



New Architecture Exploration for Radio Design using COSIDE®

SystemC-AMS & COSIDE® UGM - Munich

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On going projects in Thales

CONTACT, Europe's largest software-defined radio program

- Addressed to the whole French army
- Unique collaborative fight feature

Continuous innovations in all radio bands

- Internet in HF band
- Multi-bands radio
- Video on soldier's radio
- Satcom terminals in Ka band



Customer's expectations

Whatever the product (civil and defense)

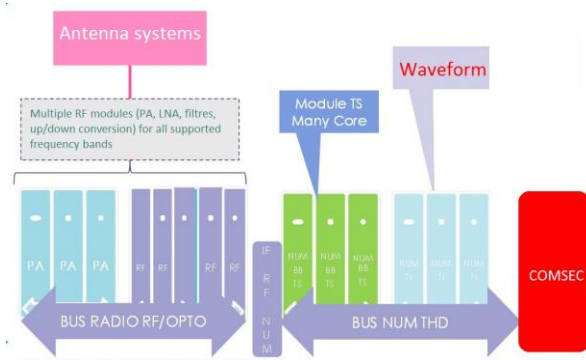
- More features (multi bands, multi modes, scalability, modularity)
- More bandwidth (tactical com : from few kHz up to 1GHz)
- More compact → Miniaturizing RF parts
- Less consumption → improve autonomy

→ New Radio Chain architectures becomes more and more complex with an increasing part of digital and digitized functions in RF

- Traditional analog vs Highly digital architecture (RF, analog, digital to enhance RF)

Different level of Virtual prototyping expectation

➤ Level 1 : system level Virtual Prototyping



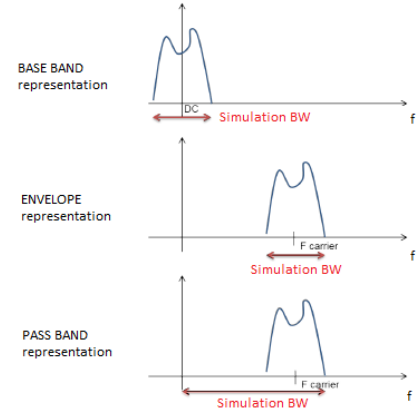
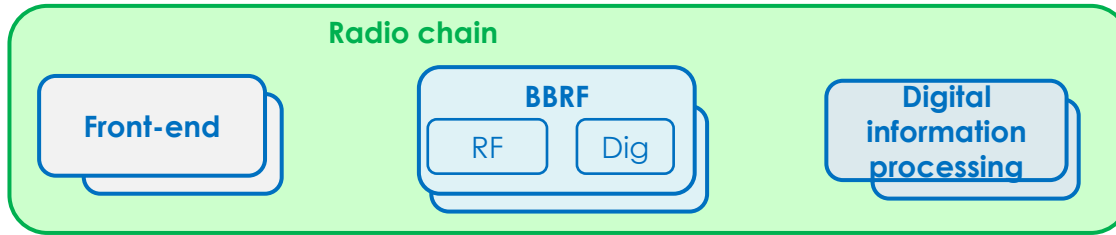
- Involving **both Hardware** (RF, analog, conversion) and **Firmware** (FPGA, DSP)
- Digital requirements (eg #cores)
- RF requirements (power, linearity, ...)
- Interfaces (data rate, BW)

➔ **Can the global system handle one or several given waveforms ?**

Customer's expectations

Different level of Virtual prototyping expectations

➤ Level 2 : Radio architecture exploration



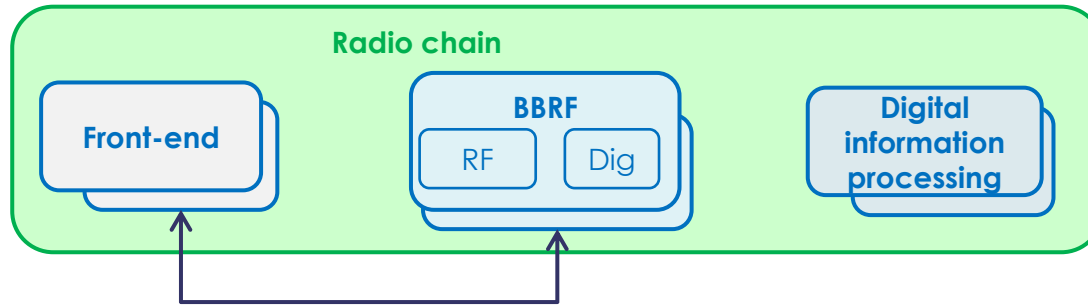
➤ Explore quickly a wide range of possible architectures based on several criteria, eg :

1. Criteria : $NF < 10\text{dB}$ and a $\text{MIN} < \text{signal level @ ADC input} < \text{MAX}$
2. More than 1000 possible configurations computed
3. 5 configurations remaining (all criteria completed)
4. Deeper analysis of these 5 config @ Level 3

So far : PASS BAND (intuitive but huge time of computation)
➔ Next step : ENVELOPE data type

Different level of Virtual prototyping expectations

➤ **Level 3** : Accurate modelling & simulation of selected configurations (from Level 2)



- More accurate models (additional non-linear effects, parameters dispersion, Temperature effect, time response, ...)
- Introduction of S-parameters models (matching impedance, more real RF behavior) coming from measurements or components providers
- Dynamic behavior (Matlab AGC & ALC algorithm import, waveform added)

Current methodology

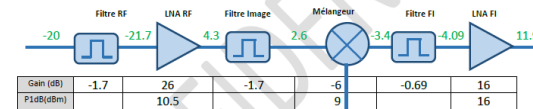
Not unified methodology

- A lot of modeling and simulation tools (Excel, SystemVue, MATLAB/Simulink, Cadence, Mentor, etc.) to cover all trades (RF, digital, system, etc.) but not connected together to cover all simulations needs
- Often usable only by specialists and expert (i.e. Excel sheet with “personal” macro)

Hard to share information between teams and between trades (SW/HW and Analog/Digital) during all design cycle

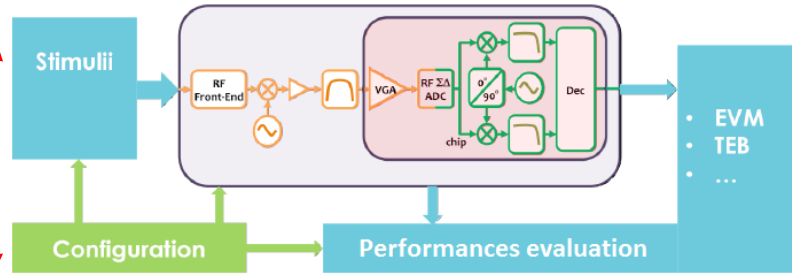
Interest in a Modelling & Simulation tool that :

- Make Radio system modelling, simulation, design more efficient (Design ROI)
- Cover RF, analog and digital system functions
- Model import/export with other simulation tools (i.e. Matlab legacy model)
- Able to cover different level (granularity) of modelling



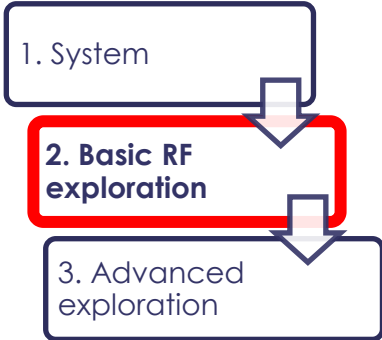
Virtual Prototyping of Radio Chain with COSIDE®

CW, 2 tons, modulated signal, w/wo jammer, ...



- Input stimuli (bandwidth, level, frequency)
- Performances evaluation tools
- With 1 script :
 1. Changing dynamically parameters of the RF chain
 2. Run simulation
 3. Save and organize results

- Computing (at a given stage of the RF chain) static and dynamic performances
 - Cumulated gain, NF, IIP2, IIP3
 - EVM, TEB
- Display features
 - Time domain signal
 - Frequency domain signal (spectrum analyzer)



Virtual Prototyping of Radio Chain with COSIDE®

SOURCE
(TX chain + channel)

RF bandpass filters
(depending on selected RX channel)

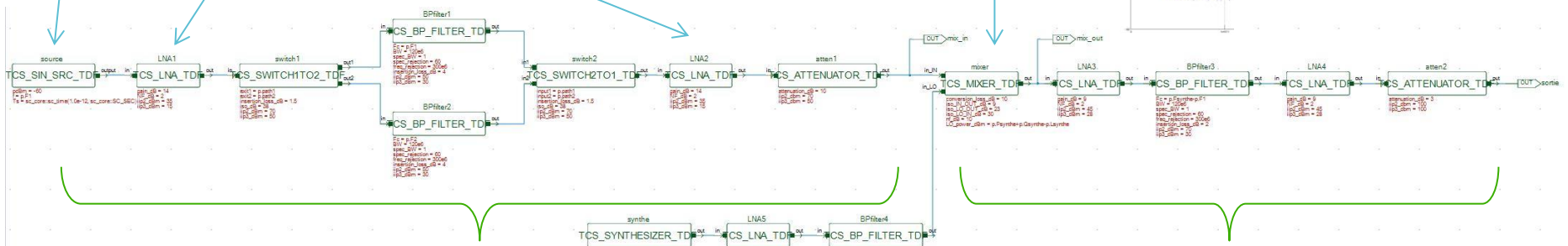
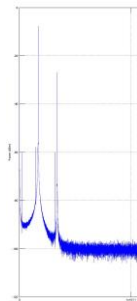
RF mixer
(down conversion from RF to IF)

LNA

1. System

2. Basic RF exploration

3. Advanced exploration

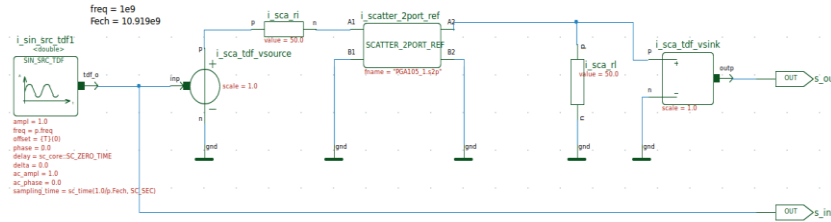


RF part ($\approx 20\text{GHz}$) \rightarrow very small simulation step required ($\approx 1\text{ ps}$)

IF part ($\approx 2\text{GHz}$) \rightarrow can afford a larger simulation step but still very small

Synthesizer

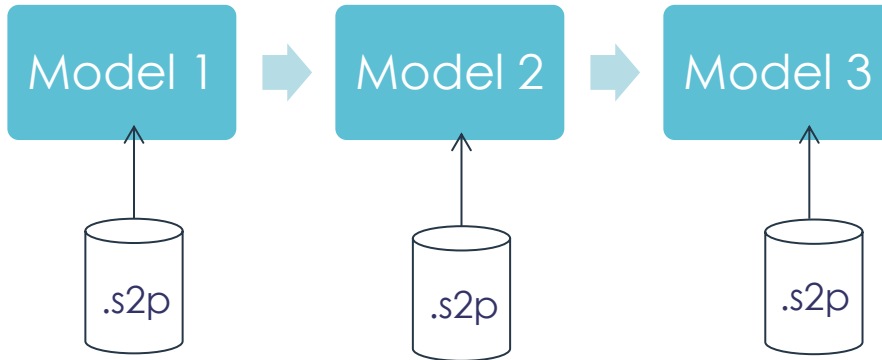
Scattering parameters module



1. System

2. Basic RF exploration

3. Advanced exploration



Level 3 (Advanced exploration):

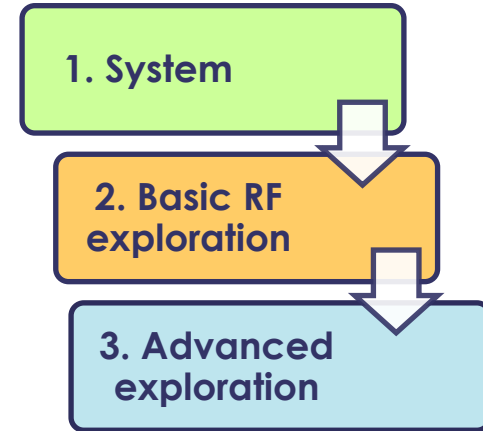
- Whole chain with S-parameters (Integration of COTS components S-parameters)
- Refine Level 2 models (additional parameters and accurate behavior)
- Mixed between S-parameters and refine models

Benefits for THALES

- Exploring quickly a wide range of scenario
- Find the best architecture (based on one or several criteria)
- Validate system's performances
- Start integration far before RF board or ASIC conception

Next steps for THALES

- Level 1 simulation
- Level 2 simulation with Envelope representation & coupling with Matlab
- Level 3 with more accurate models



THALES

Thanks for your attention

QUESTION ?

www.thalesgroup.com

