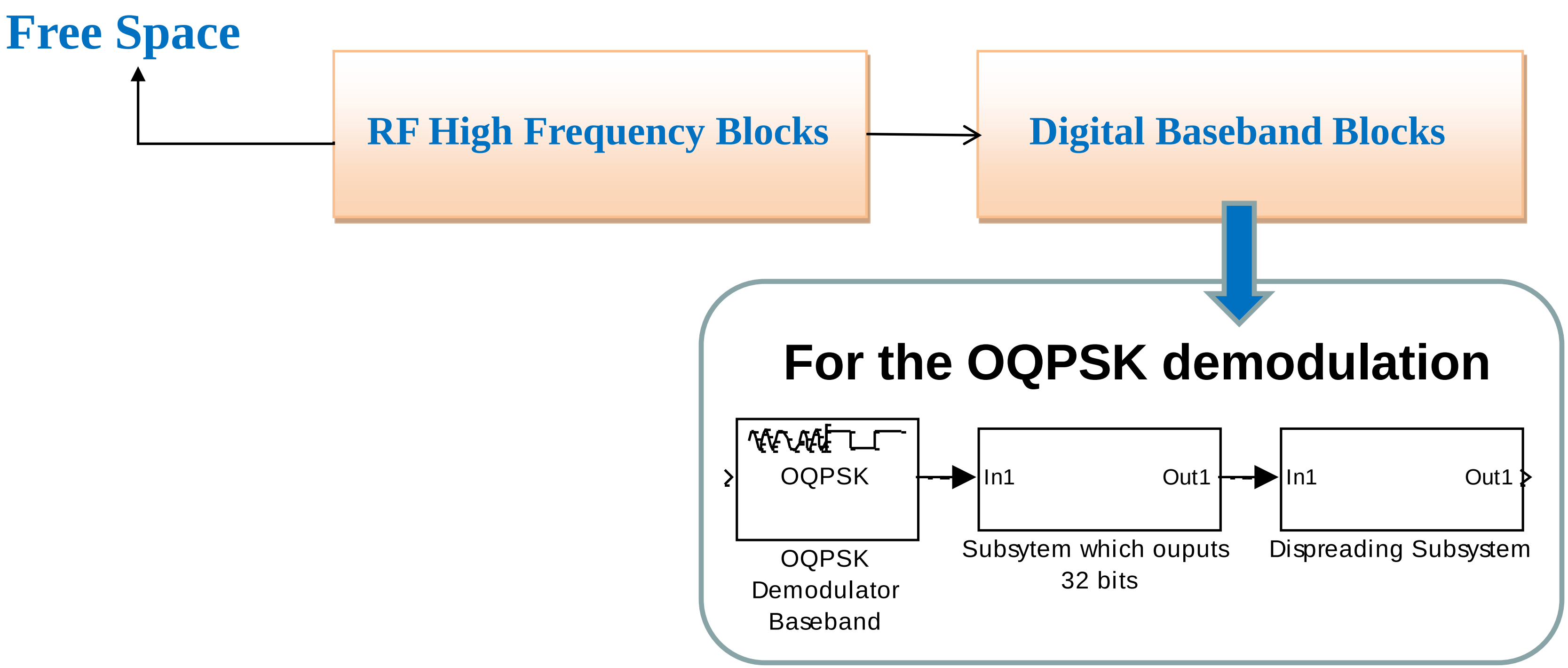
Test of a component



Test of a receiver



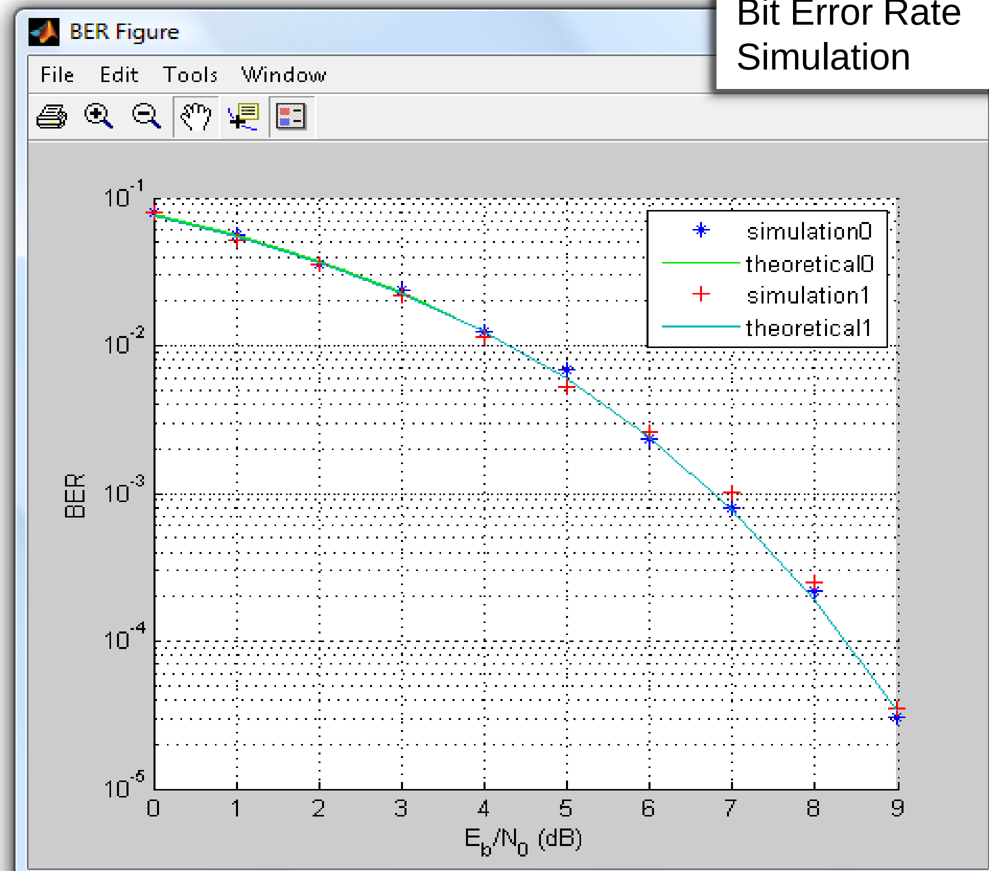
Test of a receiver



Test of a receiver

Free Space

RF High Fre



Bit Error Rate Simulation

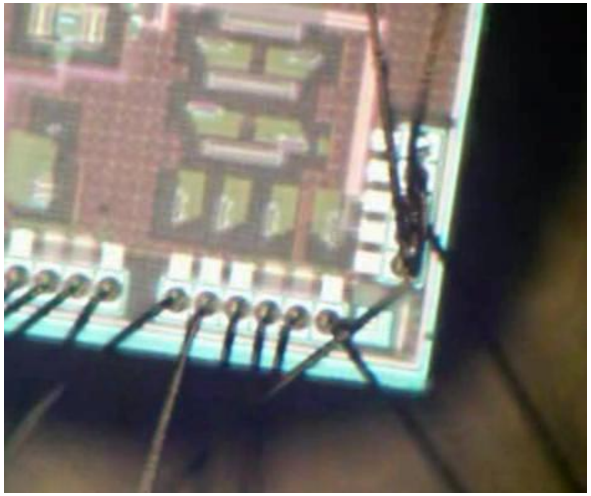
-**"Simulation 0"** refers to the **BPSK** chain

-**"Simulation 1"** refers to the **OQPSK** chain

- "Theoretical 0 and 1" refer to the **theoretical curves of the BPSK and OQPSK**

Exemple 2 : calcul de la spécification

Consist in determining the parameters or the constraints of each block, so that the complete chain meets a standard.



For example, for a Analog to Digital Converter (ADC), it is necessary to determine the noise level and the dynamics of the signal at its entry.

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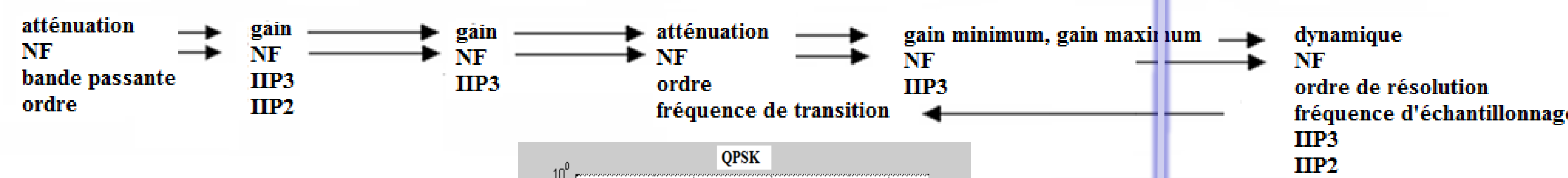
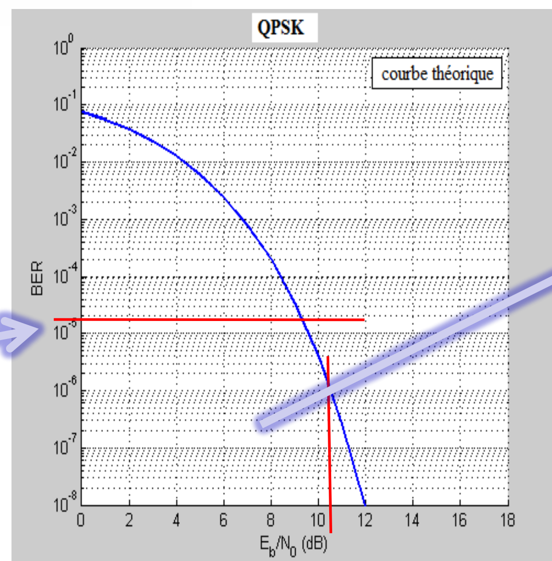
Calculation of the specification

Model of Receiver

Parameters





$$PER = 1-(1-BER)^N$$

$$N = 32 \Rightarrow BER = 0,3\%$$

$$NF = SNR_{in} - SNR_{out}$$

$$SNR_{out} = \frac{E_b}{N_0} - 10\log\left(\frac{B}{D}\right)$$

Bande passante d'un canal B	**2 MHz**
Débit binaire D	**250 kbit/s**

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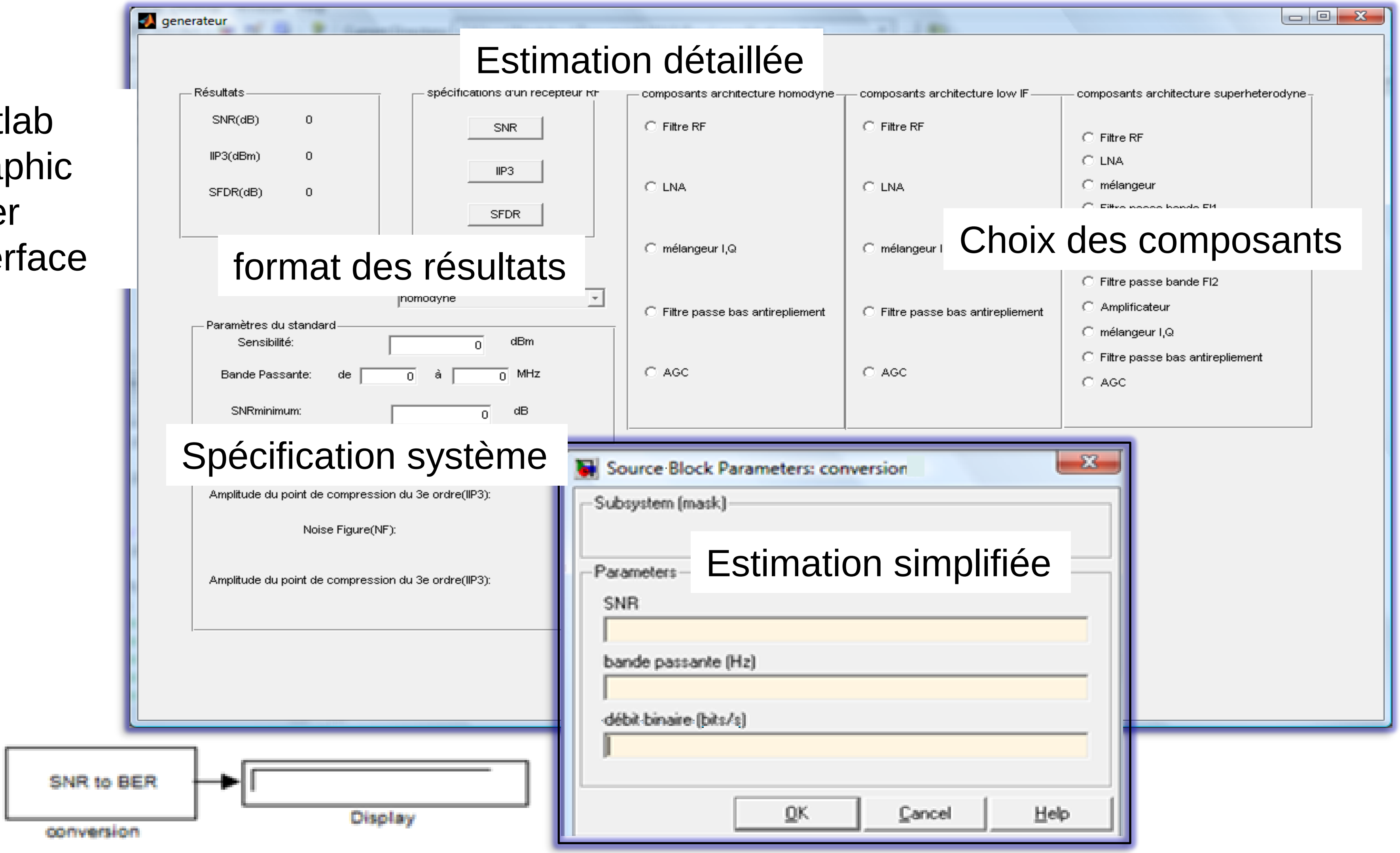
Calculation of the specification

Matlab
Graphic
User
Interface



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Summary, Future work

- Development of a toolbox allowing the validation of a transmission chain, architectural exploration and verification of a specification.

- Application: simulation of RF terminals in accordance with the standard IEEE.802.15.4

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Summary, Future work

- Making the link between behavioral parameters and physical parameters in order to automate the impact of each other.

- Integrate the physical layer in a Platform for Wireless Protocols Design Explorations.

Questions?

Thanks for your attention !

Dimensionnement d'un récepteur homodyne RF

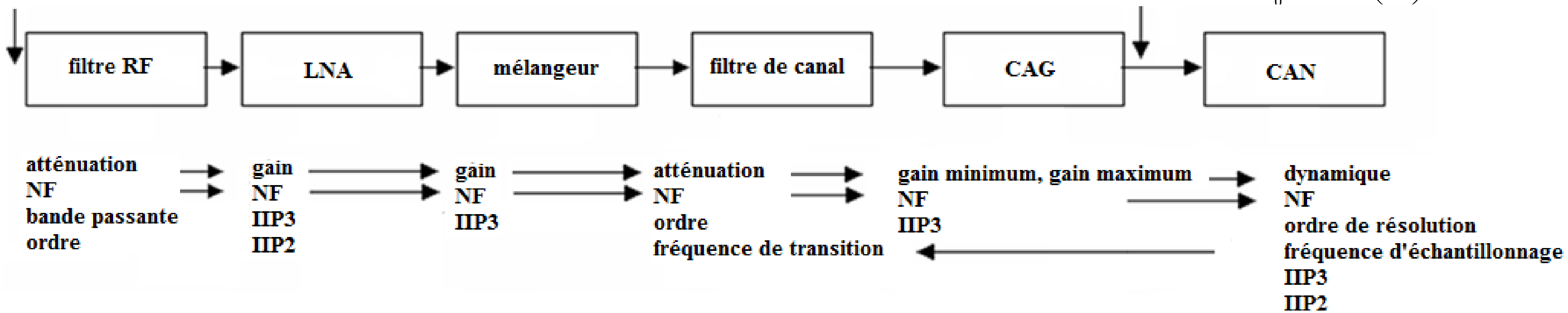
$SNR_{in} = S - N_t$

$N_t = 10\log(kBT)$

$$F = 1 + F_{RF} - 1 + \frac{F_{LNA} - 1}{G_{RF}} + \frac{F_{mix} - 1}{G_{LNA}.G_{RF}} + \frac{F_{AA} - 1}{G_{mix}.G_{LNA}.G_{RF}}$$

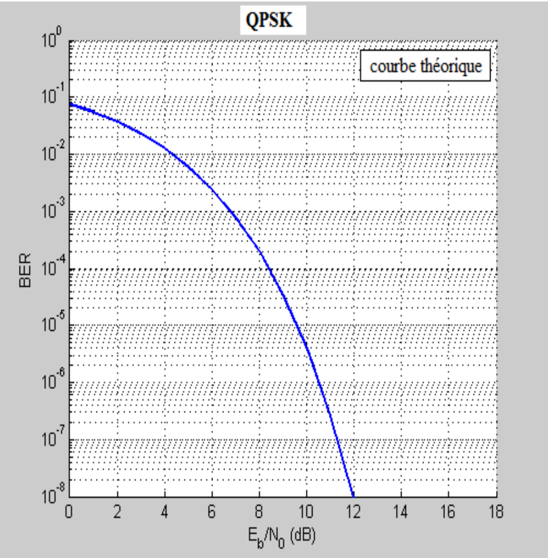
$NF = SNR_{in} - SNR_{out}$

$$SNR_{out} = \frac{E_b}{N_0} - 10\log\left(\frac{B}{D}\right)$$



Bande passante d'un canal B	2 MHz
Débit binaire D	250 kbit/s
Sensibilité du récepteur S	- 85 dBm
Valeur maximale du signal S_{max}	- 20 dBm
PER	1%

$PER = 1 - 1 - BER^{N}$ ⟹ $N = 32 \Rightarrow BER = 0,3\%$



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Calcul des spécifications

bruit

gain

non-linéarités

Équations

$$F = 1 + F_1 - 1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 . G_2} + \frac{F_4 - 1}{G_1 . G_2 . G_3} + \dots$$

$$NF = 10 \log F \qquad SNR_{in} = S - N_t \qquad SNR_{out} = SNR_{in} - NF$$

$$\frac{1}{A_{IP3}^2} \approx \frac{1}{A_{IP3,1}^2} + \frac{G_1^2}{A_{IP3,2}^2} + \frac{G_1^2 . G_2^2}{A_{IP3,3}^2} + \dots$$

Calculs

$$SFDR = \frac{2}{3} \; IIP3 - S_{min} \qquad S_{min} = N_t + NF$$

La plus grande dynamique du signal à la sortie de la partie analogique

Optimisation

Spécification

$$\frac{E_b}{N_0} = SNR_{out} + 10 \log\left(\frac{B}{D}\right)$$

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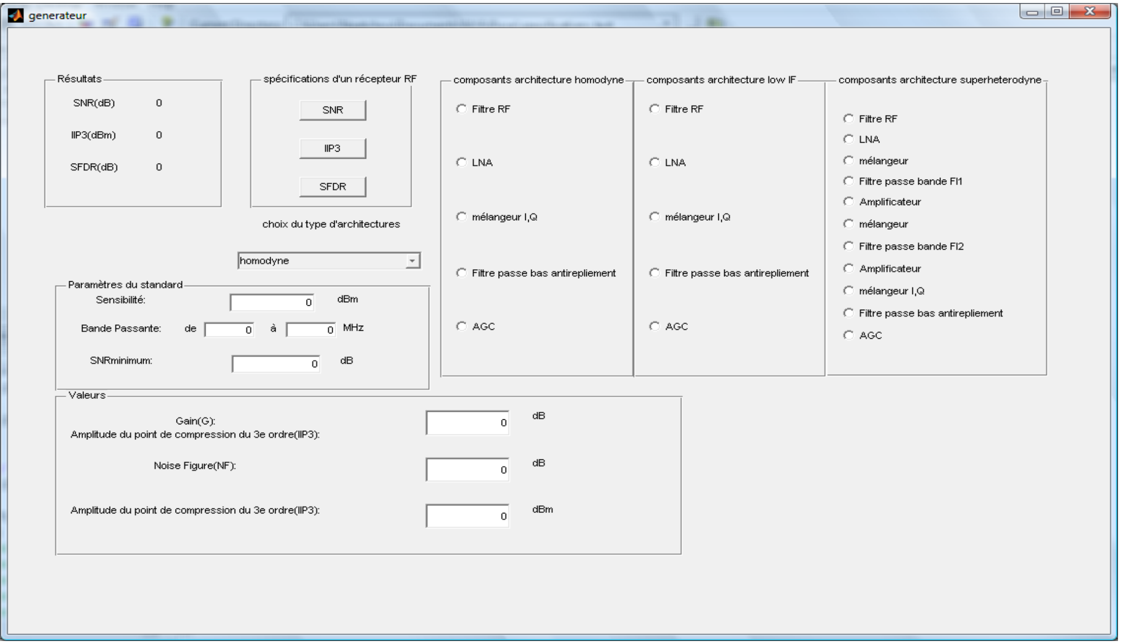
Calcul des spécifications



$$F = 1 + F_1 - 1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1.G_2} + \frac{F_4 - 1}{G_1.G_2.G_3} + \ldots$$

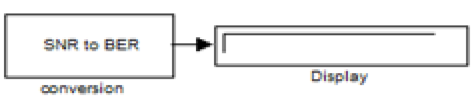
$$NF = 10\log F \qquad SNR_{in} = S - N_t \qquad SNR_{out} = SNR_{in} - NF$$

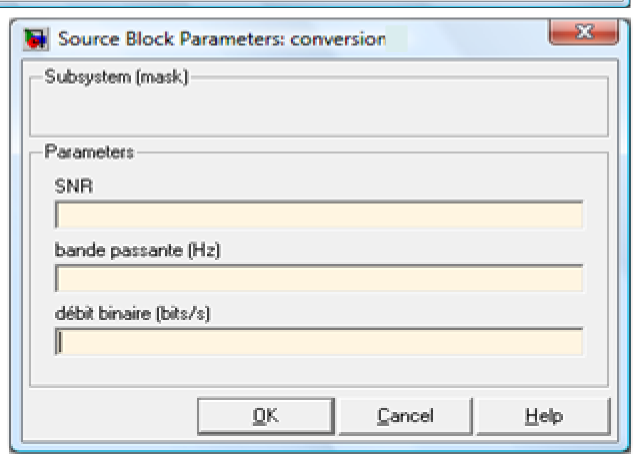
$$\frac{1}{A_{IP3}^2} \approx \frac{1}{A_{IP3,1}^2} + \frac{G_1^2}{A_{IP3,2}^2} + \frac{G_1^2.G_2^2}{A_{IP3,3}^2} + \ldots$$

$$SFDR = \frac{2}{3}\left(IIP3 - S_{\min}\right) \qquad S_{\min} = N_t + NF$$

$\Downarrow$

La plus grande dynamique qui ne génère pas de bruit supérieur au plancher de bruit





$$\frac{E_b}{N_0} = SNR_{out} + 10\log\left(\frac{B}{D}\right)$$