SIMULIM Platform

Simulation, Integration, Modelling at the University of LIMoges

System Simulation Integration and Modeling

S. Mons, A. Beaumont, E. Ngoya

XLIM – UMR CNRS - Université de Limoges, 123
av. A. Thomas, 87060 Limoges, France

Outline

Xlim lab

Context - Problematic of RF Frontend simulation

SIMULIM Platform (Xlim lab

SCERNE tool

Simulation Concept Simulim
Basic functionalities
Architecture

VISION tool (Amcad engineering)

Conclusion

XLIM : A Multidisciplinary research institute

institut de recherche

6 Research Departments

2 Platforms for Optical and Microwave

- *Technology & Instrumentation (PLATINOM)*
- *Modeling & Simulation (SIMULIM)*

5 Cross-MultiDisciplinary Programs

1 Emerging Team

4 joints laboratories

- *MITTIC (3-5 Lab), AXIS (Thales Alenia Space)*
- *NXL (NXP), LEV3E (CEA Gramat)*

XLIM : Unit created in january 2006

Since 2004

14 start-ups created

Since 2009:

scientific production per year ≈ 500
PhD students per year ≈ 45

The strengths of XLIM

Electronics & High Frequency
Components to sub-systems

Optics
Photonics

Mathematics
Computer science
Image

Challenges

Communication: Civil, space, military

Autonomous Communicating objects

Secured environments

Bioengineering
&
Health

Université de Limoges

CAD Platform for RF Systems Modeling & Design

Build a world renowned expertise on numerical techniques for analog and high frequency system modeling

- Mathematical modeling (optimization and nonsmooth analysis)
- Electromagnetic simulation methods (antenna, packages, filters, IC, EMC, ..)
- Multiphysics simulation methodologies for (nanodevices, MEMS, packaging, ..)
- RF Circuit simulation method (Spice, harmonic balance, envelope transient, ..)

Develop top-down design and bottom-up hierarchical behavioral modeling techniques, methodologies and tools for complex systems

Provide internal and external support on simulation and modeling for the optimal design of RF and electro-optical devices and systems

SIMULIM = Modeling software forge + Modeling tool

(1) Modeling Software forge

Inventory, archiving, diffusion and value-adding on calculation codes

https://forge.xlim.fr/

it gathers services enabling ones to collaboratively develop informatic projects, with many tools which make it easier to manage projects and improve their visibility.

Aims :

- make durable the projects in XLIM and beyond.
- fight again the obsolescence (backup, maintenance, documentation …)

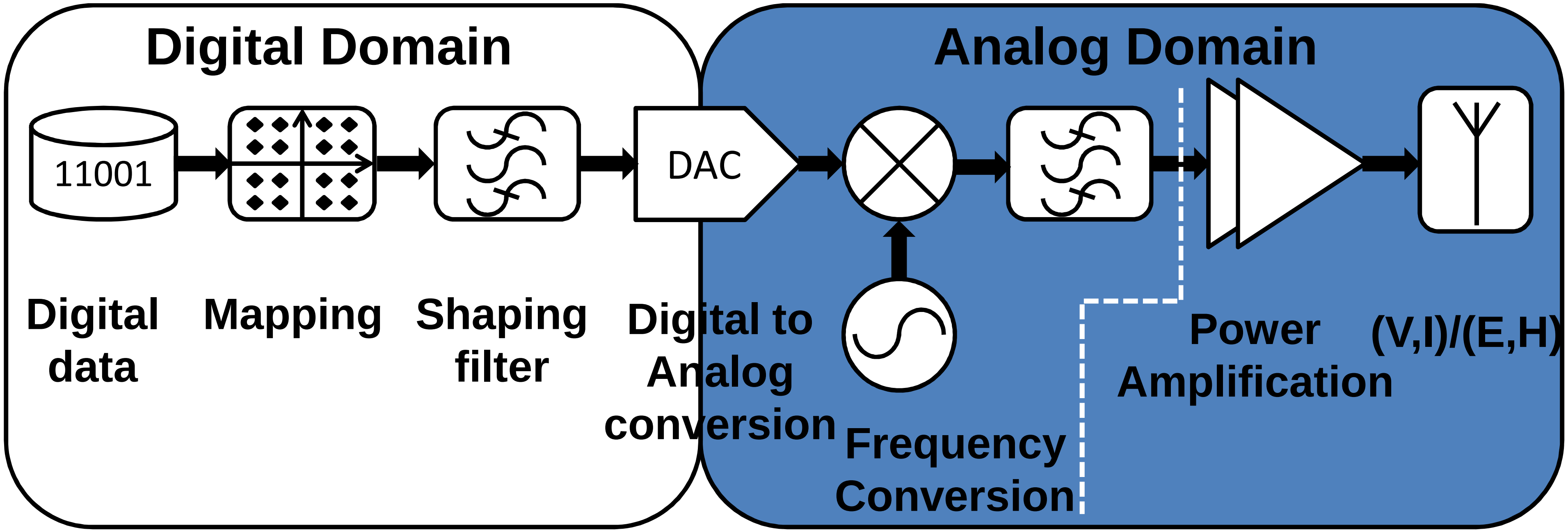
Available tools:

Attached documents (texts, multimedia files ...);
Surveys on the orientations of projects;
Diffusion announces;
A source-code manager (git, mercurial or svn);
A page for downloads (precompiled binaires, etc) ;
A Wiki-style collaborative documentation manager (Mediawiki).

An introduction page;
A page displying activity statistics;
General and thematic forums;
A bug manager; Roadmaps and task-lists; Mailing lists;

Context

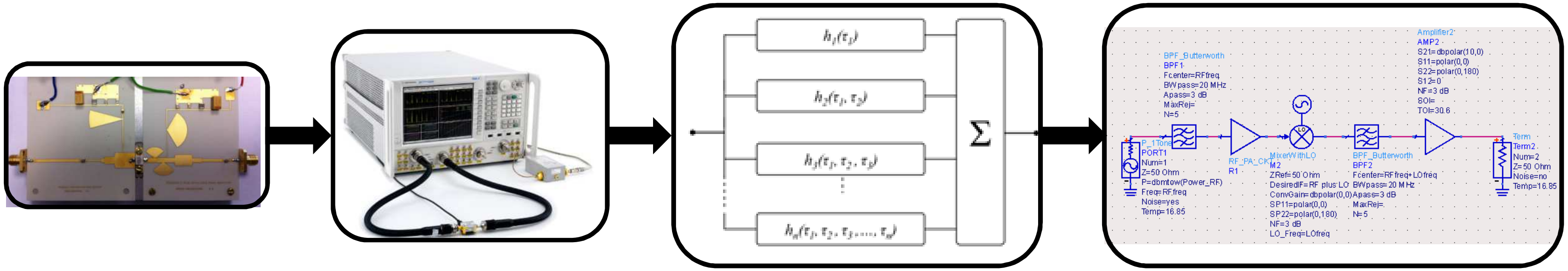
Schematic block diagram of a transmitter



Power Amplifier

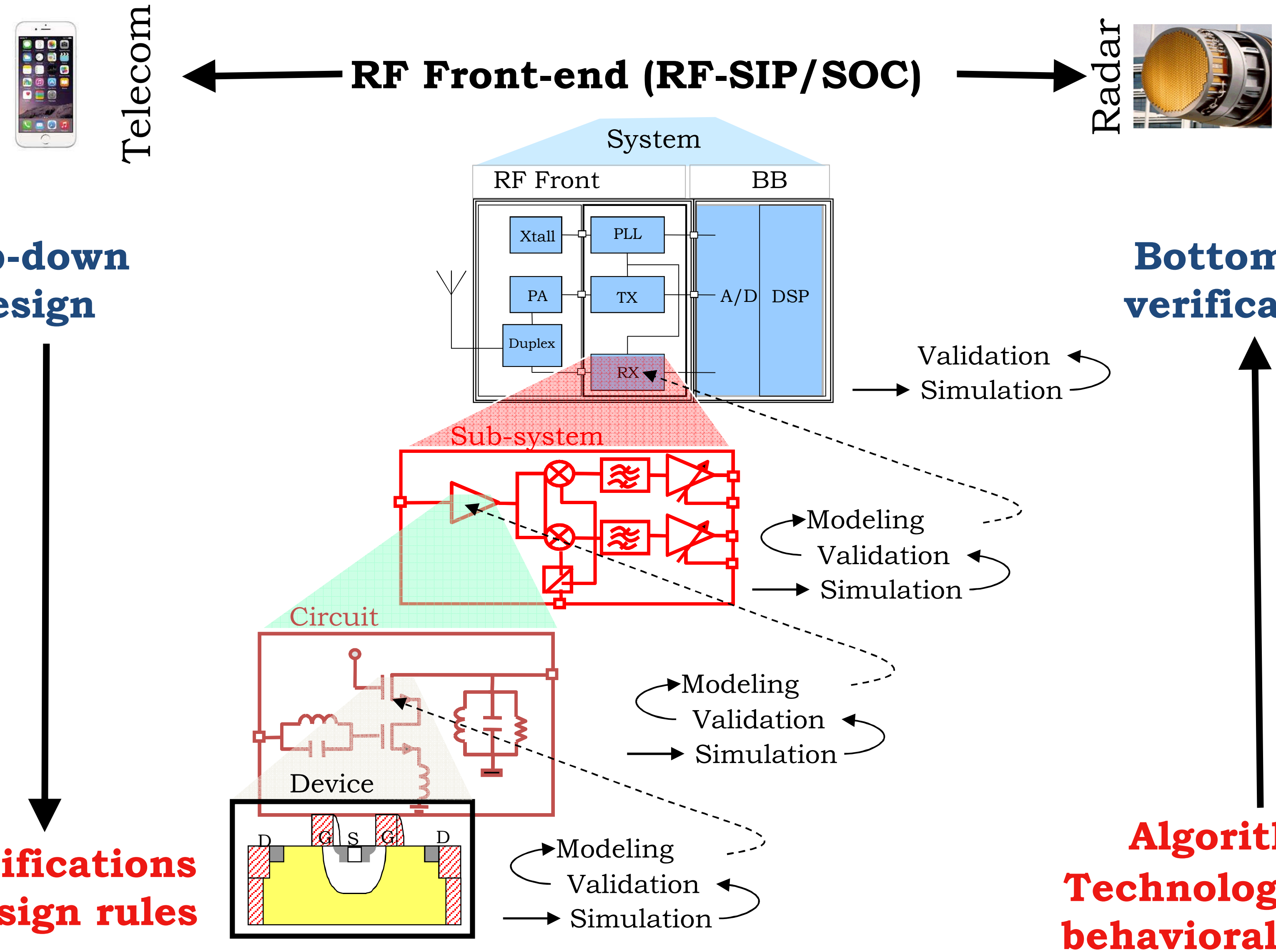
- Critical element of the transmitter linearity and consumption budgets

Modeling flow



Power Amplifier Module	**Characterization Equipment**	**Power Amplifier Models**	**System Simulation & Design**
-Standard -Power -Bandwidth…	-Time domain -Frequency domain -Bandwidth -Cost…	-PHD -TDNN -Volterra models…	-Behavioral model integration -Validation process…

The hierarchical behavioral modeling concept



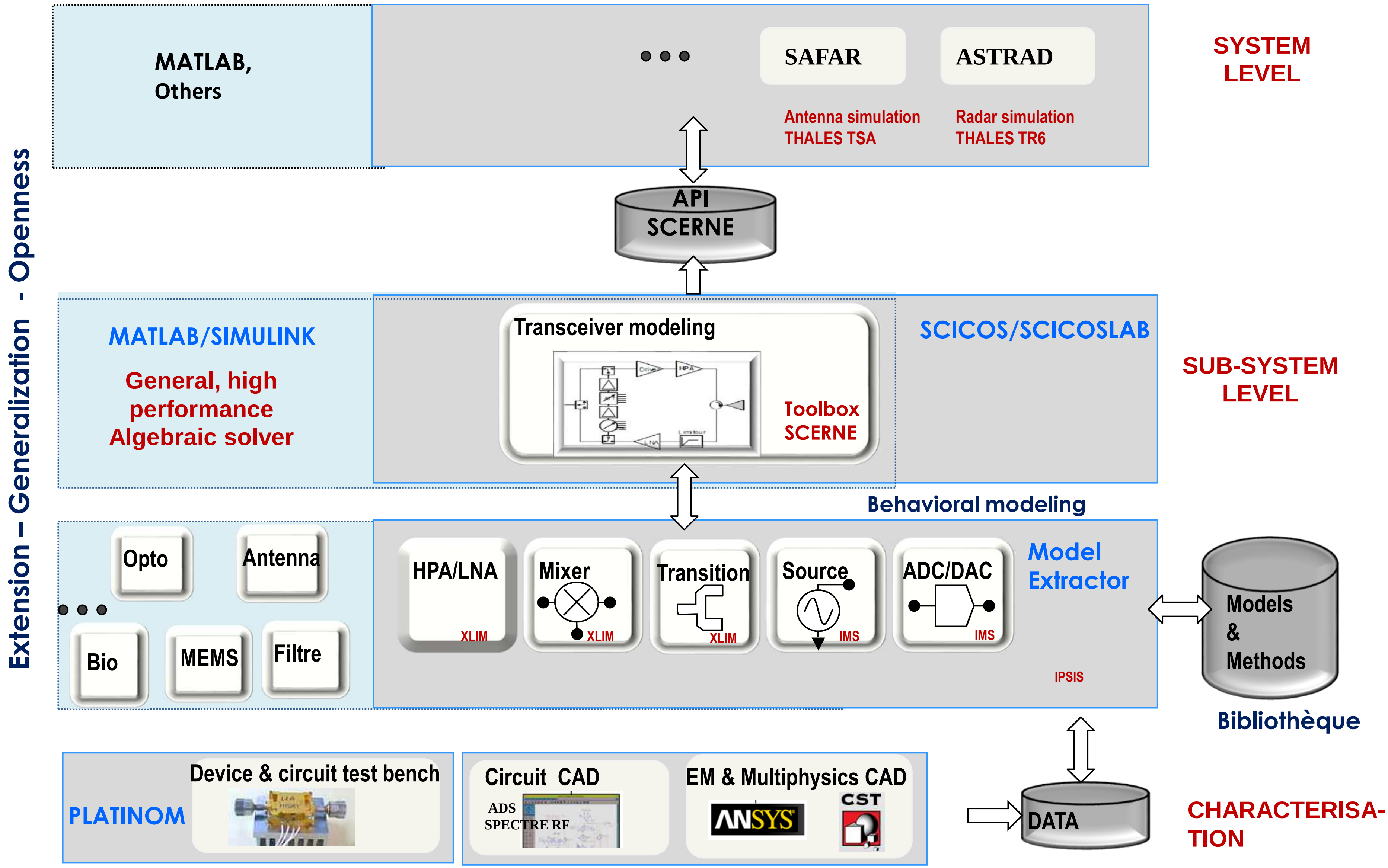
Top-down design

Specifications & design rules

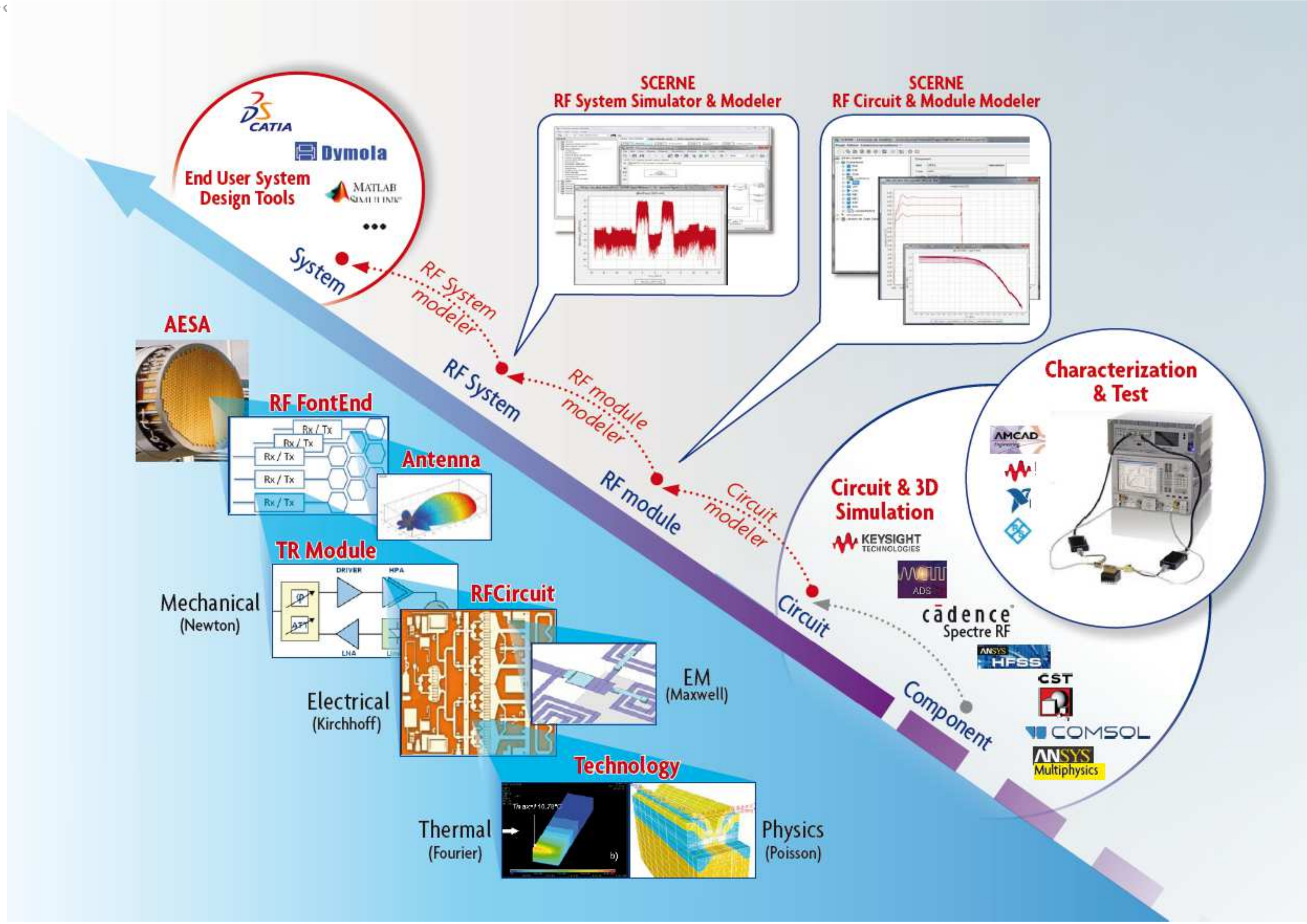
Bottom-up verification

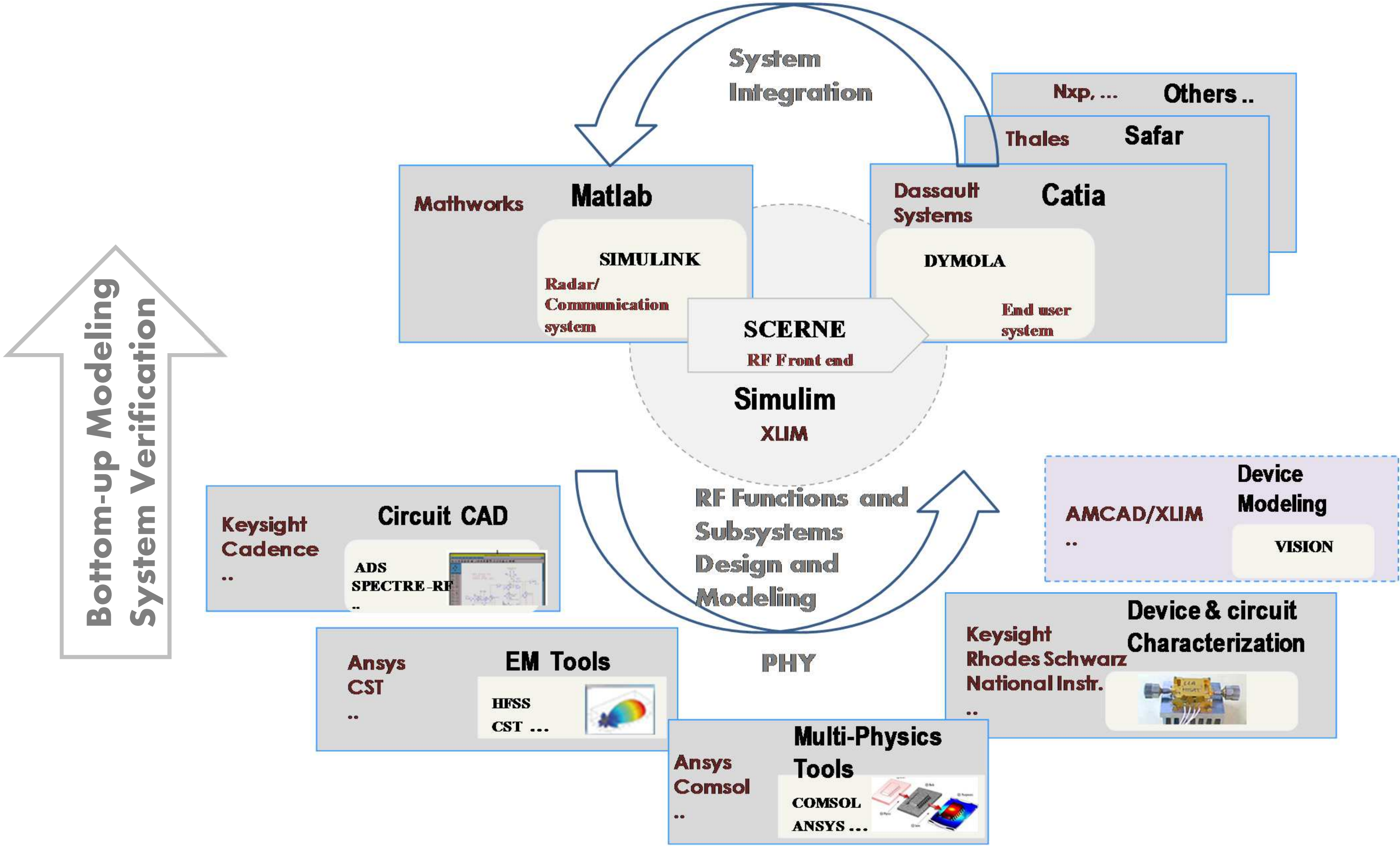
Algorithms, Technology aware behavioral models

SCERNE Tool Evolution : Fin PEA-DGA/2013 → 2015



(2) Simulim Platform




System Integration
Nxp, ...
Others ..
Thales
Safar
Dassault Systems
Catia
DYMOLA
End user system
Mathworks
Matlab
SIMULINK
Radar/ Communication system
SCERNE
RF Front end
Simulim
XLIM
Bottom-up Modeling
System Verification
Keysight
Cadence
..
Circuit CAD
ADS
SPECTRE-RF
..
RF Functions and Subsystems Design and Modeling
AMCAD/XLIM
..
Device Modeling
VISION
Ansys
CST
..
EM Tools
HFSS
CST ...
PHY
Keysight
Rhodes Schwarz
National Instr.
..
Device & circuit Characterization
Ansys
Comsol
..
Multi-Physics Tools
COMSOL
ANSYS ...

Scerne tool

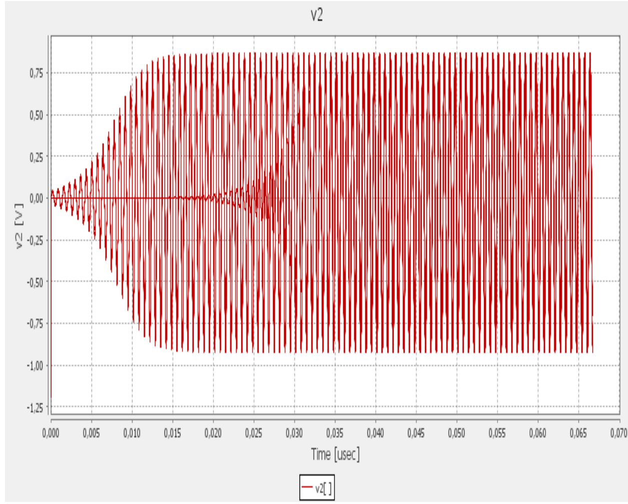
Simulation concepts

$$x(t) = Re\{\hat{X}(t)\, e^{j2p \int_0^t F_x(t)dt}\}$$

Real Signal

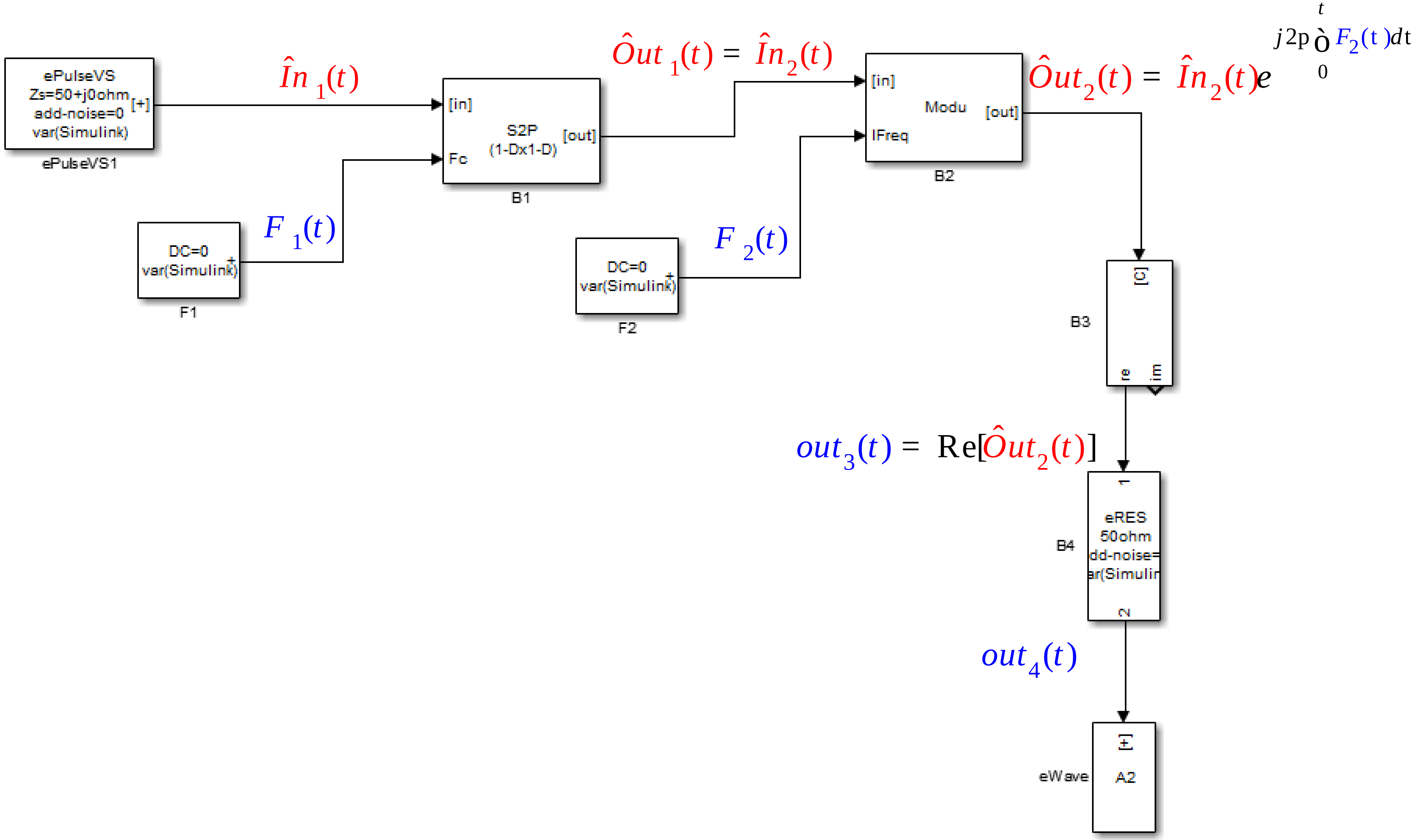
Complex Envelope
=
I-Q Modulation

Carrier frequency



Scerne Allows to combine and handle <u>explicitly</u> x(t), $\hat{X}$(t) and Fx(t) within the same simulation, which offers flexibility and efficiency analysis

Simulation concepts



Simulation concepts

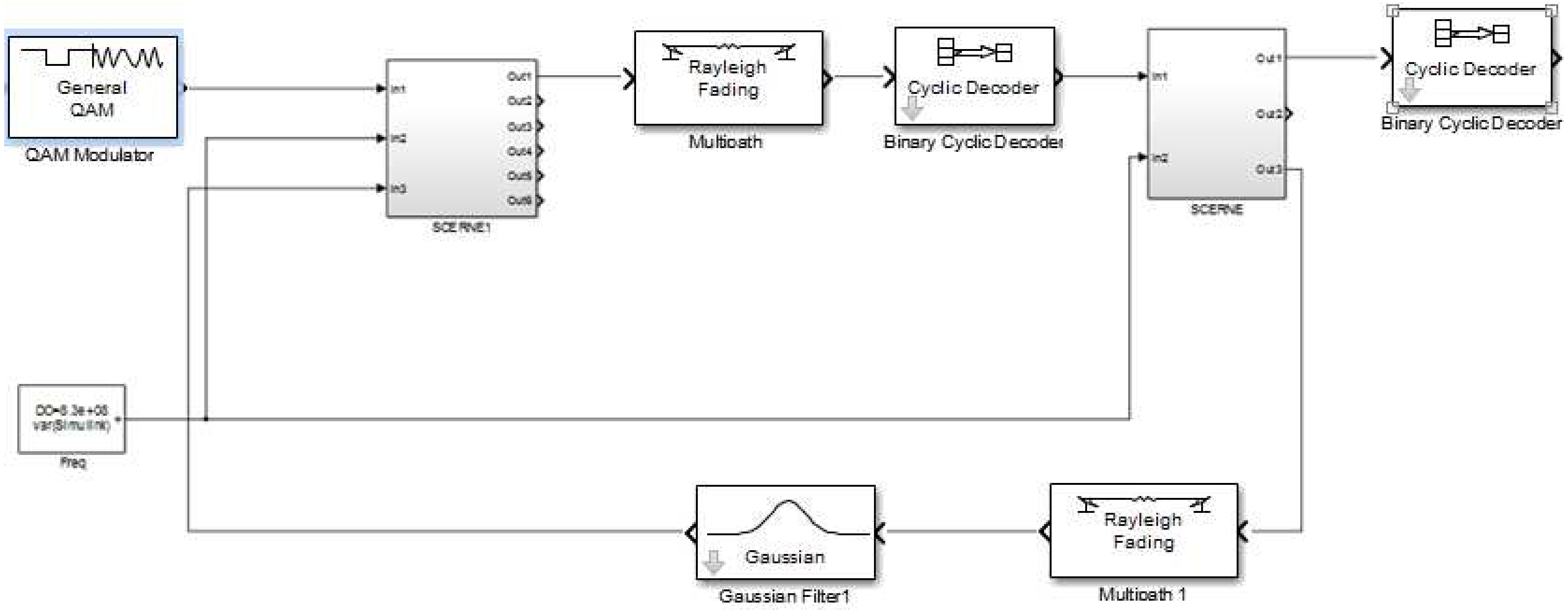
Scerne allows to deal with the concept of impedance (current voltage duality)

→ "Circuit" or Algebric simulation

Scerne can be fitted into the conventional data-flow simulation of SIMULINK

In this flow, SCERNE allows the implementation of "islands" in which the concept of impedance can be taken into account (DAE simulation)

Simulation concepts



Simulation concepts

Scerne implements powerful modeling concepts and a toolbox that allows an effective bottom-up modeling

Scerne integrates an efficient DAE solver, allowing the the system simulation of several thousand fonctions.

Scerne offers a large palette of behavioral models with highly effective processes (ie. multidimensional interpolation functions), particularly useful for behavioral modeling.

Simulation concepts

Models present today were developed on the basis of radio frequency electronic functions … but the principles are general and could also be applied to other physicals , including thermal and mechanical, MEMS , optics, enclosures , cooling …

Scerne gives the opportunity to develop compiled models (C, C ++). Programming templates are available with a Visual Studio project to develop and integrate the DLL model .

Simulation concepts

There is still “infrastructure” work to do in achieving a professional quality.

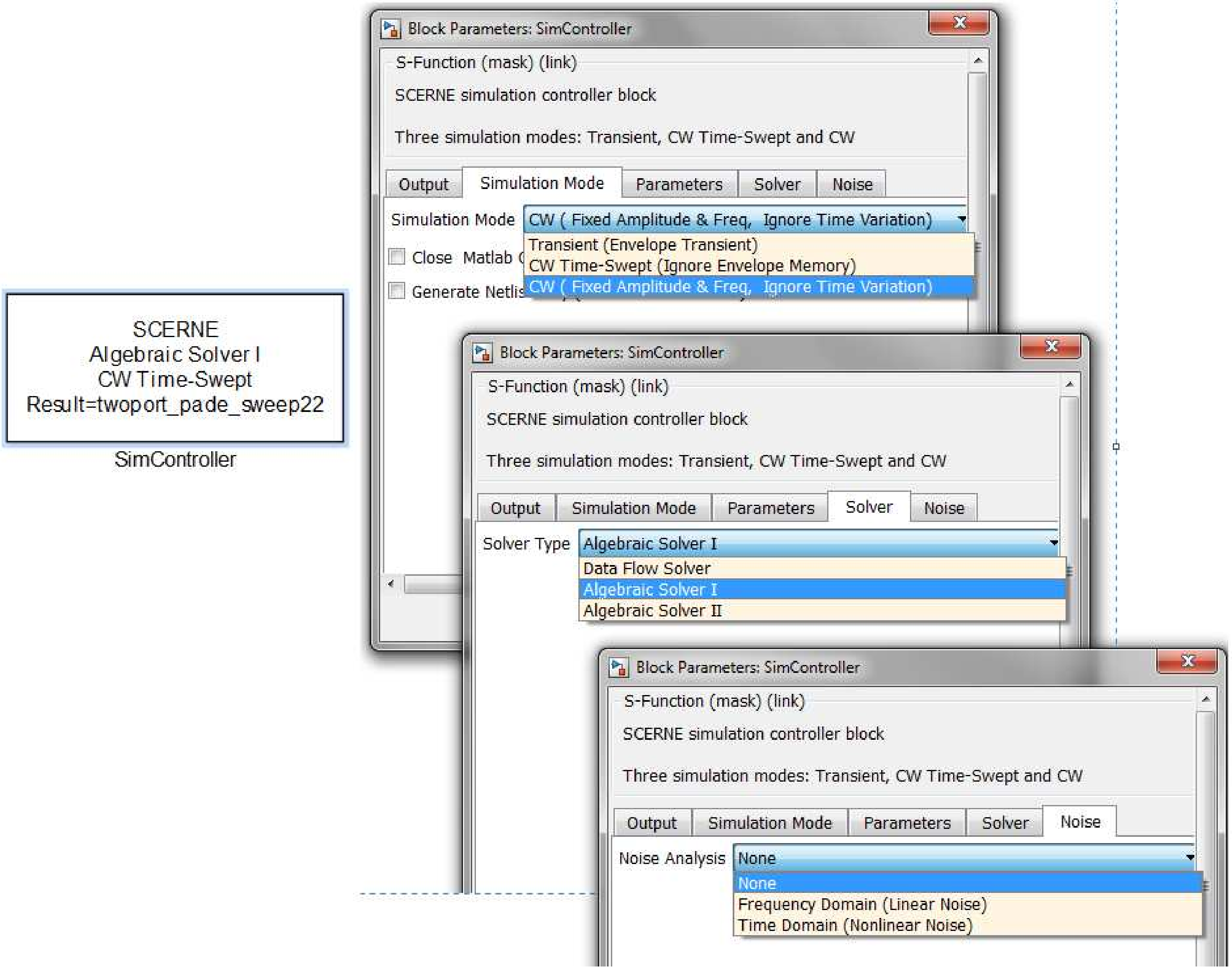
Scerne today offers only a summary documentation
The help of potential users will be appreciated to enrich this documentation !

We have a RAPID ongoing project in collaboration with AMCAD company that will provide professional graphics solution treatment in one or two years .

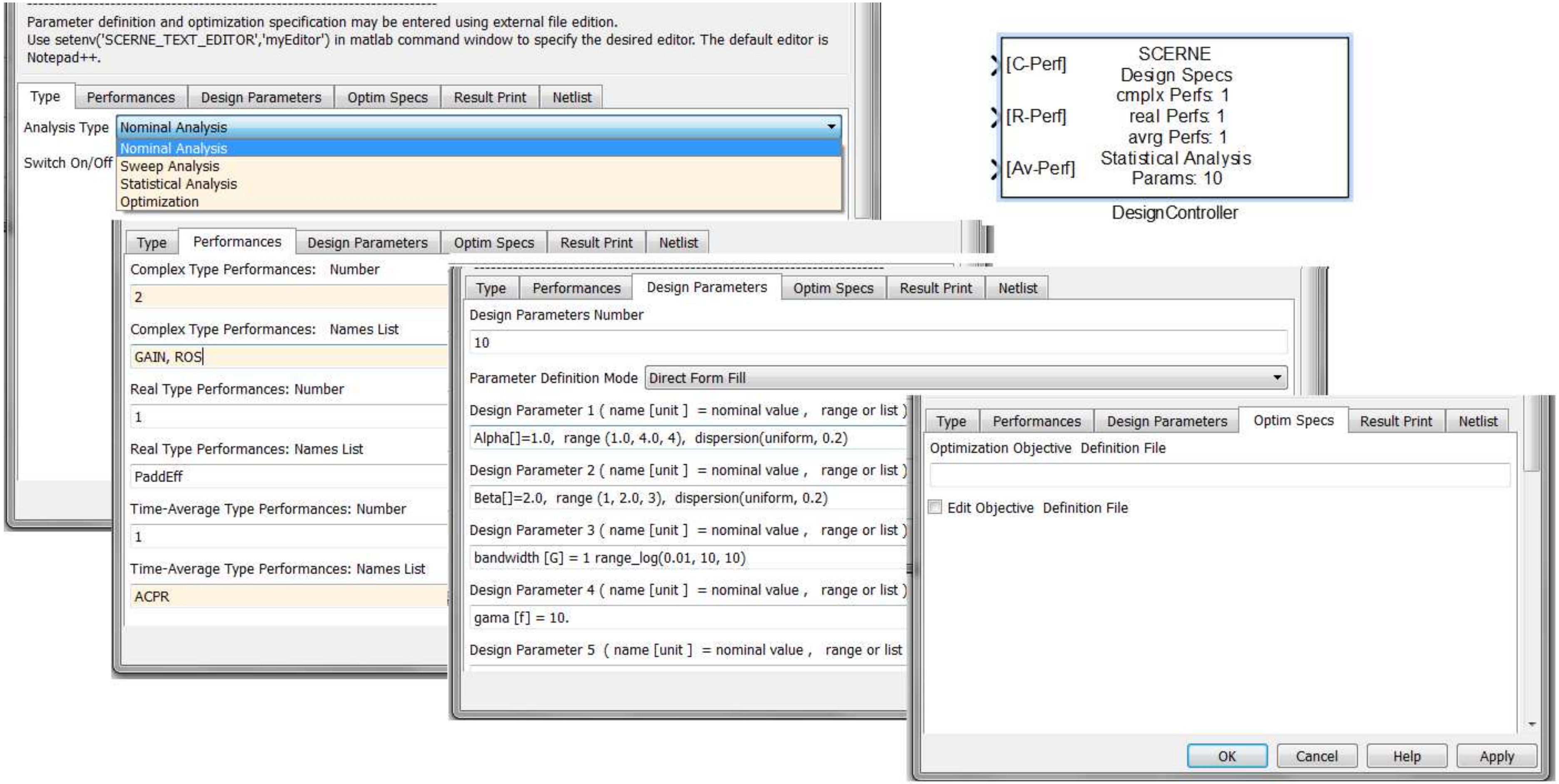
RAPID-DGA “VISION” (AMCAD ENGINEERING / XLIM)

Basic functionnalities

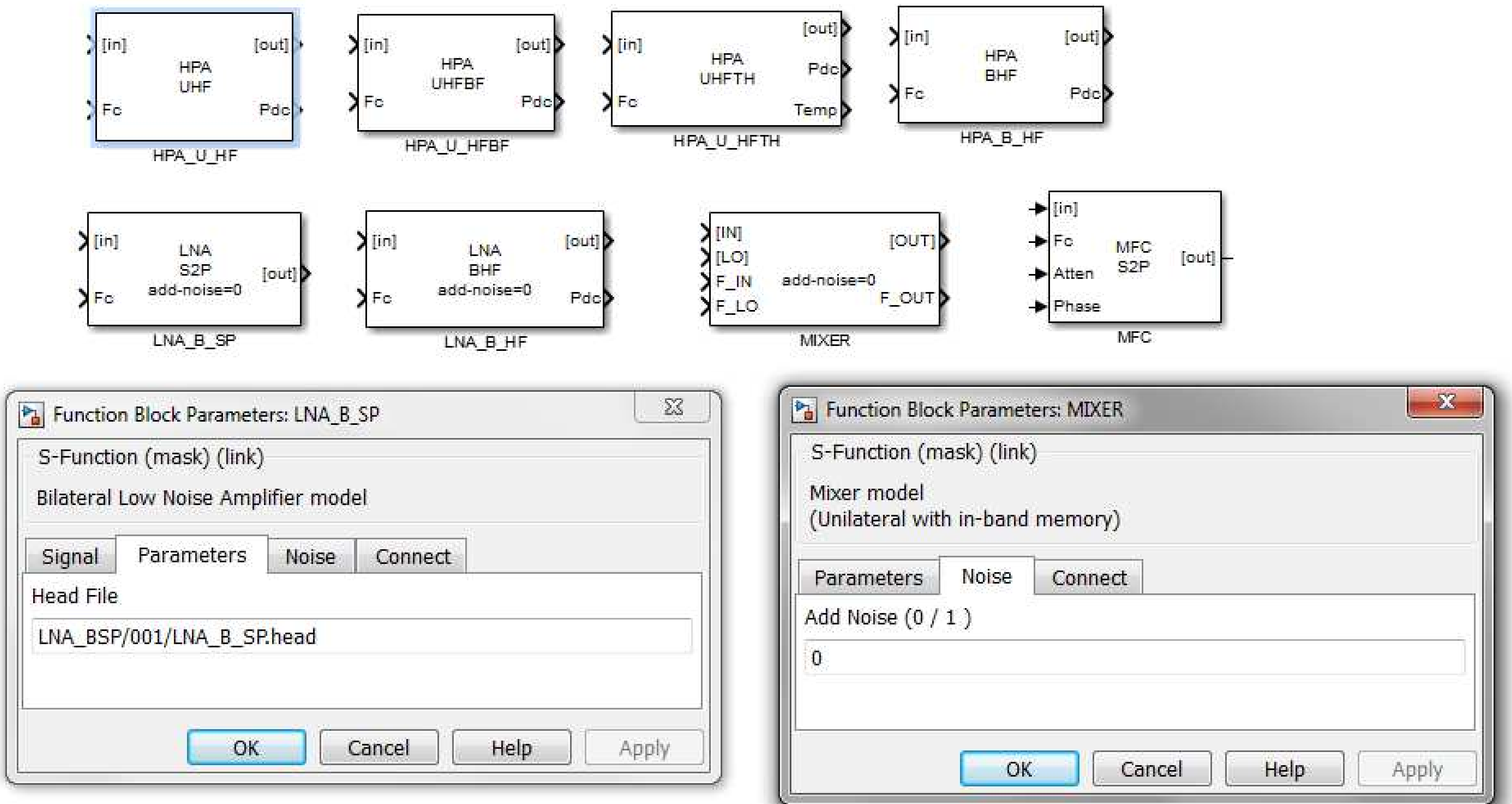
Simulation Controller



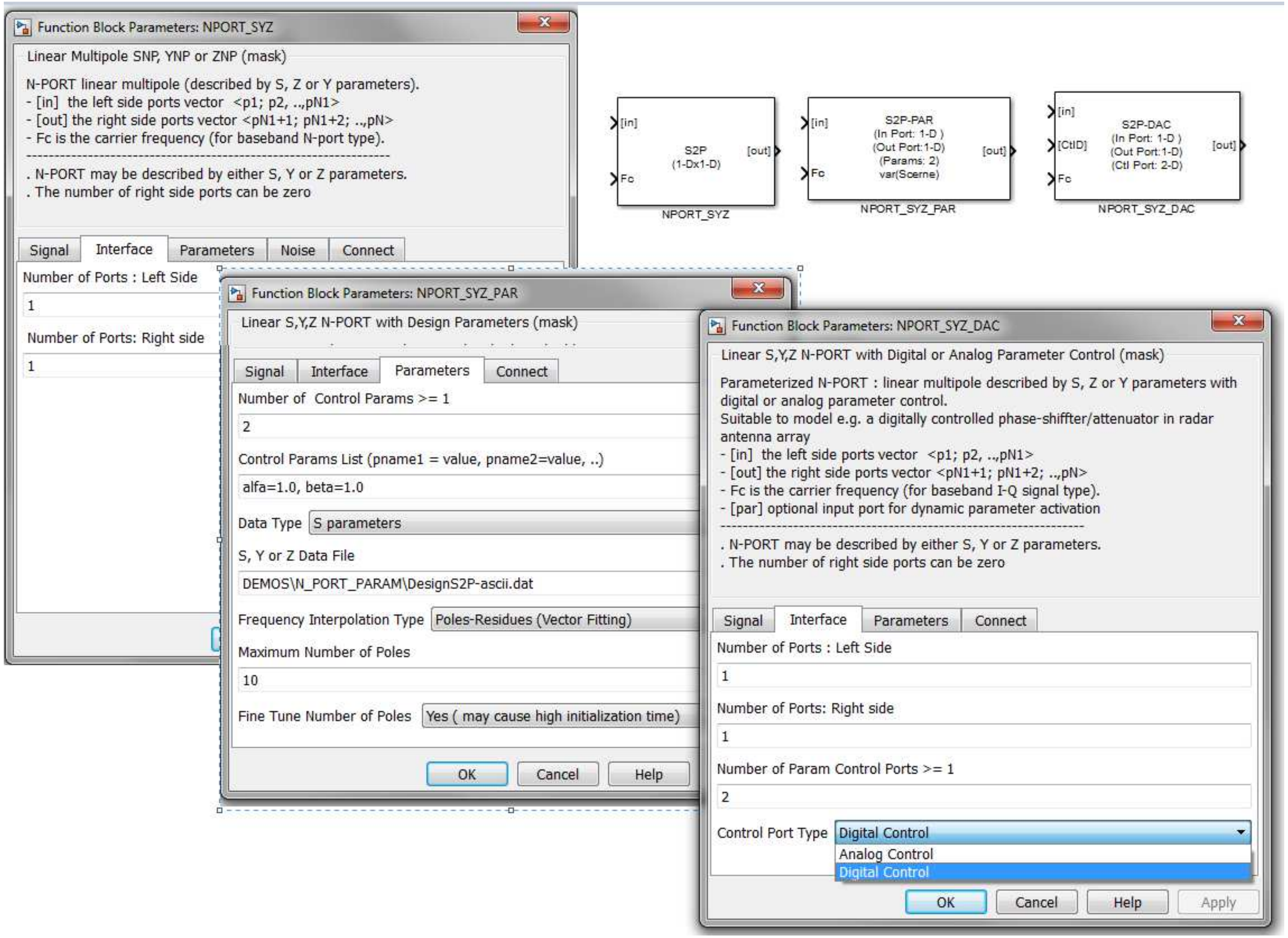
Design Controller (Nomin, sweep, statis, optim)



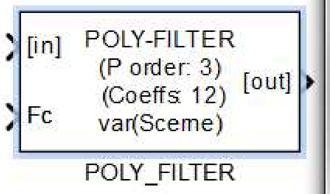
Basic nonlinear models (Volterra)

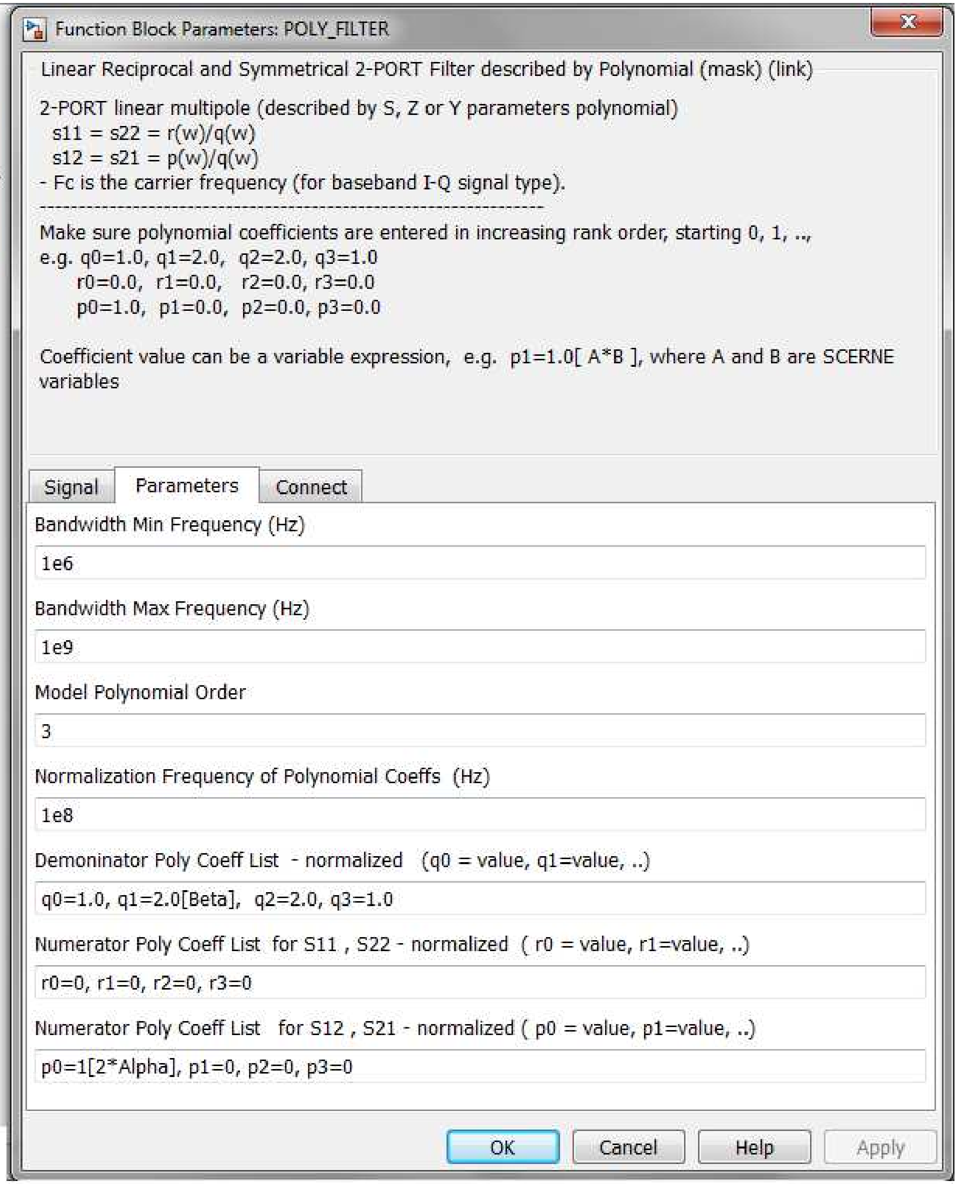


Linear Multipole (SNP, YNP, ZNP)

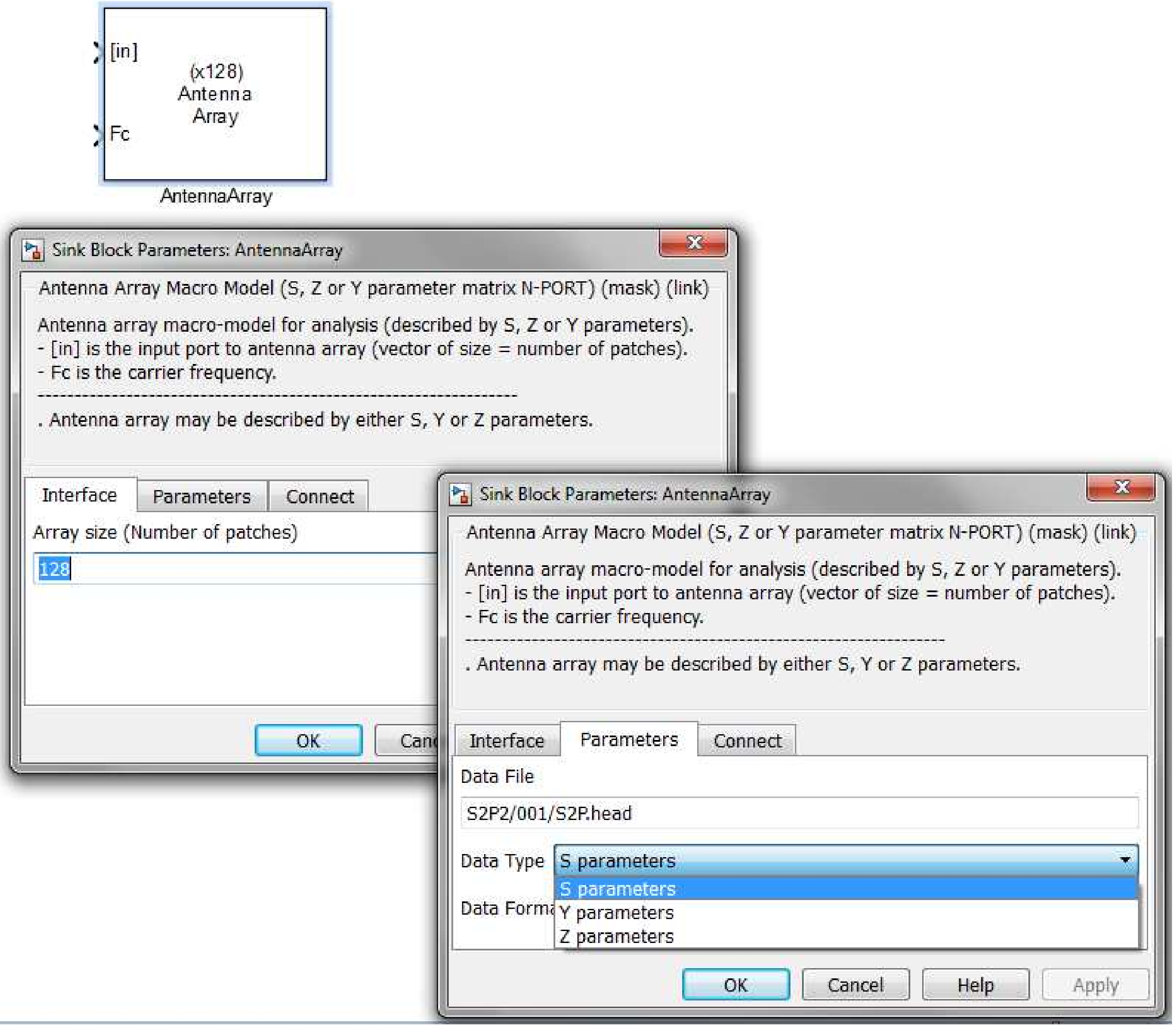


Polynomial Filter (S, Z, Y)

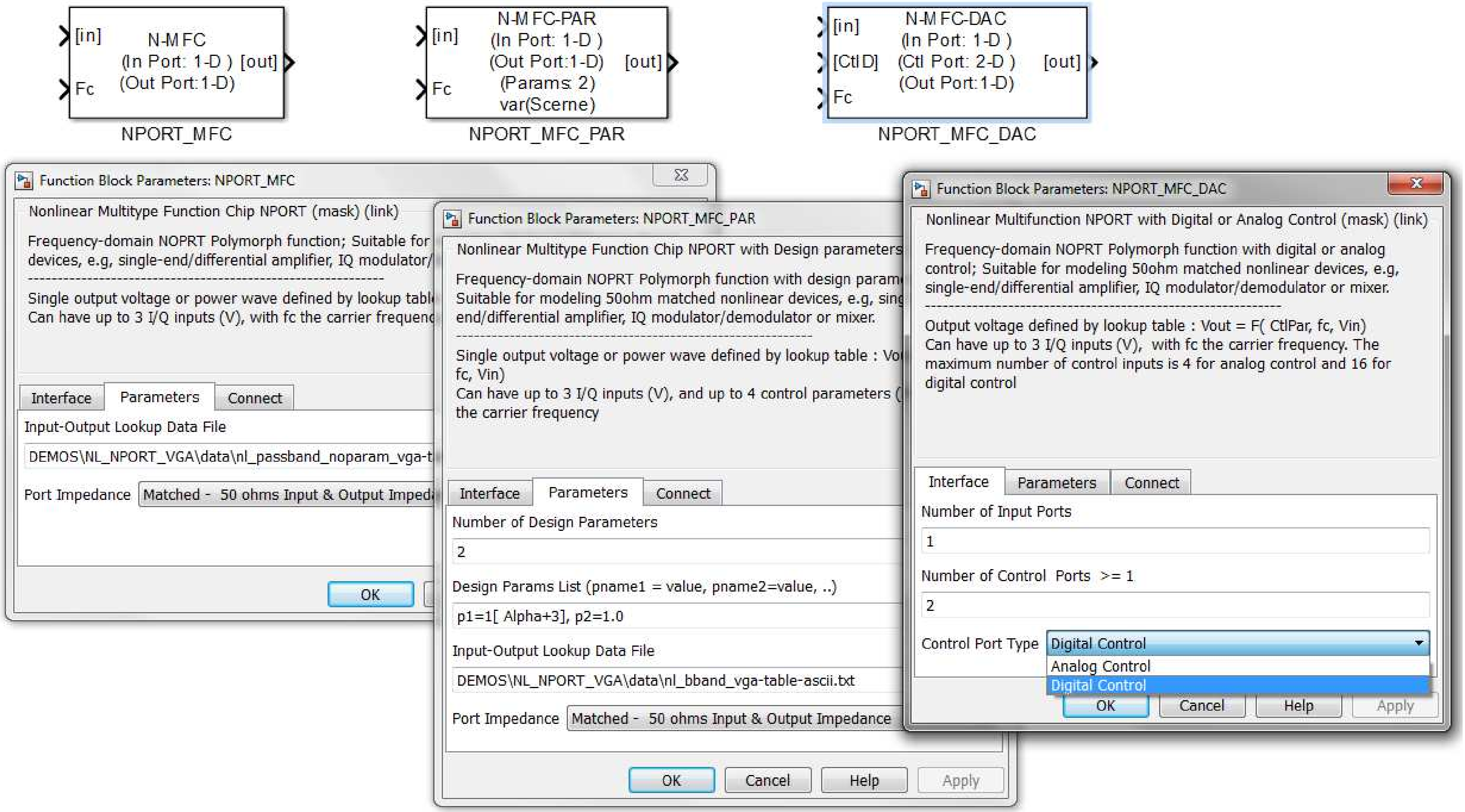




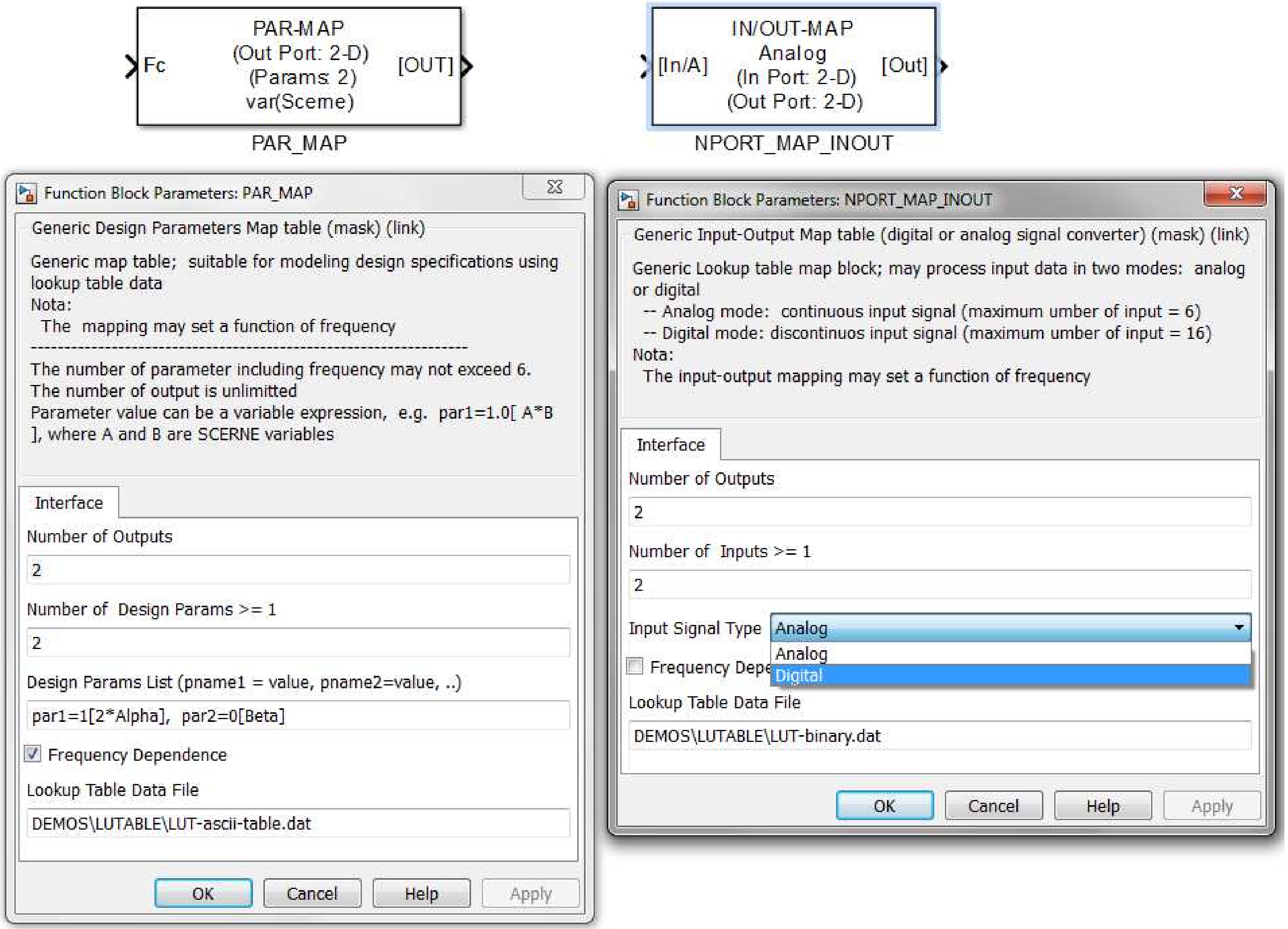
Antenna Array Model (S, Z, Y)



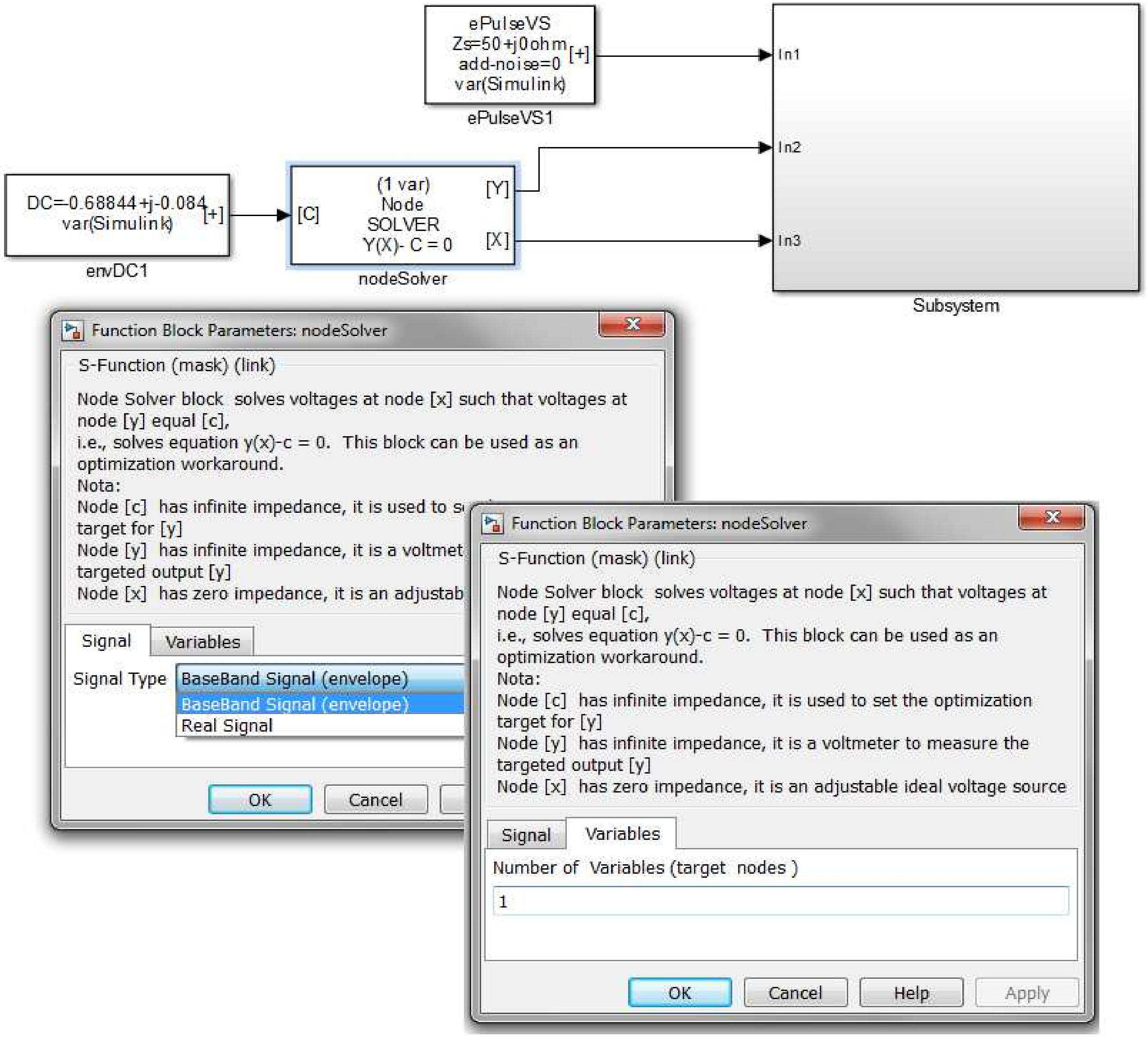
Nport Nonlinear Generic MFC (HF memory)



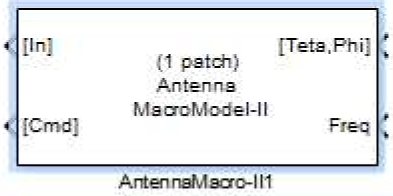
Generic Map Table (EXCEL)

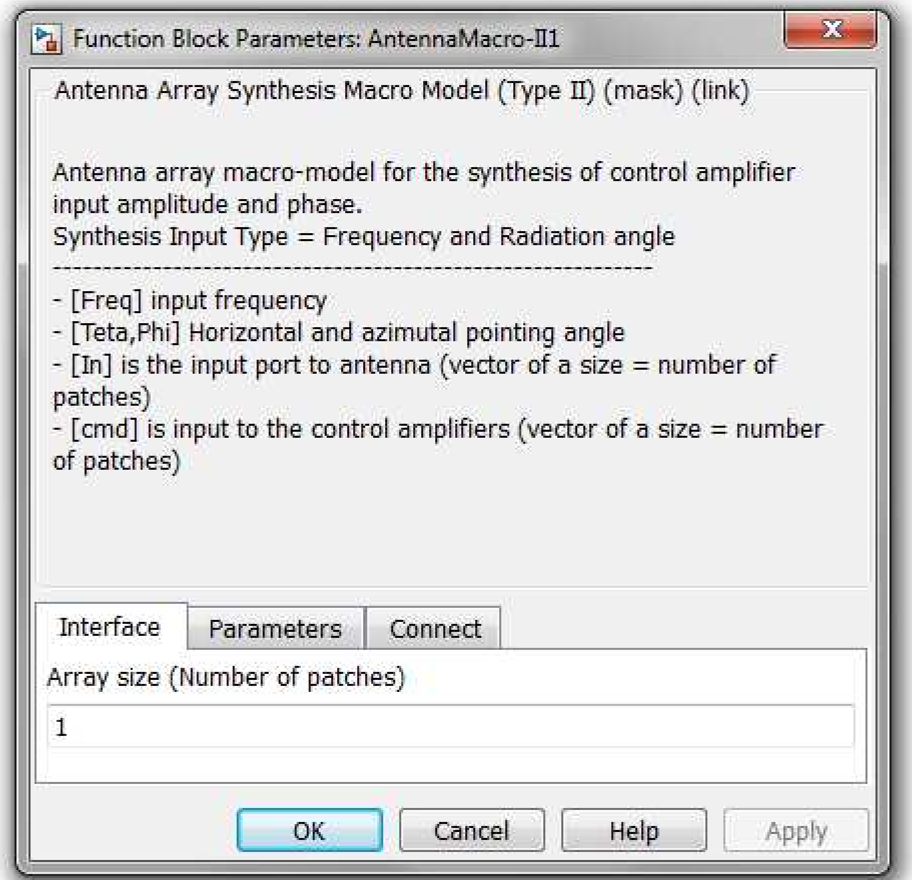


Node Solver (synthesis)

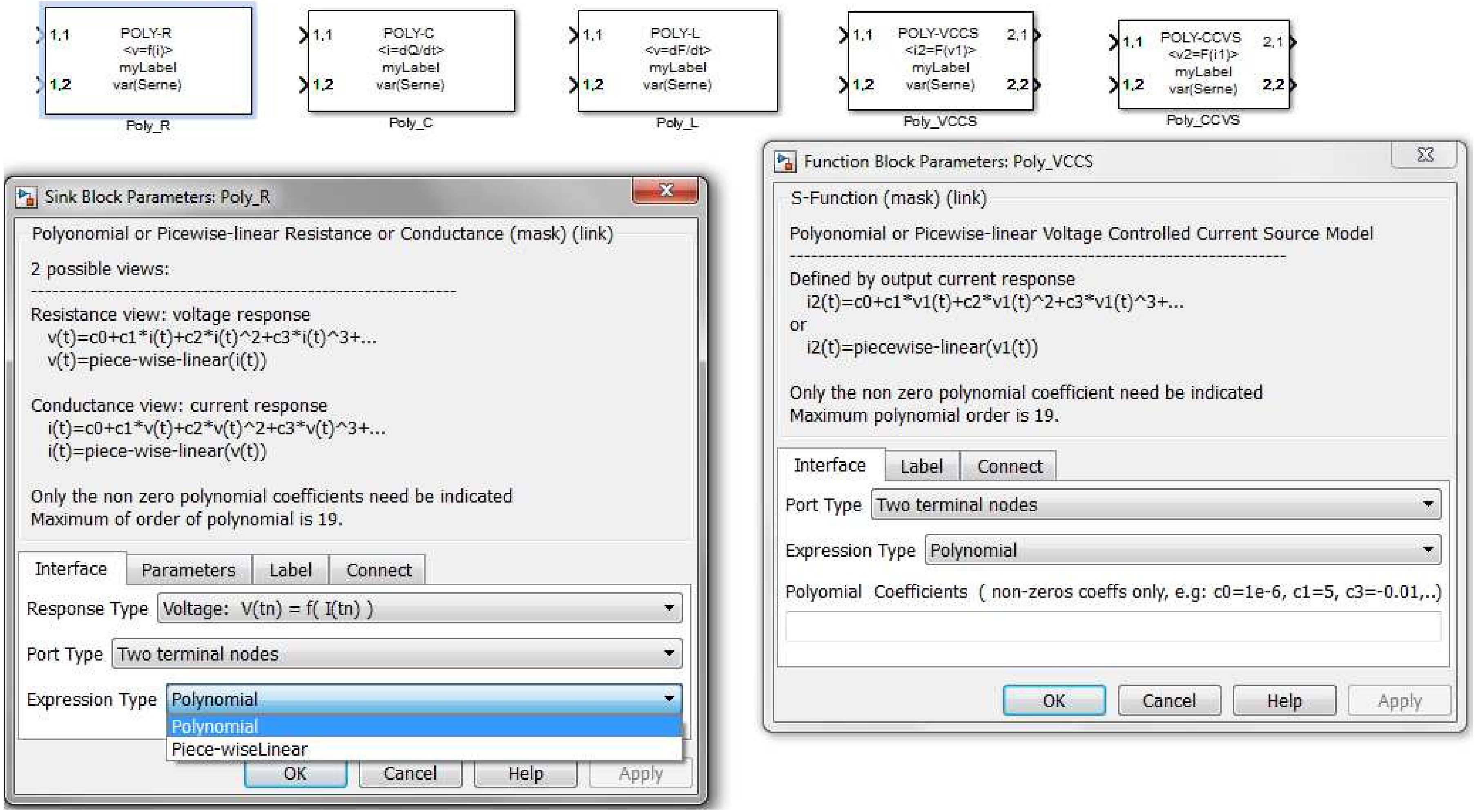


Antenna Array Synthesis Macro Model

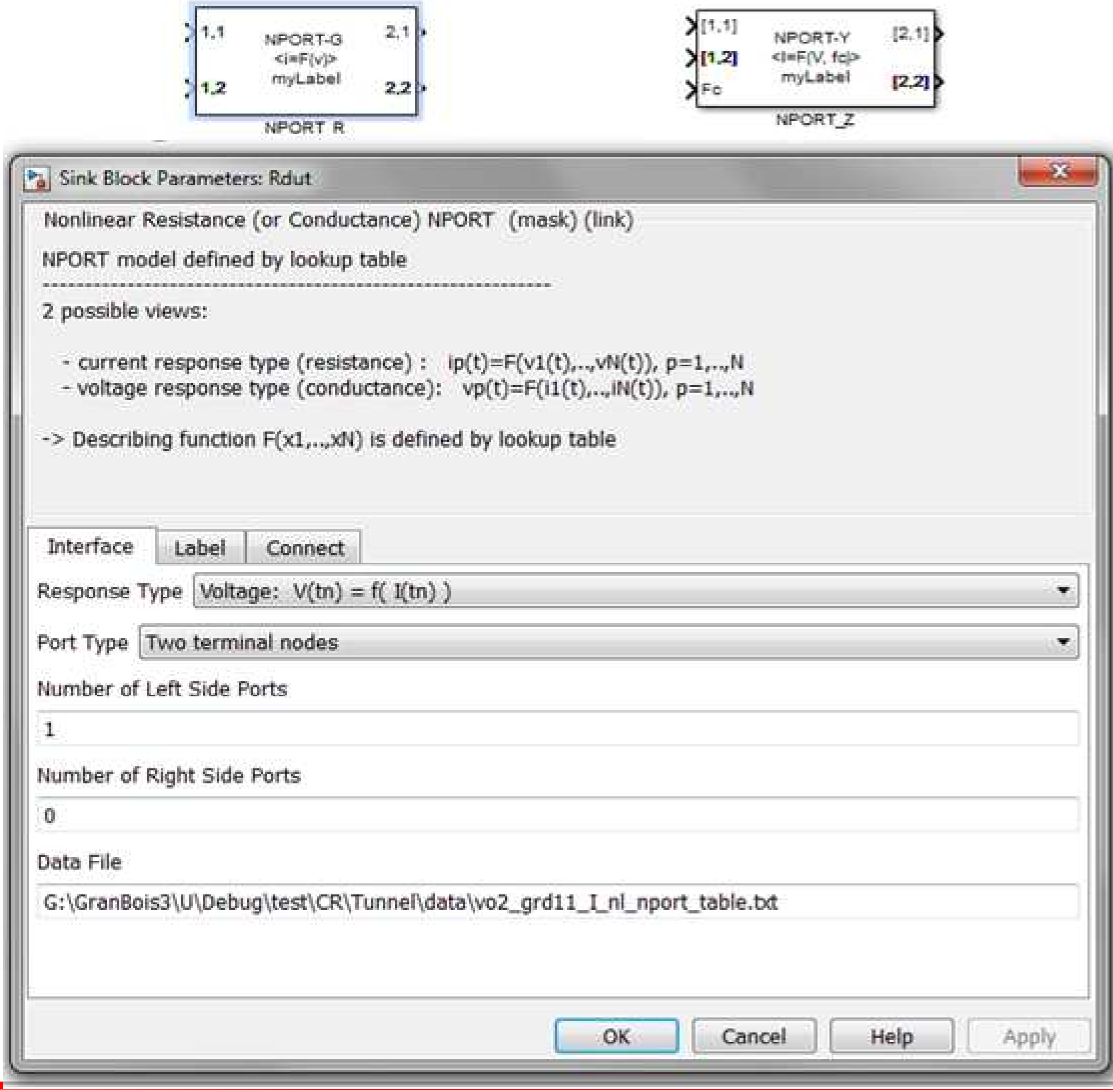




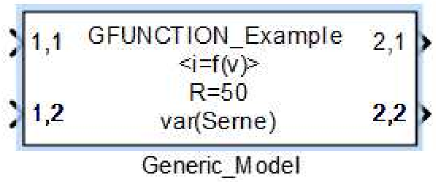
Common Components : Res, cap, ind, I(V), Q(V)

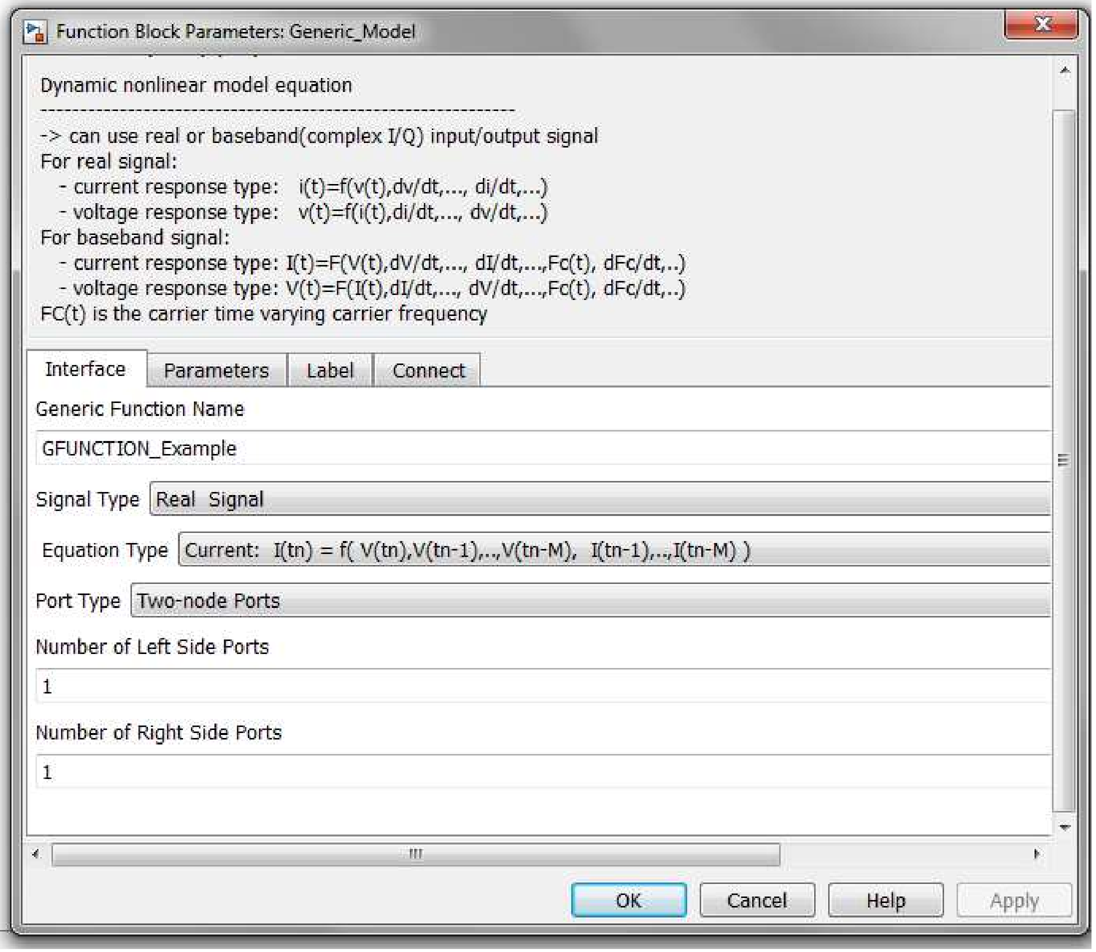


Nonlinear Nport - AM/PM complex enveloppe table

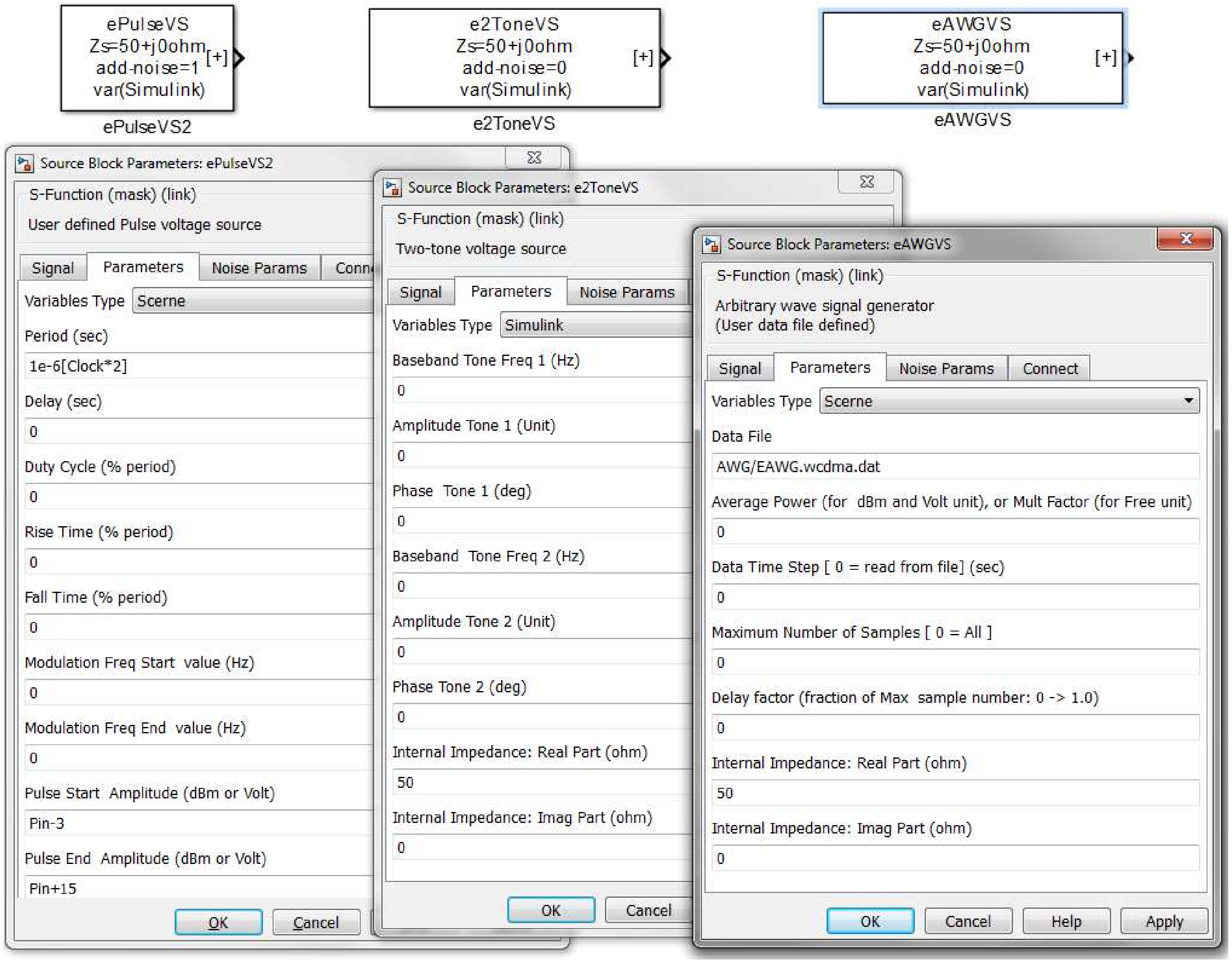


Generic Nport



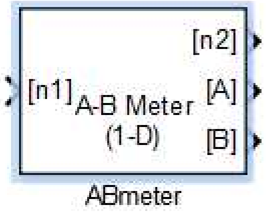


Signal generators

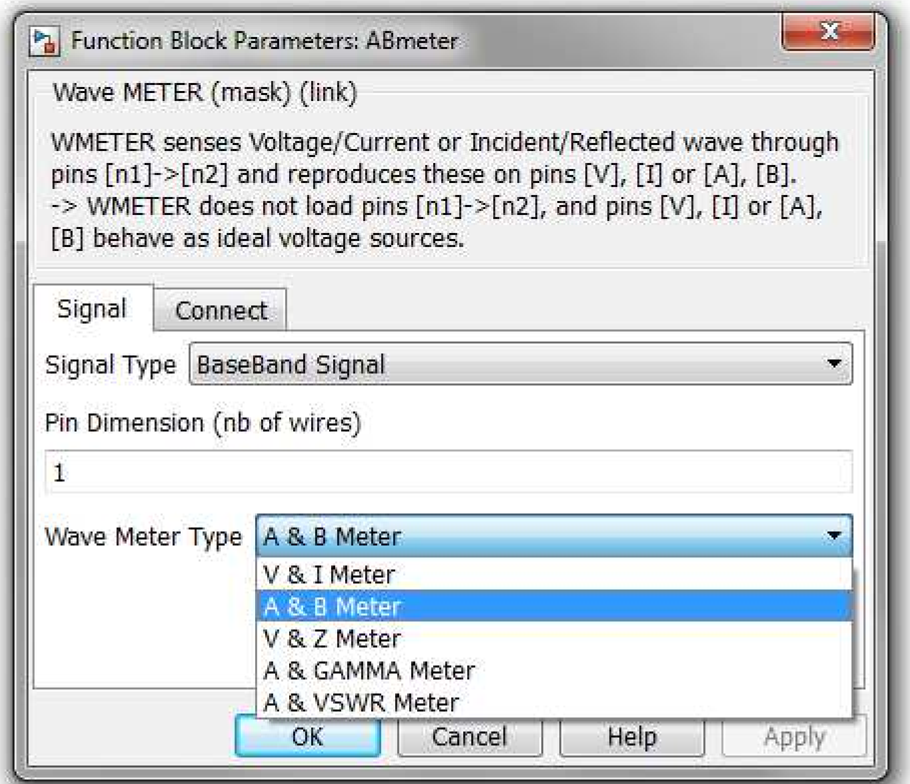


Probes

[+] Vout
eWaveform
[+] Pout
eSpectrum
[+] ACPR var(Simulink) +
PowerRatio
[in] [out] NF var(Simulink) +
NoiseFigure



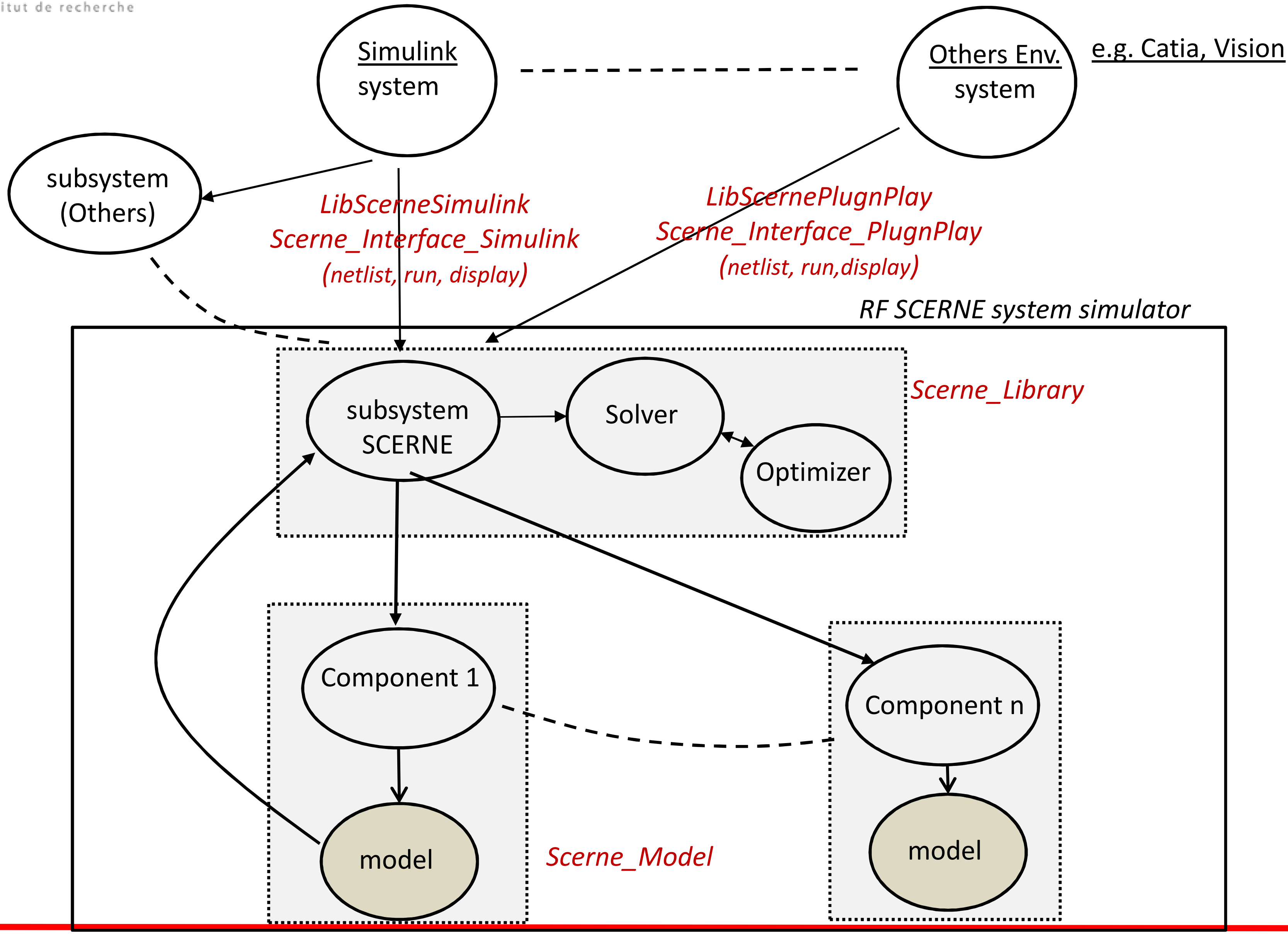
[n2]
[n1] A-B Meter (1-D)
[A]
[B]
ABmeter



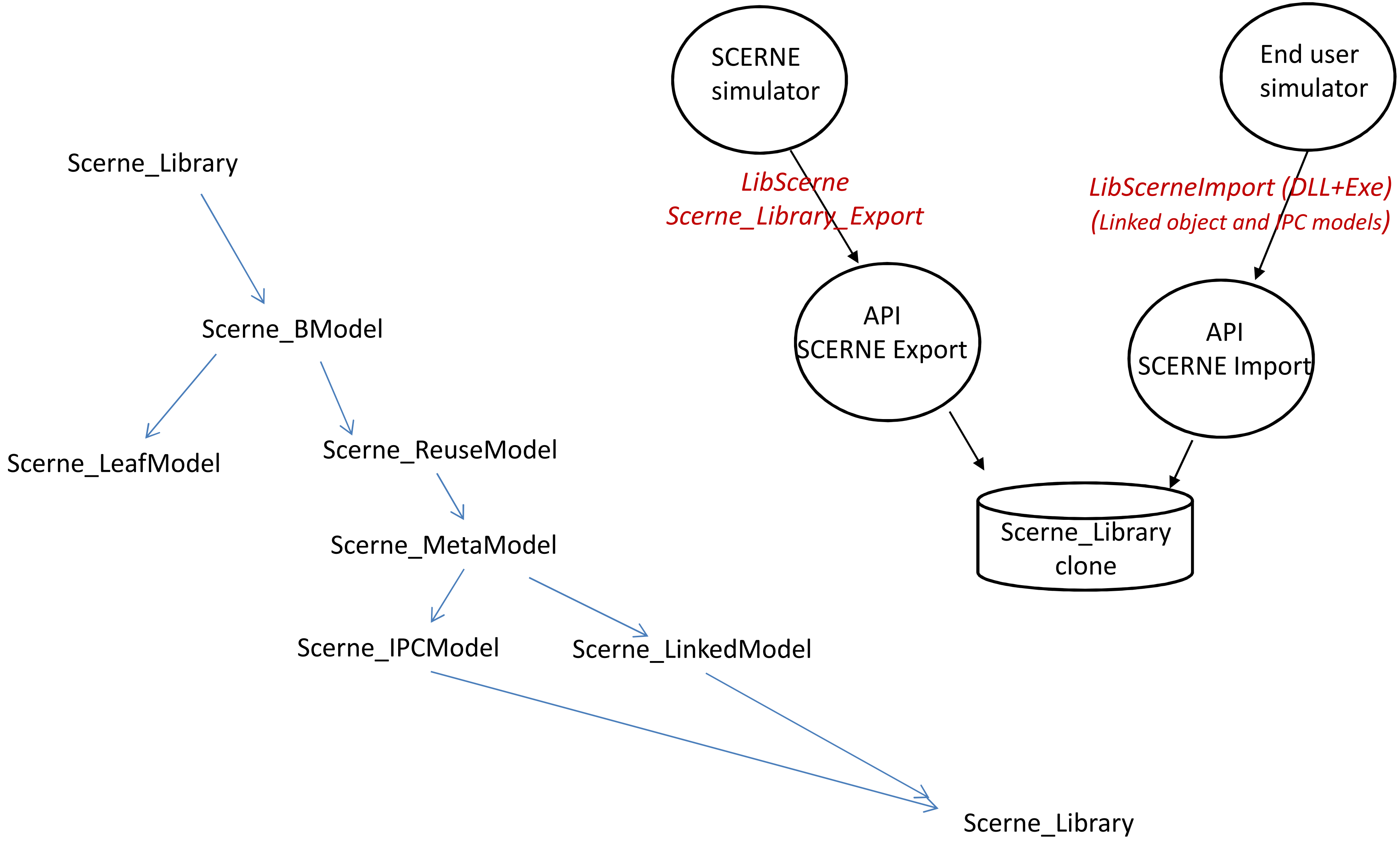
Function Block Parameters: ABmeter
Wave METER (mask) (link)
WMETER senses Voltage/Current or Incident/Reflected wave through pins [n1]->[n2] and reproduces these on pins [V], [I] or [A], [B].
-> WMETER does not load pins [n1]->[n2], and pins [V], [I] or [A], [B] behave as ideal voltage sources.
Signal
Connect
Signal Type
BaseBand Signal
Pin Dimension (nb of wires)
1
Wave Meter Type
A & B Meter
V & I Meter
A & B Meter
V & Z Meter
A & GAMMA Meter
A & VSWR Meter
OK
Cancel
Help
Apply

Scerne Architecture

RF SCERNE tool



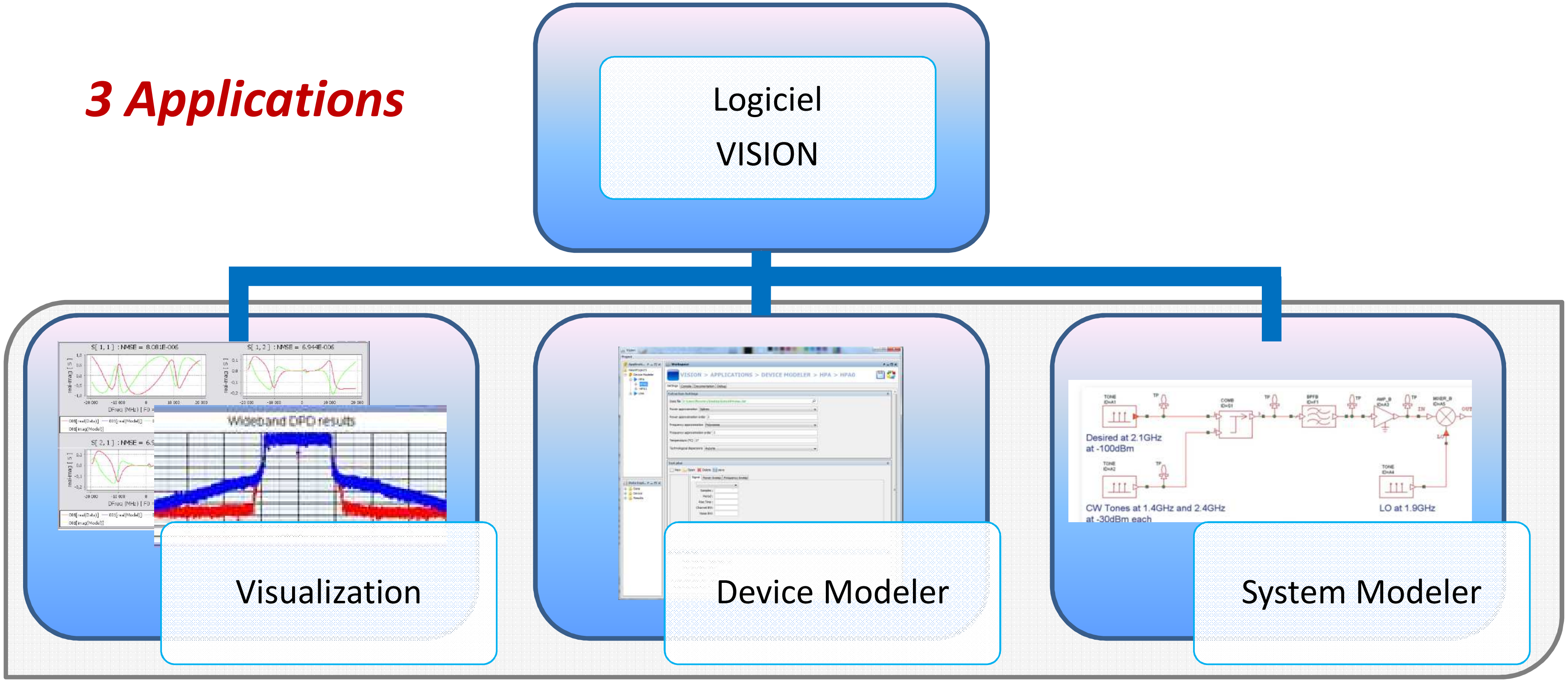
Export functionalities



Vision tool

VISION tool

3 Applications

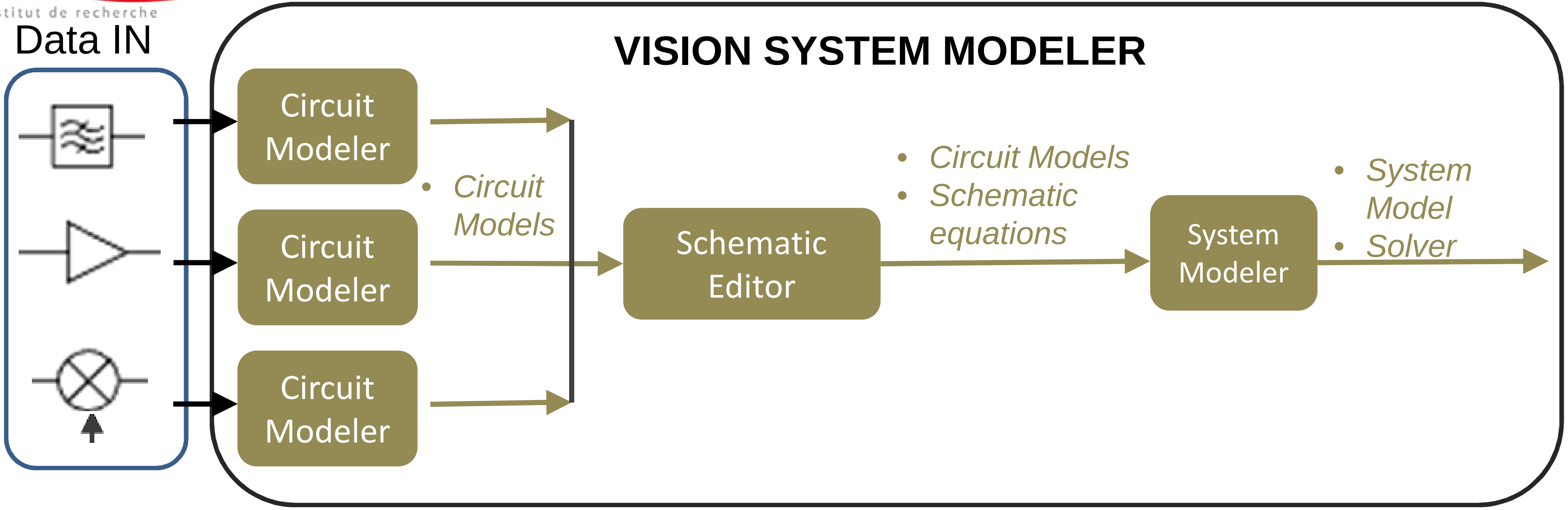


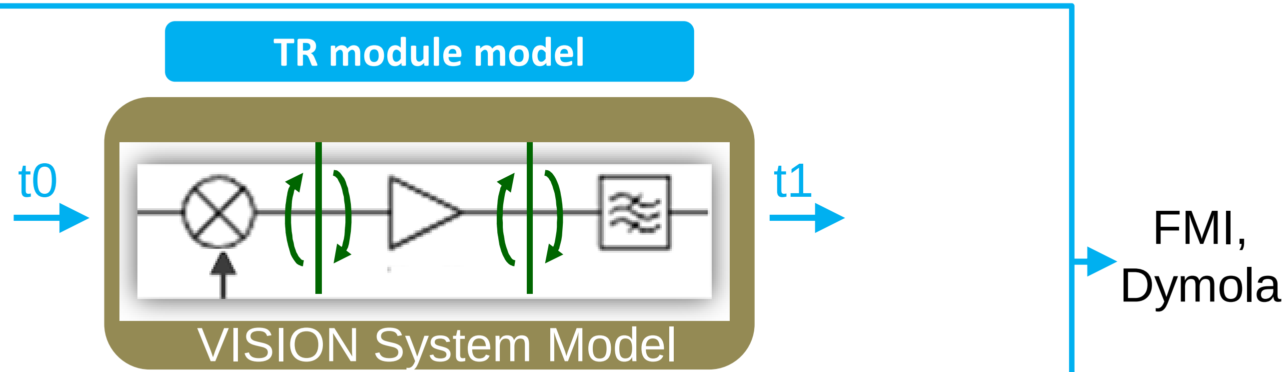
❑ Outil qui permet de Visualiser et mettre en forme la visualisation des résultats obtenus via le Device Modeler et le System Modeler.

❑ Outil qui réalise l'extraction de modèles de composants à partir de mesure ou de simulation.

❑ Outil qui réalise la concaténation de modèles de composants afin d'embarquer leurs interactions dans un modèle système autonome.

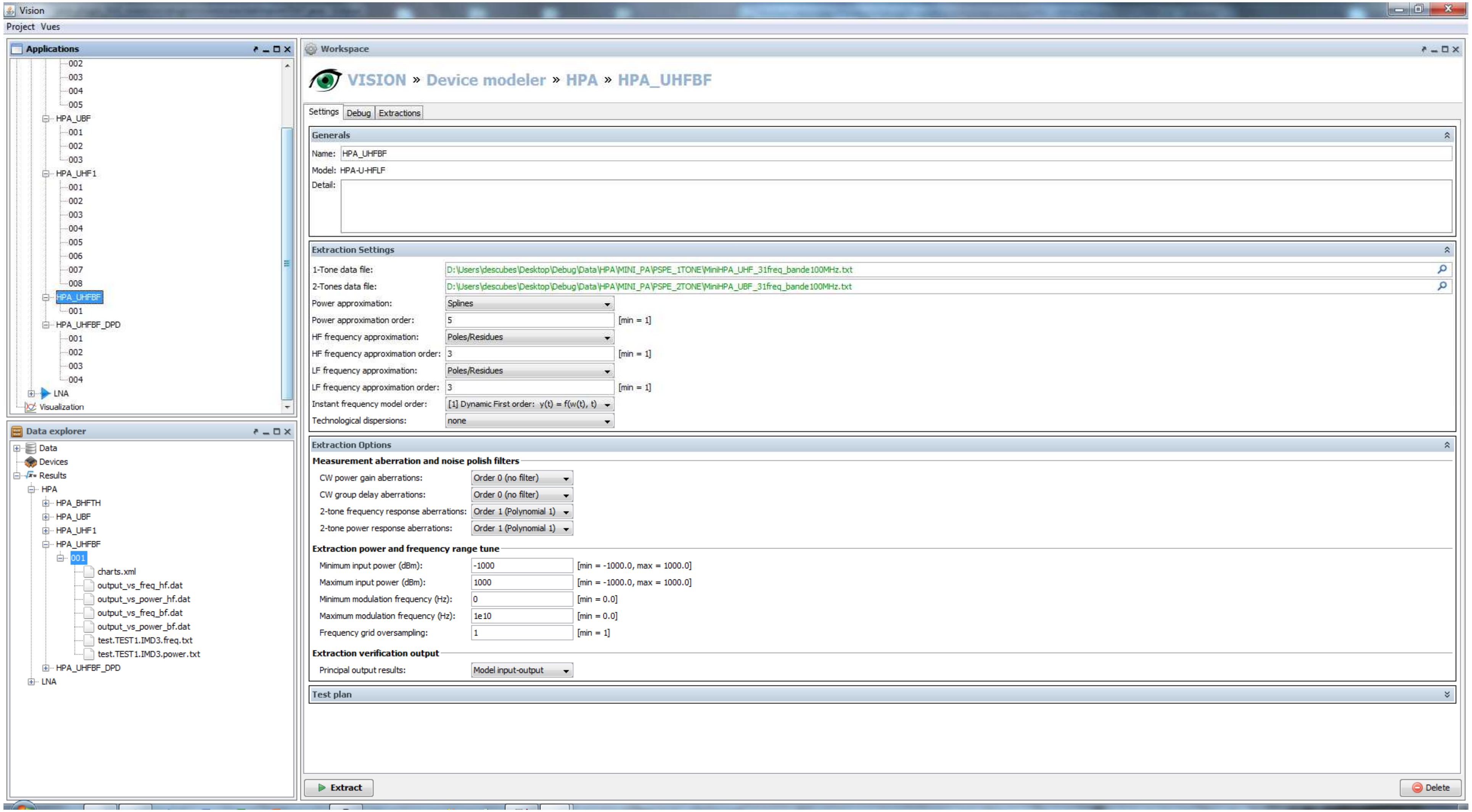
VISION tool



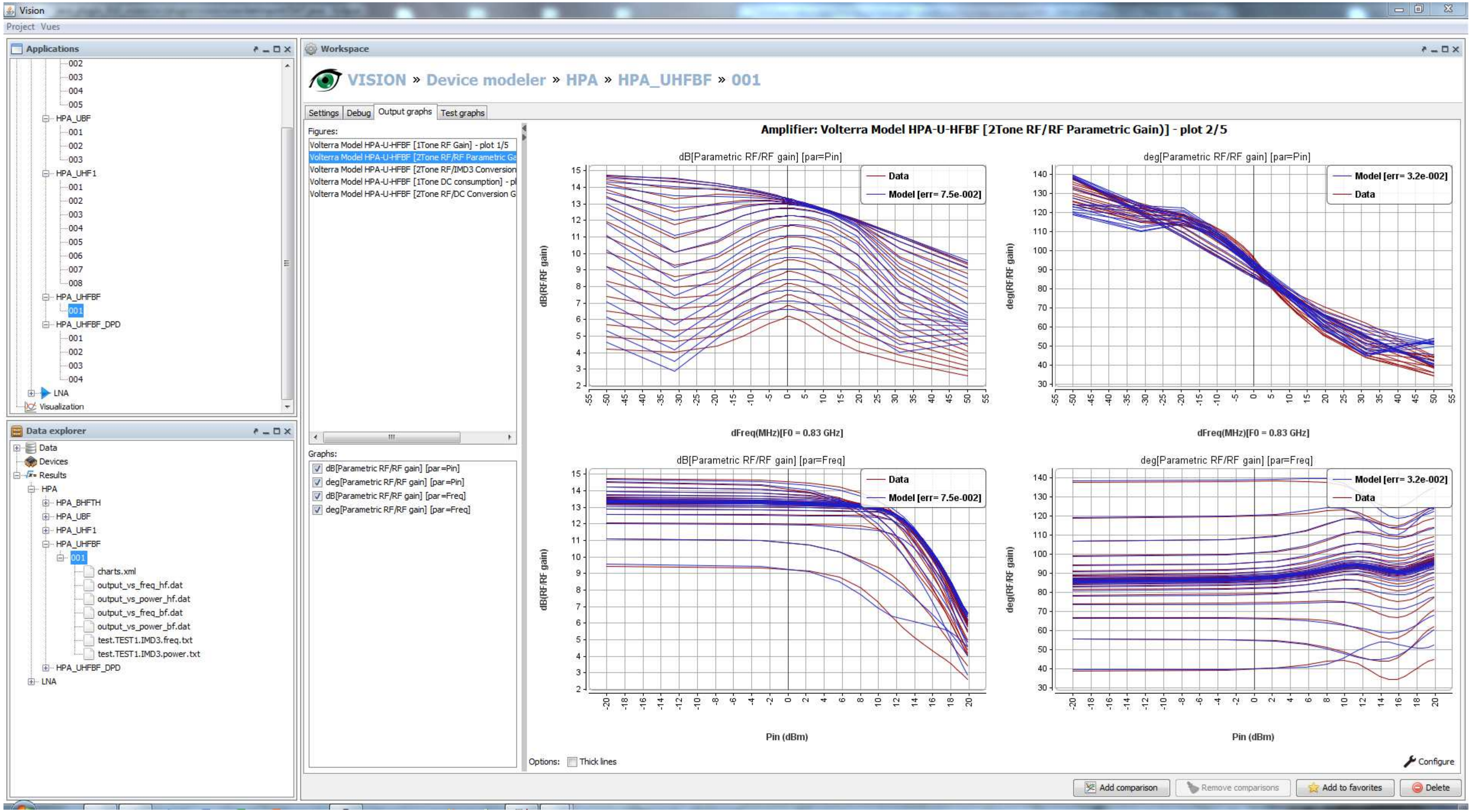


Inclusion of mismatches between bloc 1,2,3, & memory effects

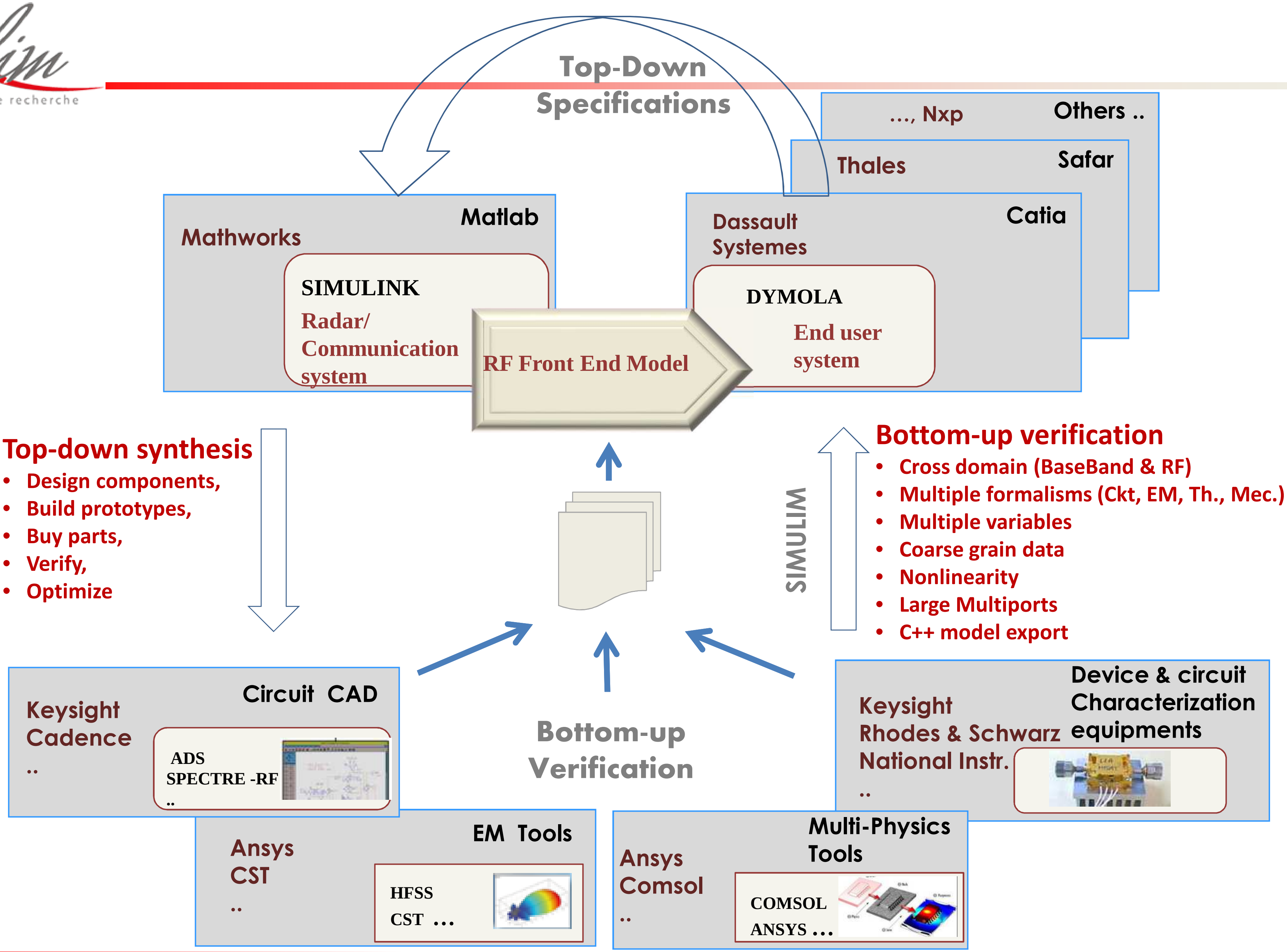
VISION – IHM Device Modeler (settings)



VISION – IHM Device Modeler (graphics results)



Conclusion



Top-Down
Specifications
..., Nxp
Others ..
Thales
Safar
Mathworks
Matlab
SIMULINK
Radar/
Communication
system
RF Front End Model
Dassault
Systemes
Catia
DYMOLA
End user
system
Top-down synthesis
• Design components,
• Build prototypes,
• Buy parts,
• Verify,
• Optimize
SIMULIM
Bottom-up verification
• Cross domain (BaseBand & RF)
• Multiple formalisms (Ckt, EM, Th., Mec.)
• Multiple variables
• Coarse grain data
• Nonlinearity
• Large Multiports
• C++ model export
Keysight
Cadence
..
Circuit CAD
ADS
SPECTRE -RF
..
Bottom-up
Verification
Keysight
Rhodes & Schwarz
National Instr.
..
Device & circuit
Characterization
equipments
Ansys
CST
..
EM Tools
HFSS
CST ...
Ansys
Comsol
..
Multi-Physics
Tools
COMSOL
ANSYS ...

RF Front-End Modeling Challenges

institut de recherche

Higher functional complexity

- Heterogeneous technologies
- Multiple standards
- Higher data rate
- Larger bandwidths
- Carrier aggregation
- Low RF to Millimeter wave carriers
- Device to device communication

Co-design paradigm

- RF-Baseband
- Antenna and Circuit

Flexible and accurate Bottom-up modeling methods and tools of the RF Link

Model, combine and export lower-level data from

- Heterogeneous simulation tools and environments
- Diverse test and characterization equipments