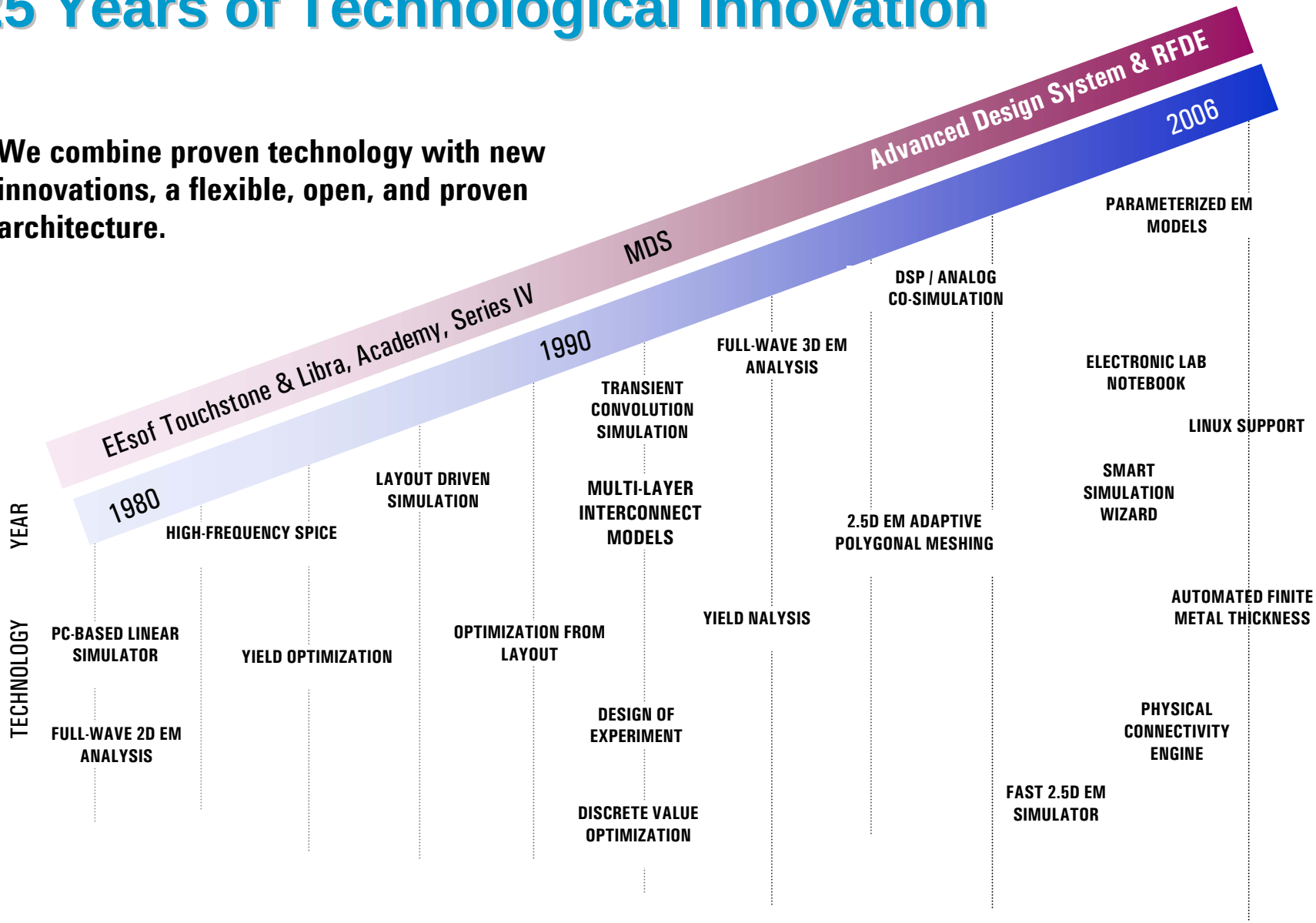
3DEM, Simulation and Measurement Advances for 2006

Expands SI Horizons

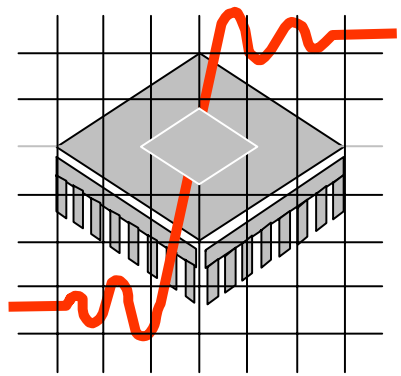
25 Years of Technological Innovation

We combine proven technology with new innovations, a flexible, open, and proven architecture.



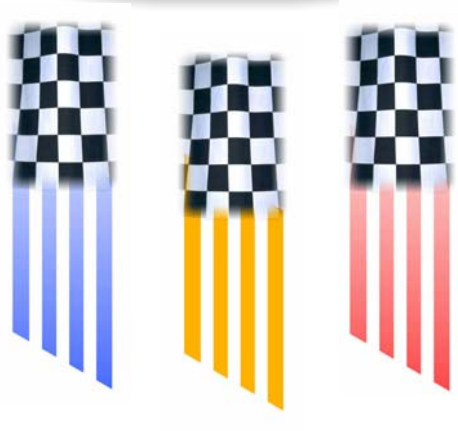
Digital modeling systems under stress

- Higher data rate
- Fast edge rate
- Smaller noise margins
- Thinner and longer lines
- Clock distribution
- Differential systems
- Impedance control, terminations
- Imperfect power and ground
- High density connector and package



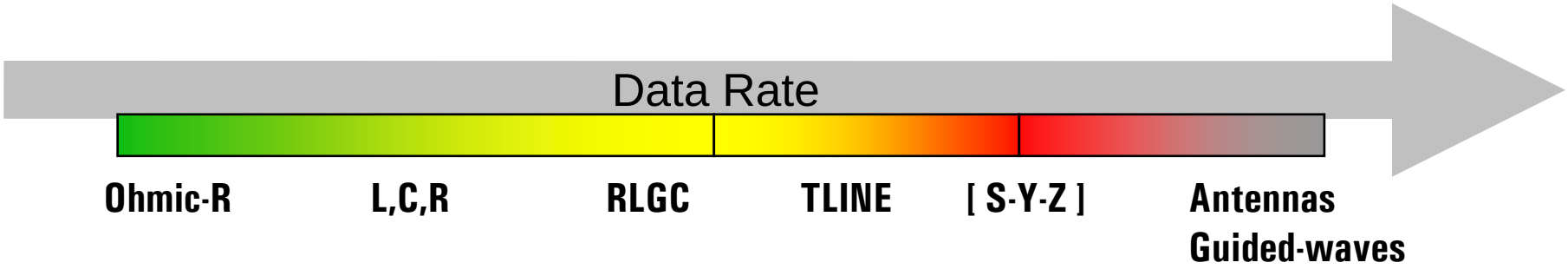
What's in ADS for High Speed Digital

"Expands SI Horizon"



1. **Leading Simulation Technology**
   solves new problems and
   gives you a design advantage
2. **Accurate Models**
   conquer existing problems so
   you are confident that designs
   will work the first time
3. **Accessibility & Flow Integration**
   within your Design Flow puts Agilent
   tools closer to the design problems
4. **Usability and Quality**
   frees your creativity and makes the most of your effort

Distributed & EM models: Why you may not have needed them before ?

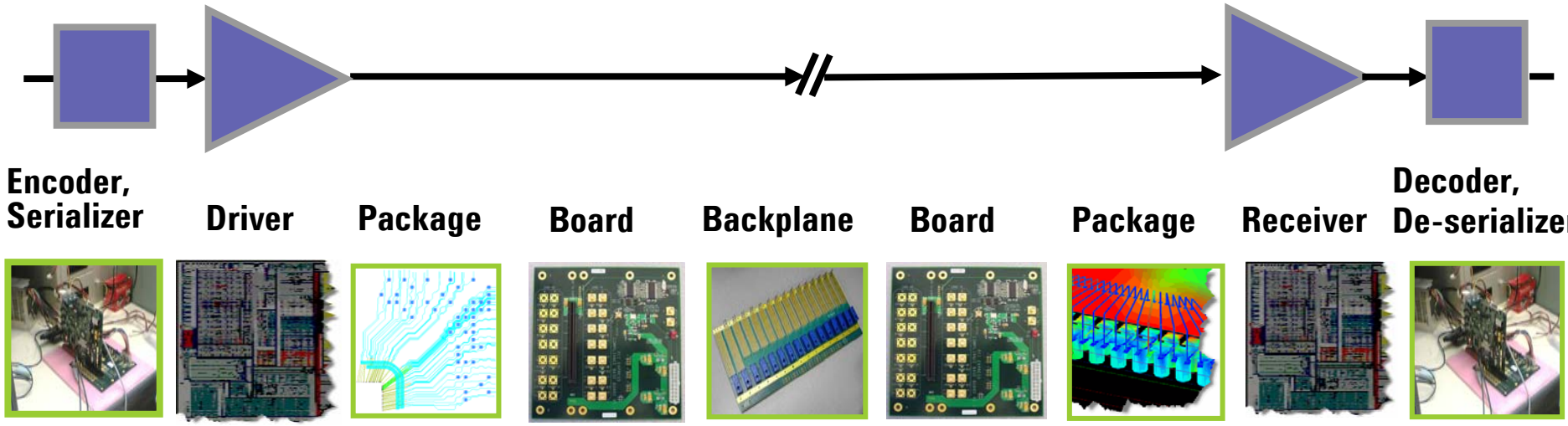


Lumped-element models for length << λ

Quasi-static distributed element models for length > λ**/10**

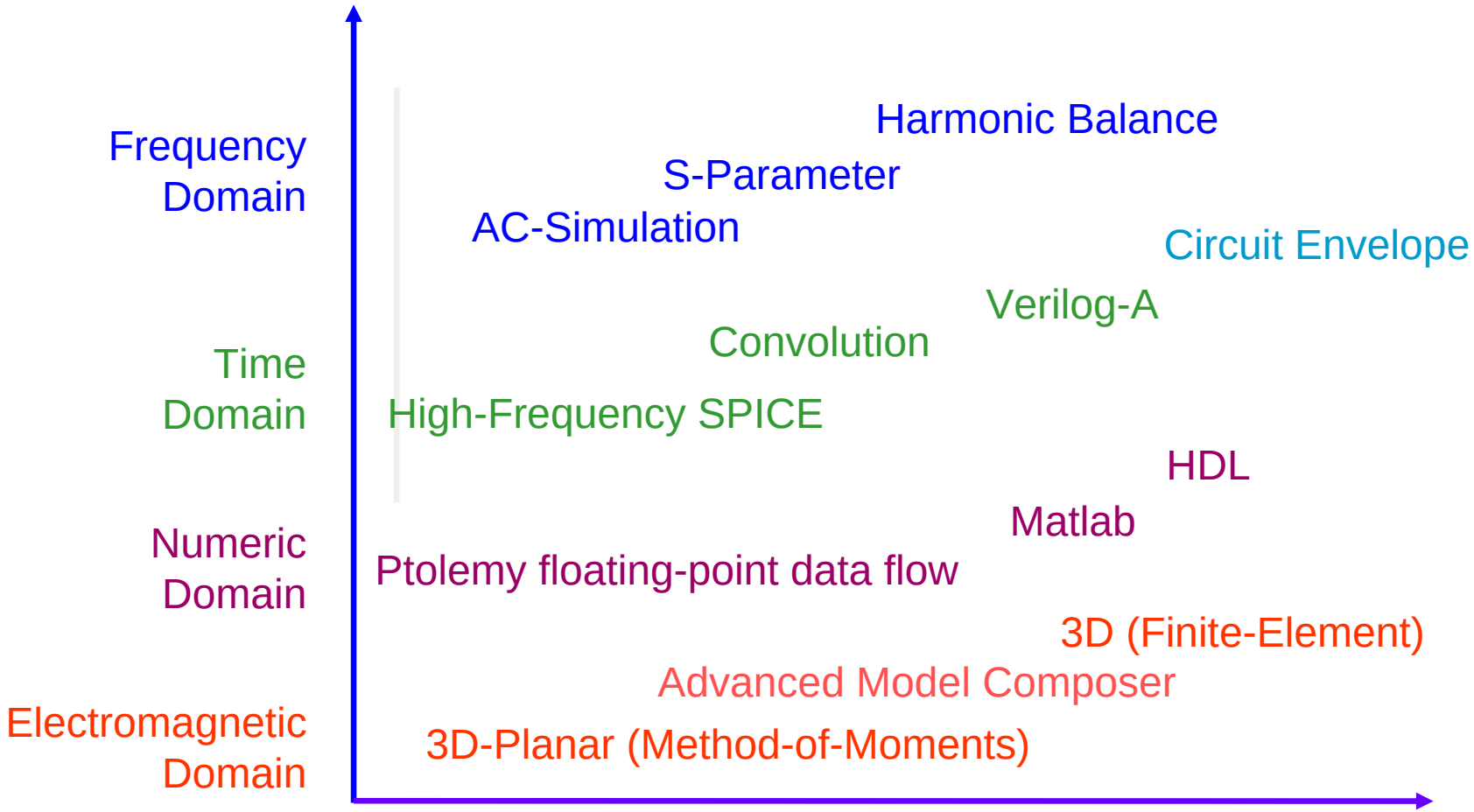
- Transmission line effects prevail at sub-nanosecond rise-times
  - Impedance, delay, loss, dispersion, crosstalk, etc.
- Full-wave electromagnetic models for width > λ**/2**

High Speed Digital Channel Design
Expands SI Horizon

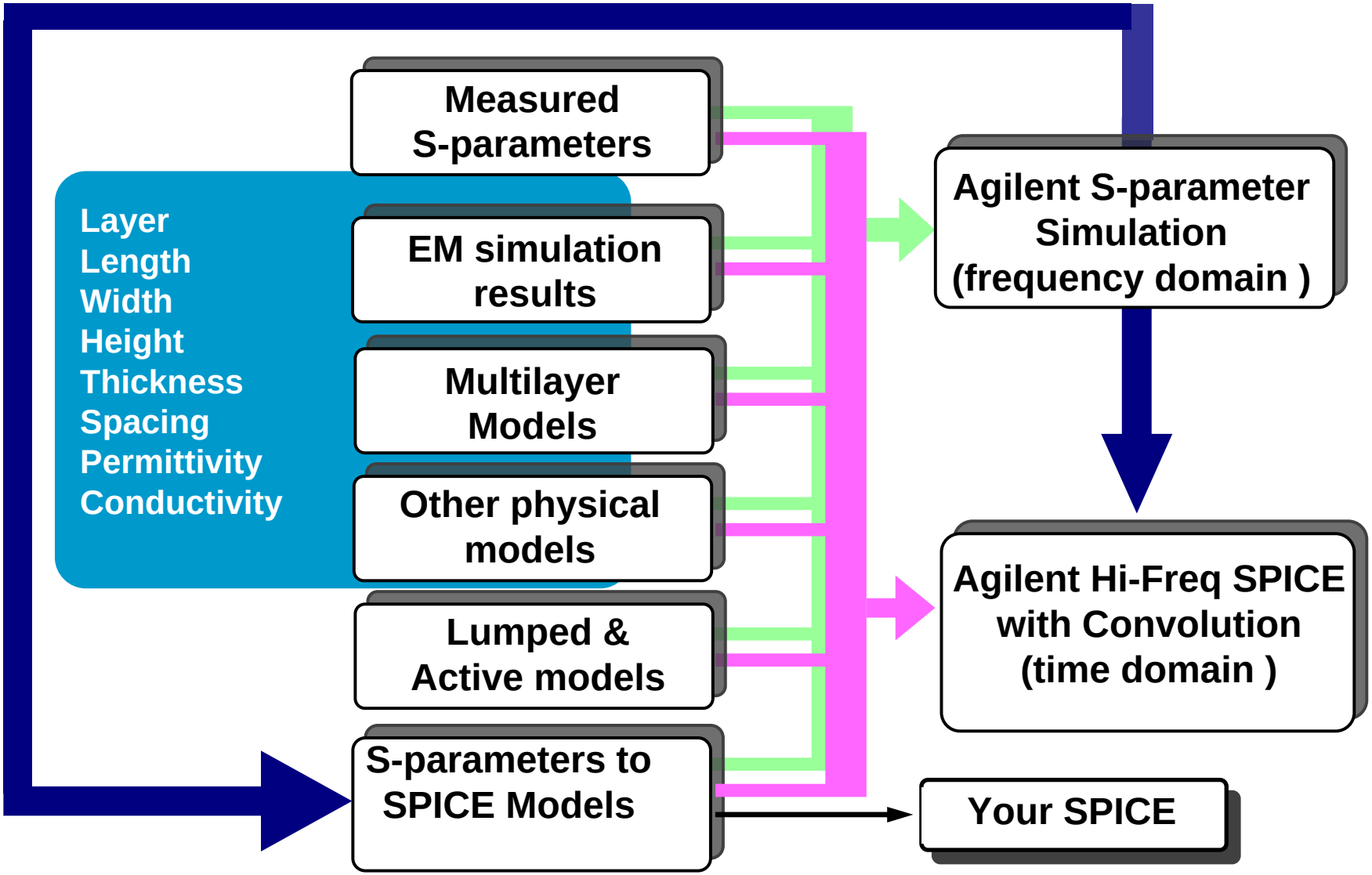


- ADS supports all implementation domains (IC, Module, Board)
- ADS can analyze the full digital channel – data in to data out
- Integrated data models and simulation technology

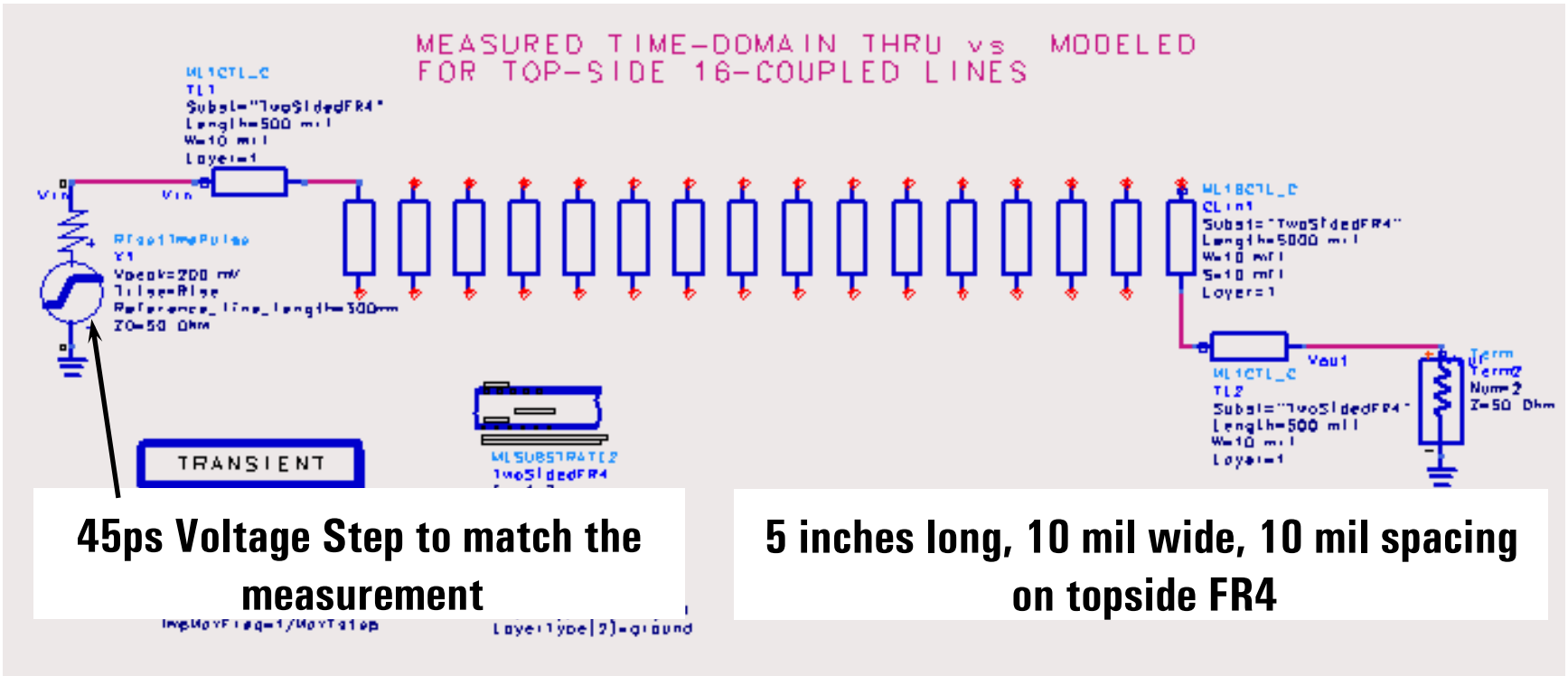
Combining Simulation Technologies



Analog Design Flow within ADS



Measured vs. modeled for the 16-coupled line model



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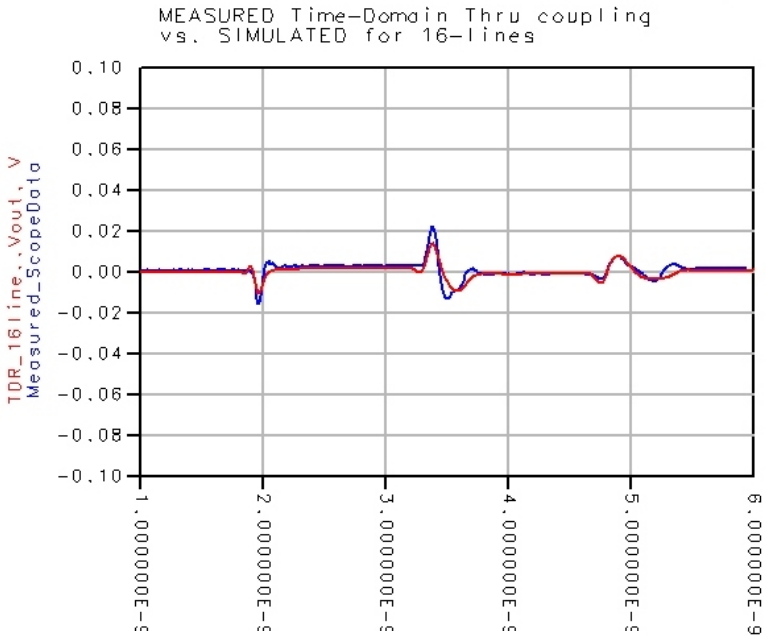
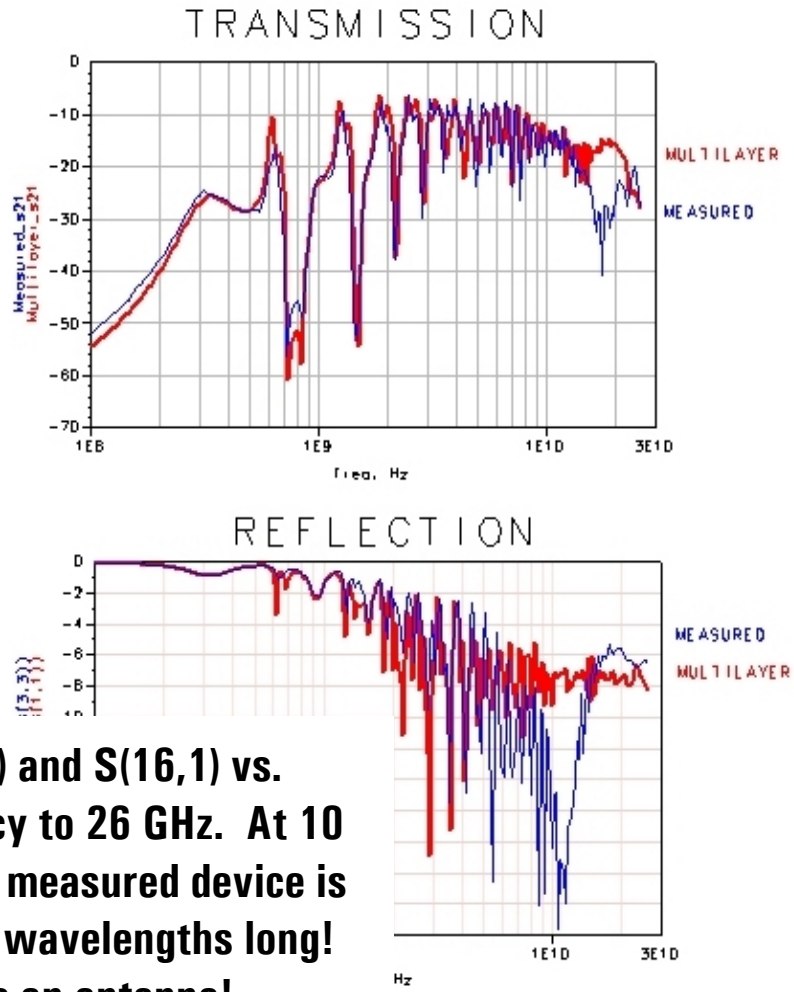
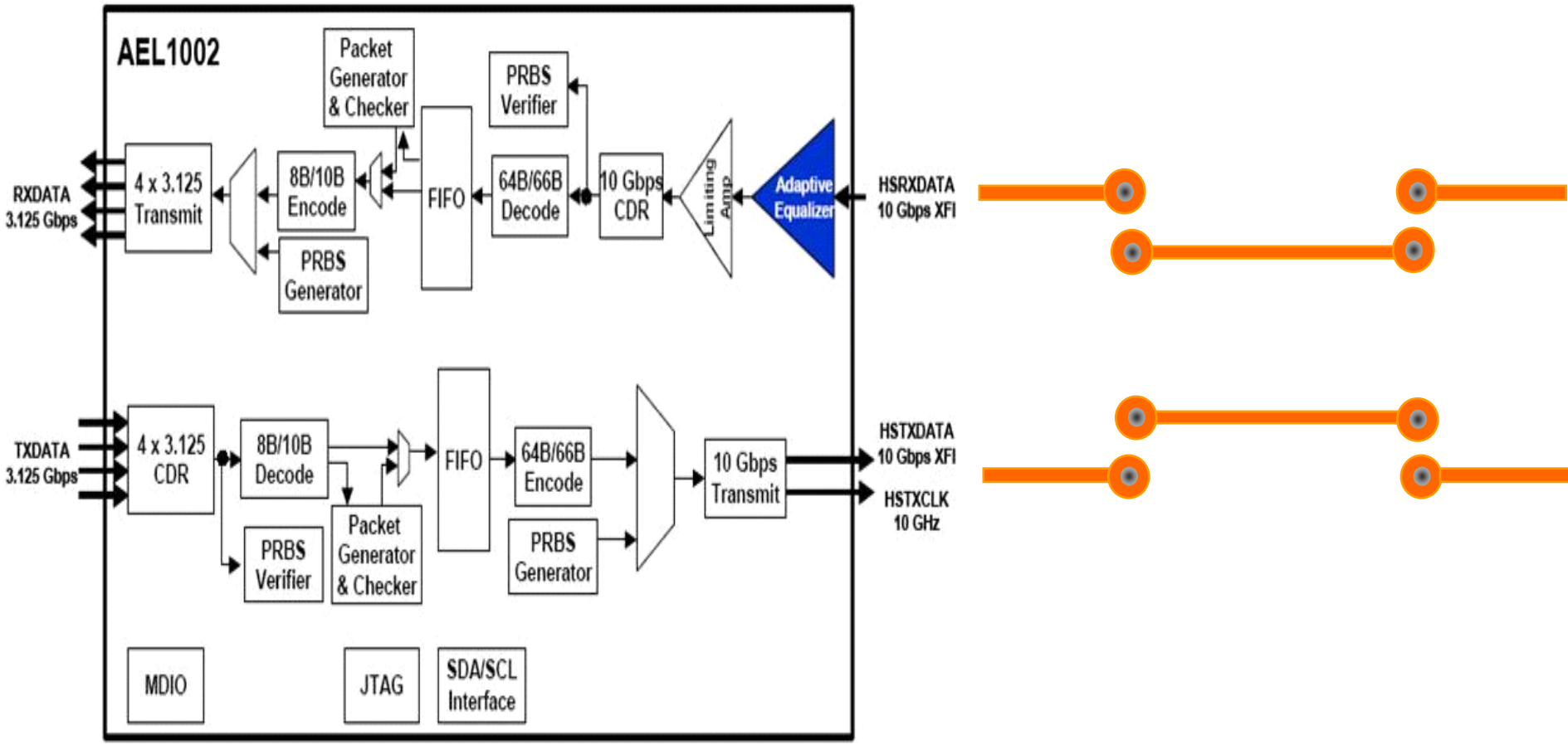


Time-domain Thru measurement vs. simulated for the crosstalk between traces 1 & 16 (2% peak)



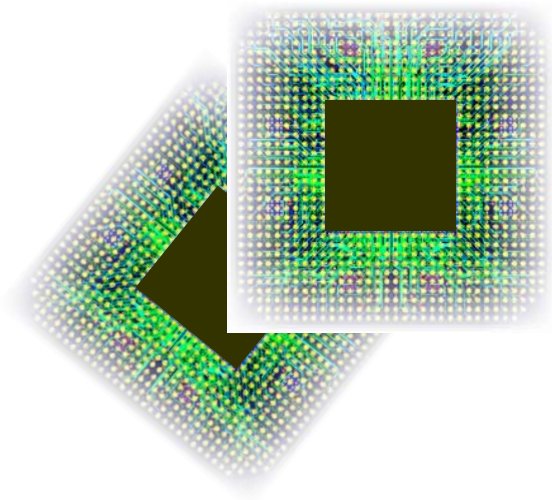
S(1,1) and S(16,1) vs. frequency to 26 GHz. At 10 GHz, the measured device is about 6 wavelengths long! It's an antenna!

High Speed Digital Design Using ADS



Serial Link System Level Modeling

A new challenge for Signal Integrity Engineer



- High data rate
- Electrically long Backplane and Cables
- Eye pattern closed at receive end

Design Requirements

- Decision Feedback Equalizer
- Feed Forward Equalizer
- Clock and Data Recovery
- Gain Controls
- Integrate SERDES models provided by IC vendors

Is time domain simulator sufficient?
SERDES model availability & format?

Analog Components of a Channel

Transmission Lines

Via Holes

High Speed Connectors

Package

I/O – IBIS models and Transistor level models

Best represented in Time & Frequency domain

Behavior Components in a Channel

Decision Feedback Equalizer

Feed Forward Equalizer

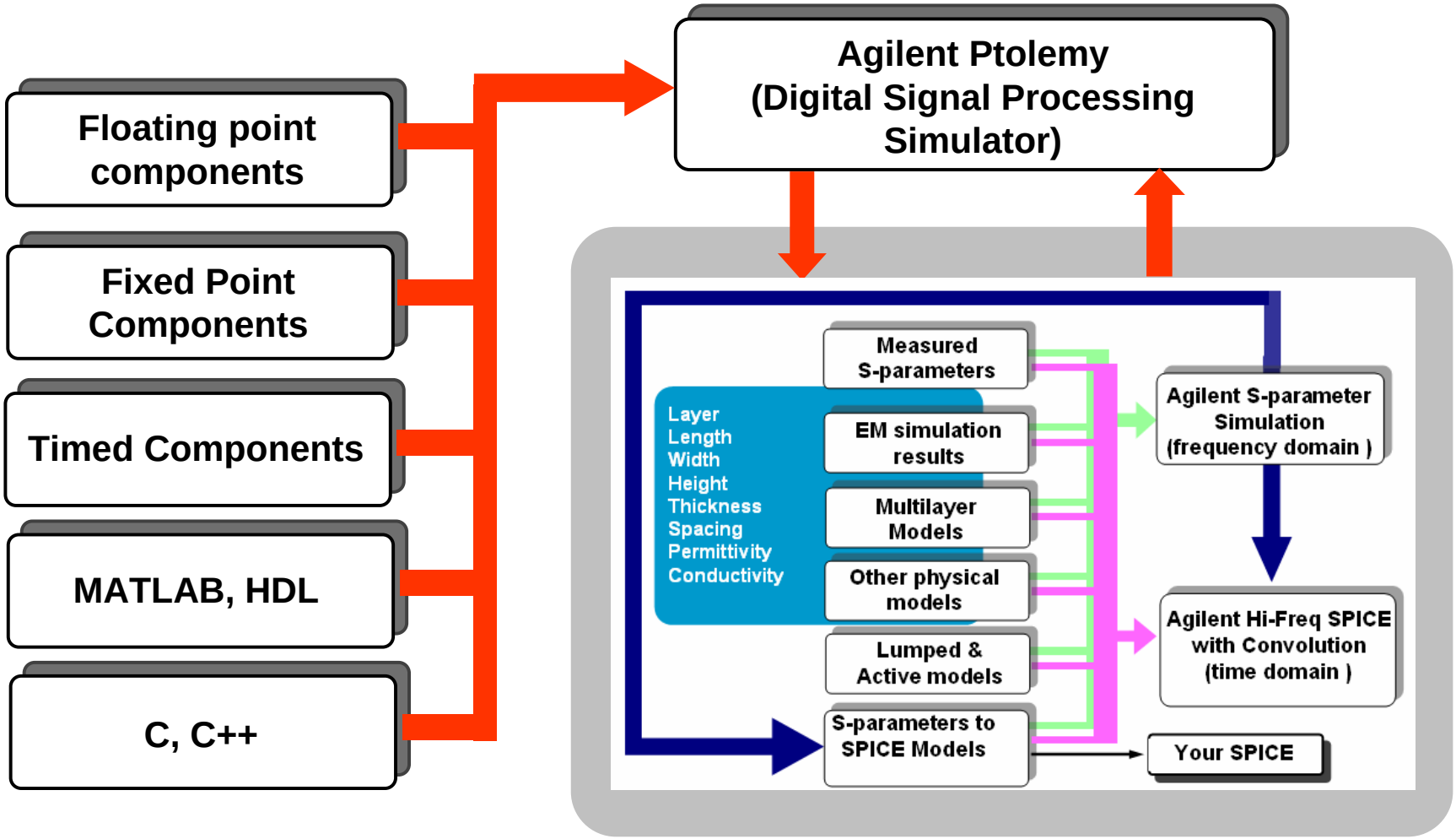
Clock and Data Recovery

Gain Controls

SERDES Models

Best represented in Numeric domain

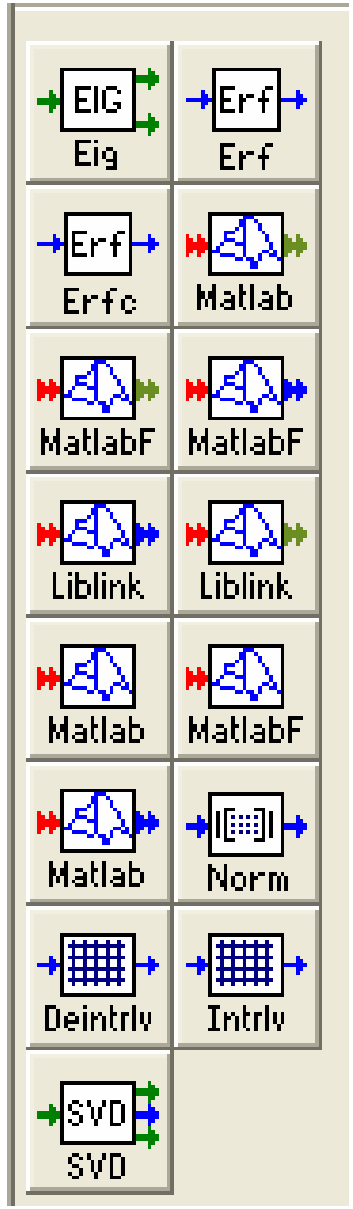
ADS Co-Simulation Design Flow with High Frequency SPICE



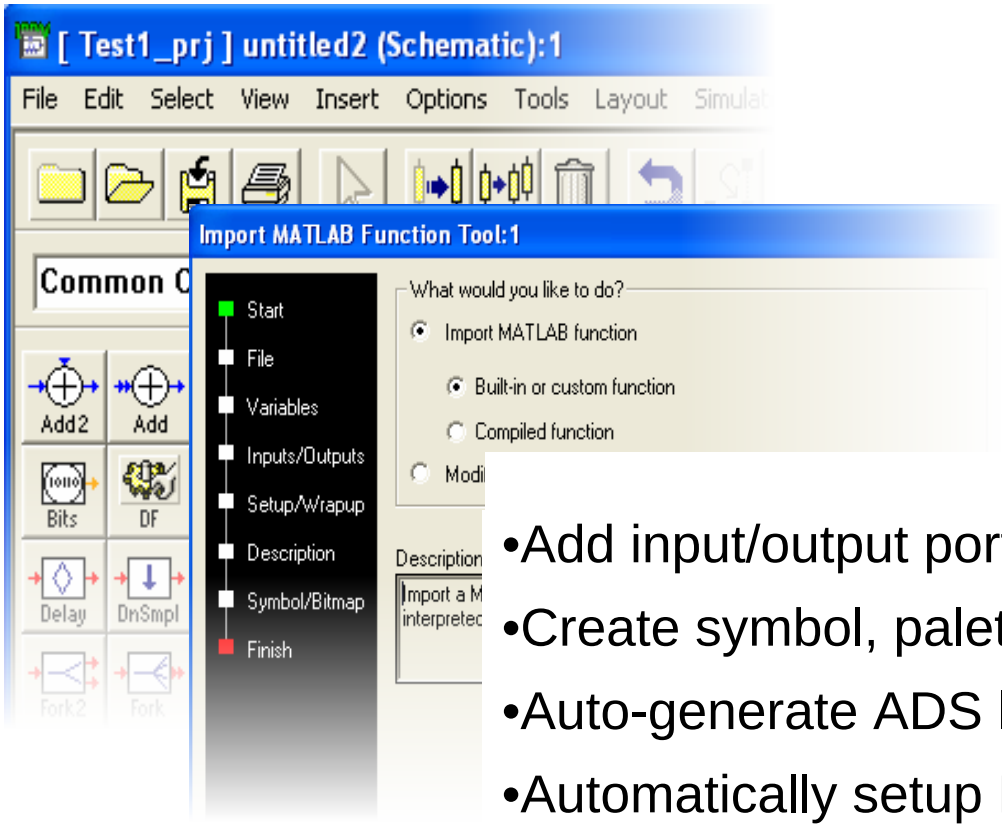
Matlab Co-simulation in ADS

MATLAB Co-simulation is increasingly becoming important for SI design community because:

- Integrate existing IP
- Fast implementation of behavioral models
- Familiarity with the tool and comfort zone
- SERDES models - available as MATLAB models



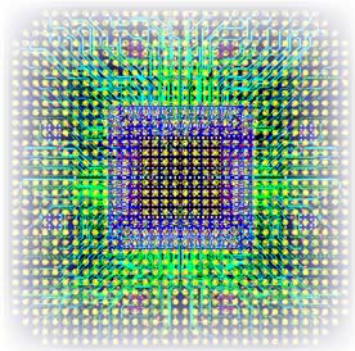
MATLAB Import Wizard in ADS2006A



- Add input/output ports
- Create symbol, palettes, and bitmaps..
- Auto-generate ADS library components
- Automatically setup Multi-rate operations
- Allow iterative update of generated MATLAB model
- Compiled MATLAB model support

ADS High Frequency SPICE Simulation Technology

Gives you confidence that your design will work right, the first time



Passivity and Causality

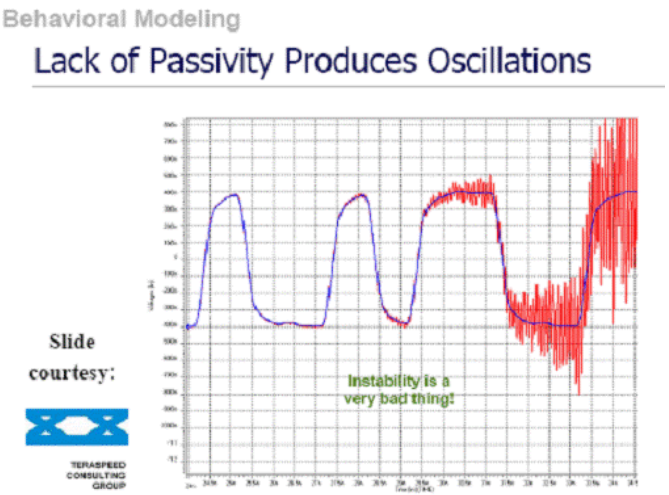
Passive System – A Passive system is the one which can not produce energy

Insufficient attention to measurements or calibration

- Interconnects do not amplify signals
- Even if individual measurements are passive, combined system measurements can be non passive

Causal System – A Causal system in the one whose output at any time depends upon the past inputs and not on future inputs

Passive system needs to be Causal. If a system is non-Causal, it can not be passive



S-Parameters and many SPICE Simulators

- Difficult simulation setup
- Convergence issues
- Questionable accuracy
- Passivity issues
- Causality issues

ADS High-Frequency SPICE with Convolution

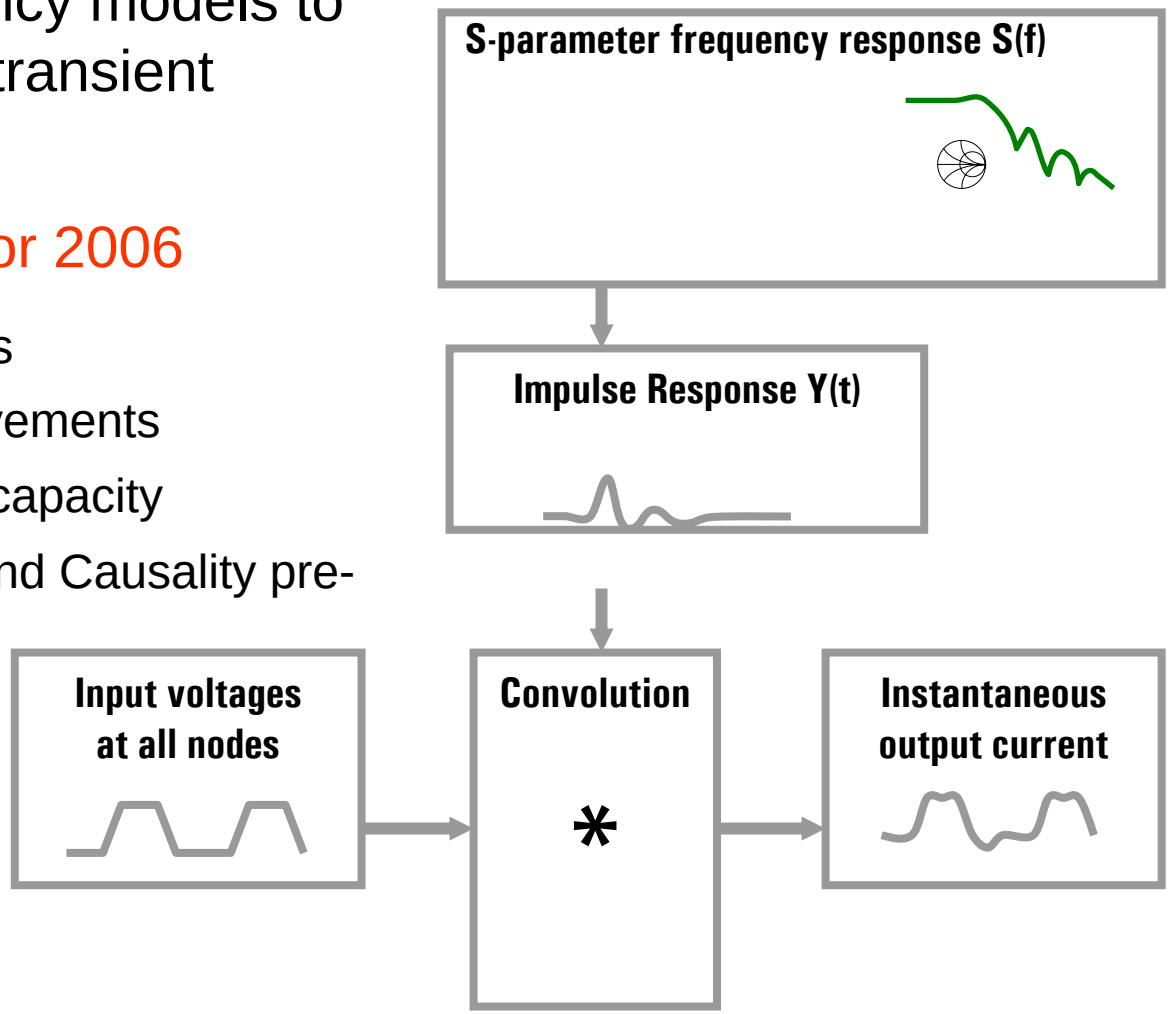
- SPICE developed as an internal tool since 1970 (date)
- High-Frequency SPICE commercialized in 1983 (date)
- Convolution simulator commercialized in 1992
- Fast and Accurate time-domain simulation of S-parameters

Convolution Simulator in ADS

Allows high-frequency models to be used directly in transient simulations

EEsof R&D focus for 2006

- Speed improvements
- Convergence improvements
- Increase simulation capacity
- Enhance Passivity and Causality pre-conditioner



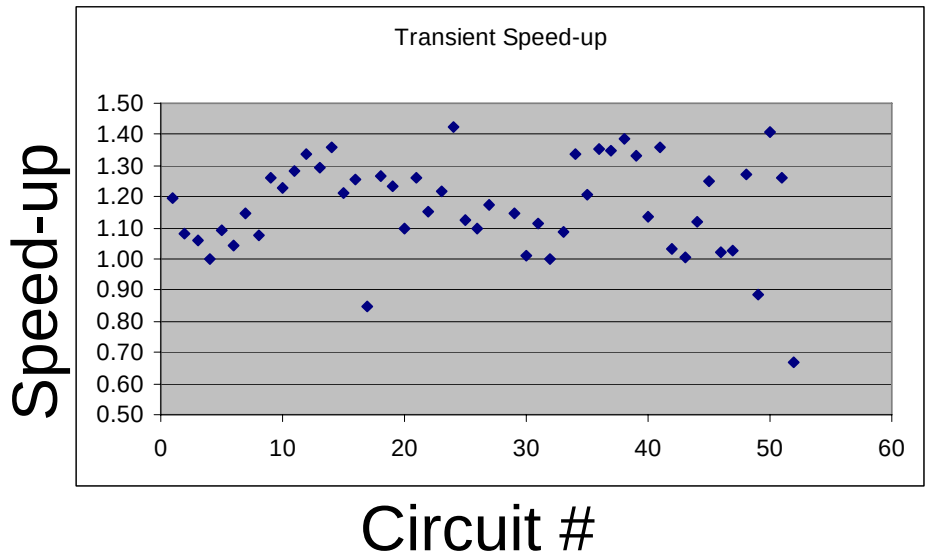
Strong focus on High-Frequency SPICE

High-Frequency SPICE is slower than H-SPICE and SPECTRE

The October release is 30% faster

- *Early Access Code available*

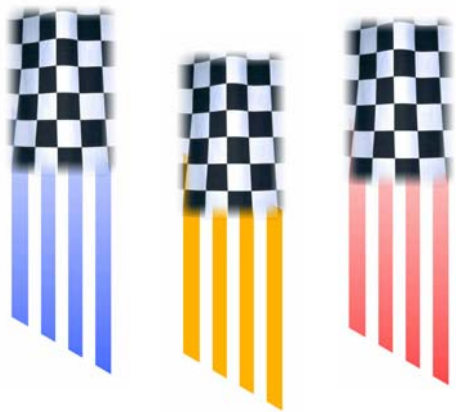
  – Algorithmic improvements
  – Device optimization
  – Code optimization



Convolution Technology Advances

New engine for robust handling of S-parameter data in the time domain, employing:

- Break-through technology for built-in causality correction
- Optional passivity correction

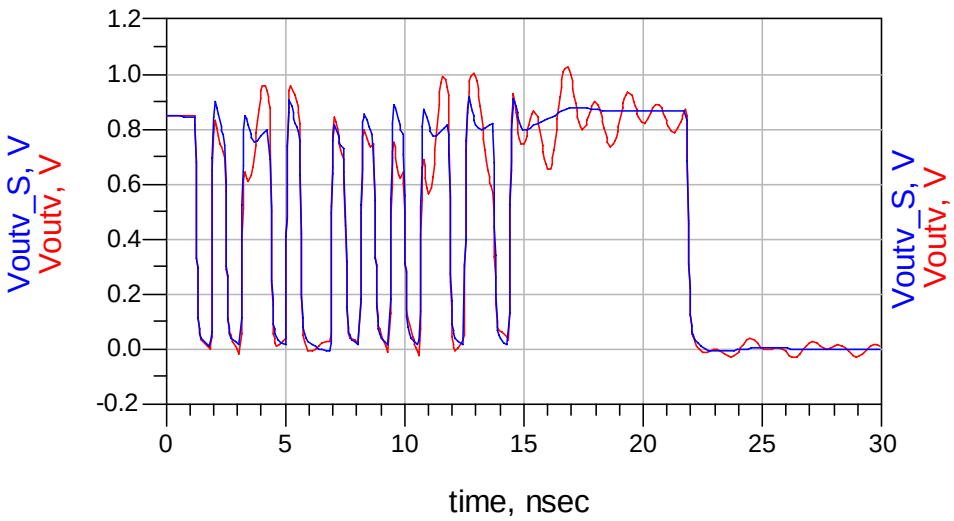


Convolution Technology Improvements
High Accuracy

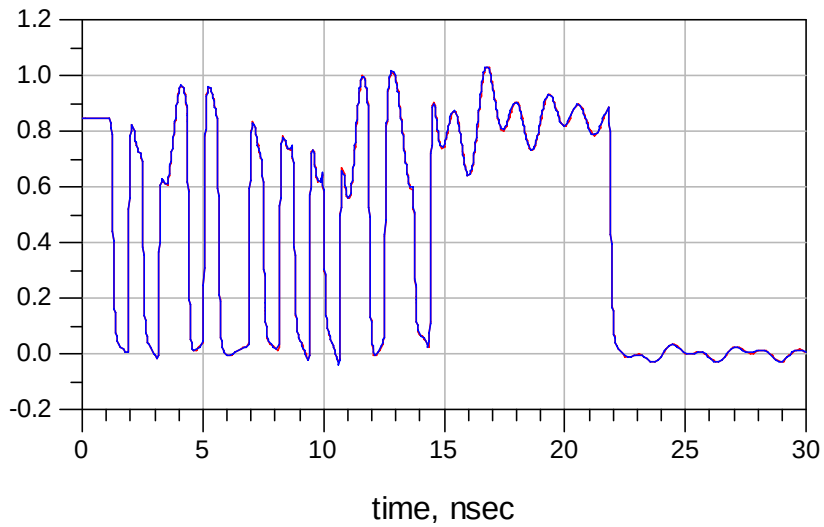
Example:

Low impedance power/ground plane(mOhms) into 50 Ohm reference impedance

Reference Results Existing Engine

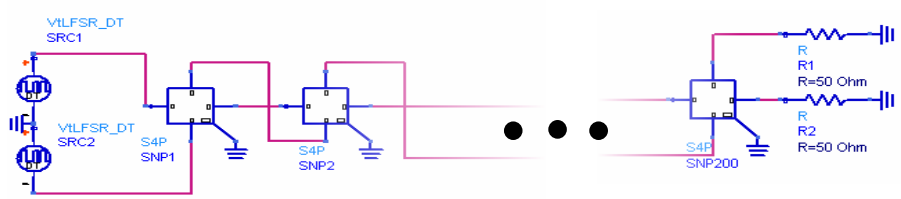


Reference Results New Engine



Convolution Technology Improvements

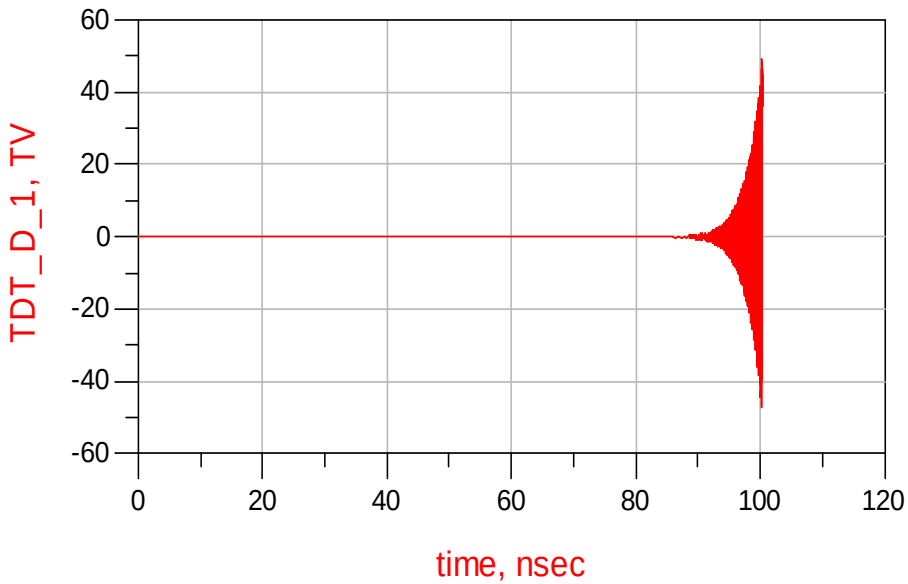
Robustness



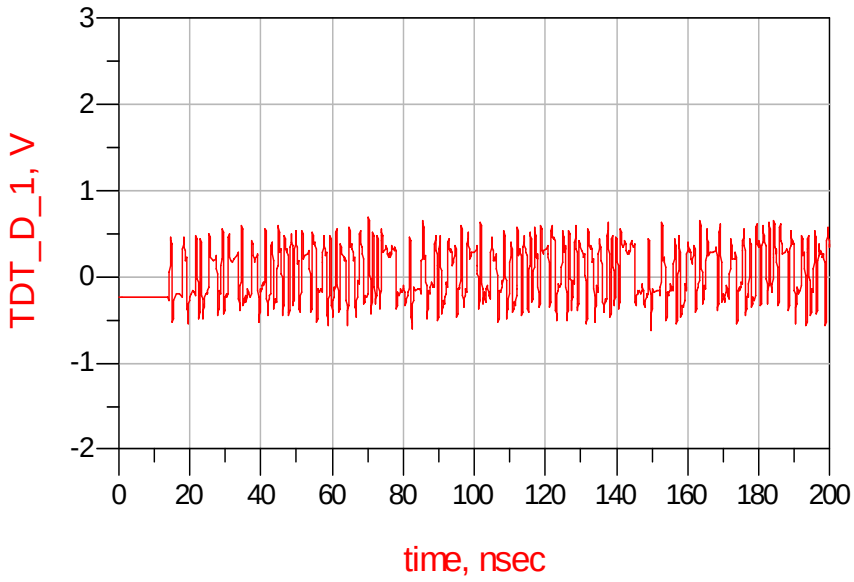
Example:

- 200 identical, 4-port s-parameter devices in cascade
- Each s-parameter file slightly **non-passive**

Existing Engine



New Engine



Agilent Technologies

Why Digital Designer needs Electromagnetic Simulator?

- Convenient and inexpensive way to evaluate arbitrary structure performance.
- What if analysis is possible with inexpensive iterations
- Expands varieties and range of analytical models
- Overcome limitation of analytical models

Two personas

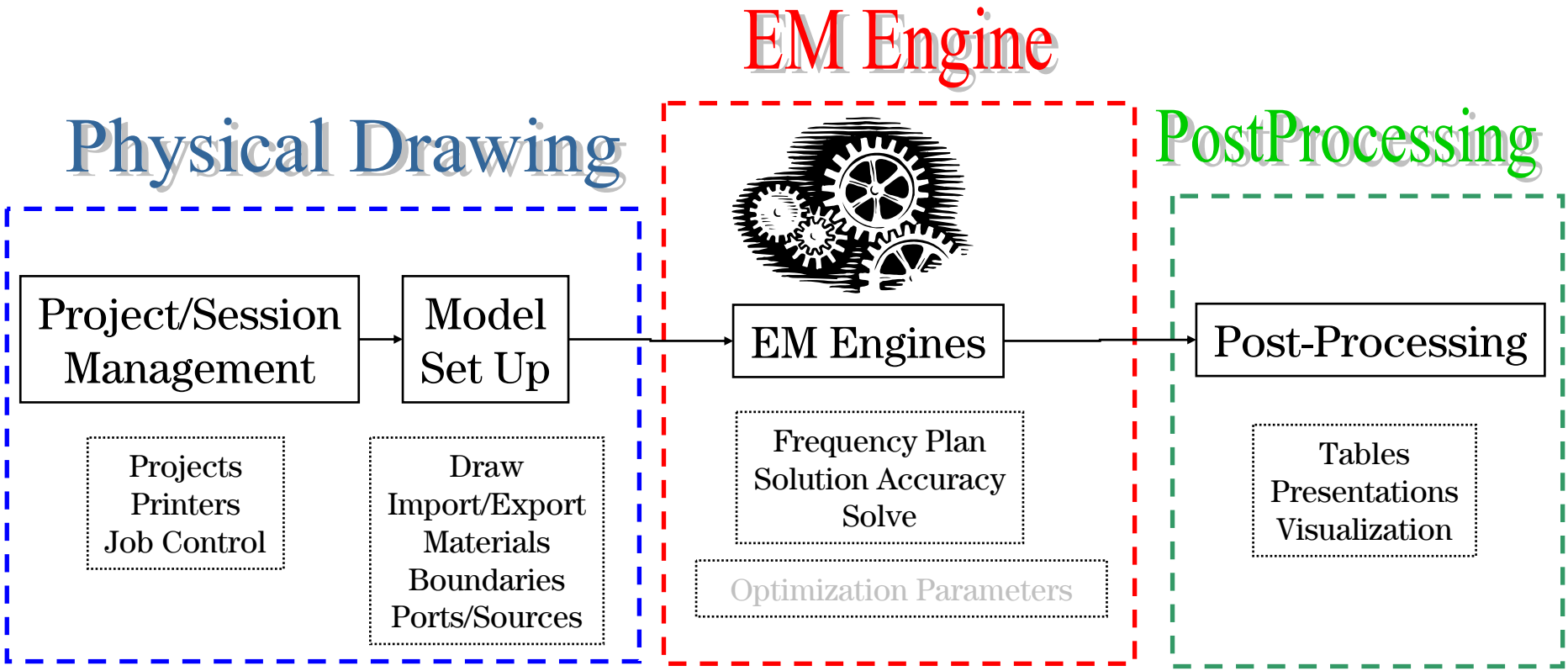
Signal integrity gurus who creates design rule

- Requires simulation tool flexibility and power
- Accurate EM simulation
- Requirement to model electrically small structures

Post layout design verification

- Requires high capacity EM solver
- Approximate EM solutions
- Single click button operations

Electromagnetic Simulation



- **Momentum Simulator**
- **EMDS (Electromagnetic Design System)**

Momentum 3D Planar Electromagnetic Simulator

Momentum is a 3-D planar fullwave electromagnetic solver based on Method-of-Moments

- “3-D planar” because it assumes metal lies in distinct planes between slabs of dielectric, possibly connected with vias

Calculates S-parameters for metallization on PCB’s, MCM’s, IC’s and Package

- S-parameters are then used directly in circuit simulations or to create an equivalent circuit model
- Can handle imperfect ground planes, vias, semiconductors, lossy dielectrics, skin effect losses, dispersion, radiation and surface-wave effects
- Static solvers are faster but miss many fullwave effects

Electromagnetic Simulation Flow

Allegro/Gerber/Mentor/GDSII/Mask…

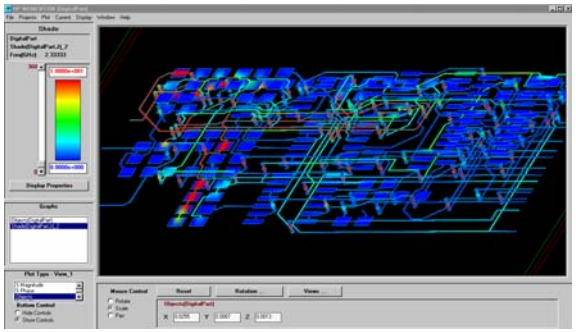
.sat File Import
(To be released in Oct'2006)

ADS Layout

EMDS Interface

Momentum

EMDS



S-Parameters

Agilent Broadband SPICE Model Generator

Lumped Equivalent

—— Enhancements in ADS2006A

Agilent's Broadband SPICE Model Generator

Solves new challenges

"***Expands SI Horizon***"

Preview: Agilent Broadband SPICE Model Generator *(January 2007)*

- Takes an S-parameter frequency response and outputs a lumped equivalent SPICE netlist fragment
- S-parameters can come from simulations, EM, or measurements
- Helps you to export models for connectors, packages, and interconnects to your customers and other designers
- You can continue to work at higher frequencies with deeper understanding
- Helps extend the simulation frequency range for band limited data

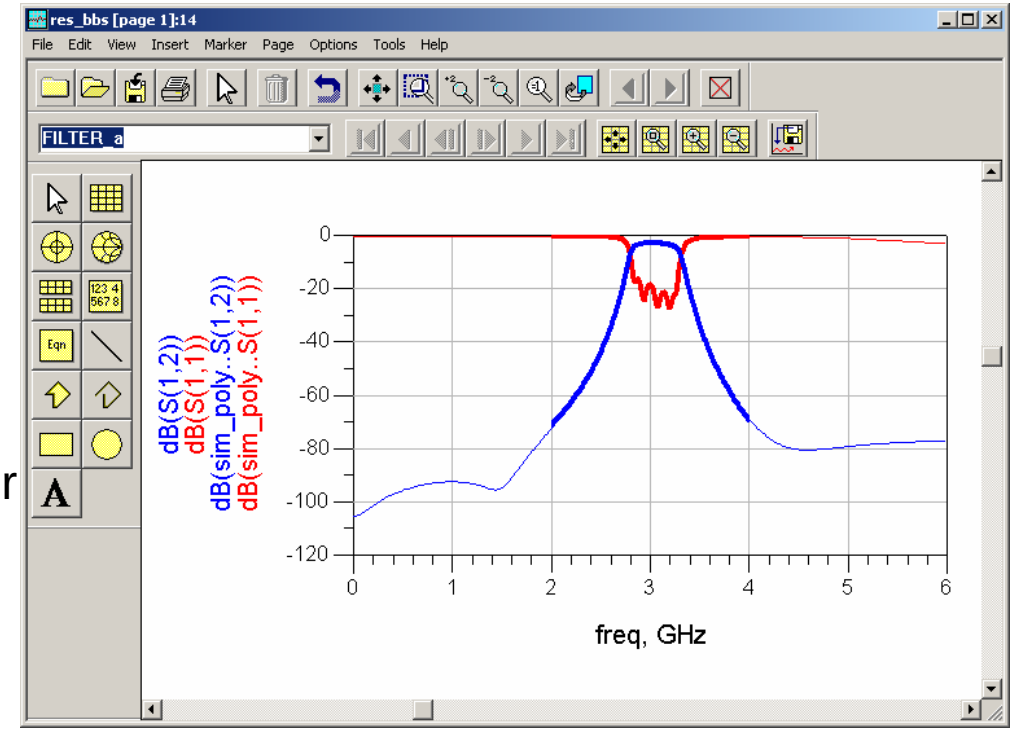
Typical applications:

- RFIC: data for spiral inductors, IC packages, DUT boards
- Signal integrity and high-speed interconnect applications
- Wideband physical structures, and connectors

Preview: the E4687 Agilent's Broadband SPICE Model Generator *(January 2007)*

What it does:

- Takes in frequency-domain S/Y/Z-parameters
- Outputs a fast, well-behaved SPICE equivalent circuit
  - Berkeley Spice 2G6 & 3, rational polynomials, and other native formats



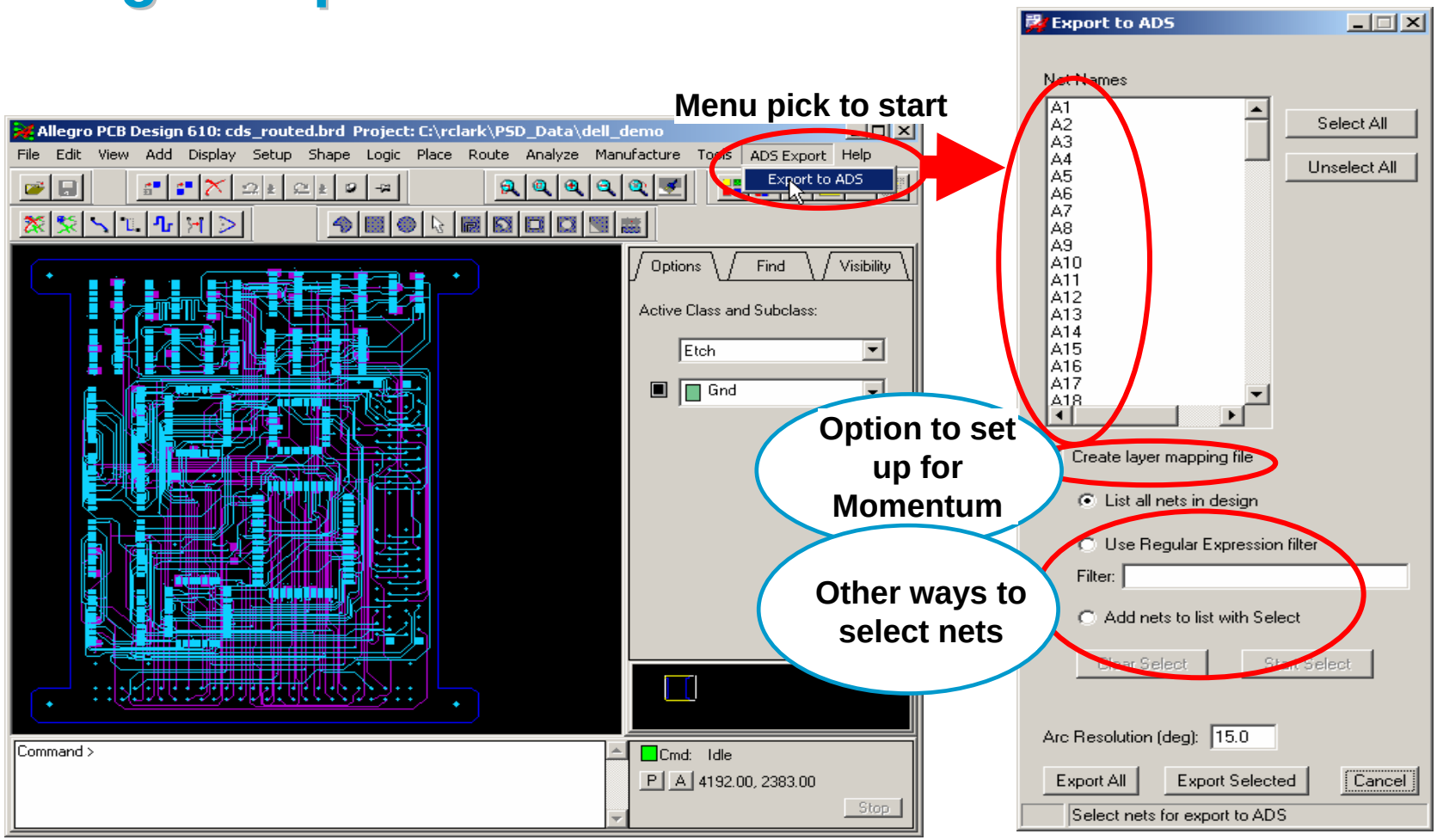
Design Flow Integration
Allegro→ ADS

Solves new challenges

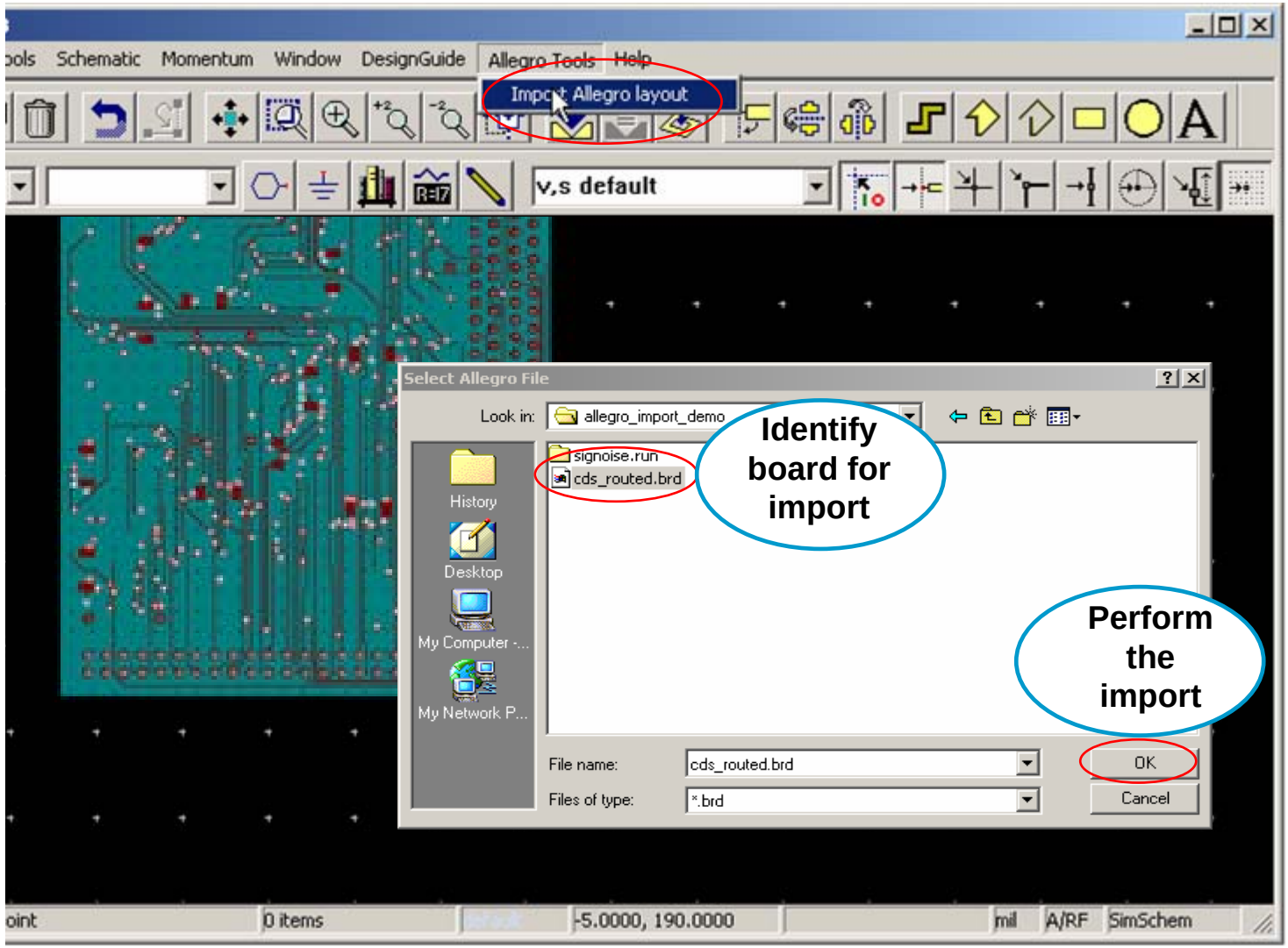
"***Expands SI Horizon***"

Shipment Date- January 2007
(ADS 2006A Update 1)

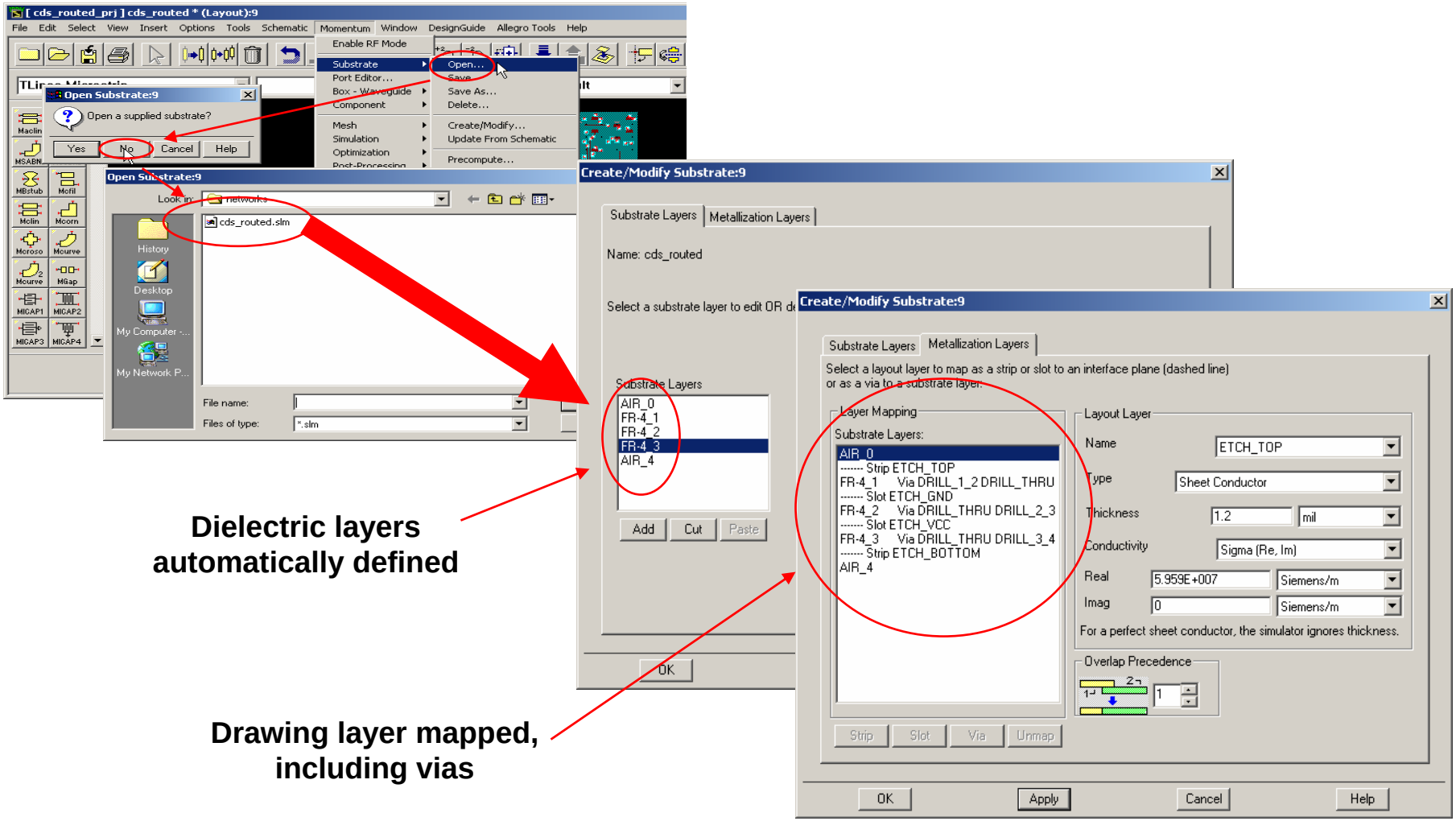
Allegro export interface



ADS import interface



User loads exported Momentum substrate information



Dielectric layers automatically defined

Drawing layer mapped, including vias

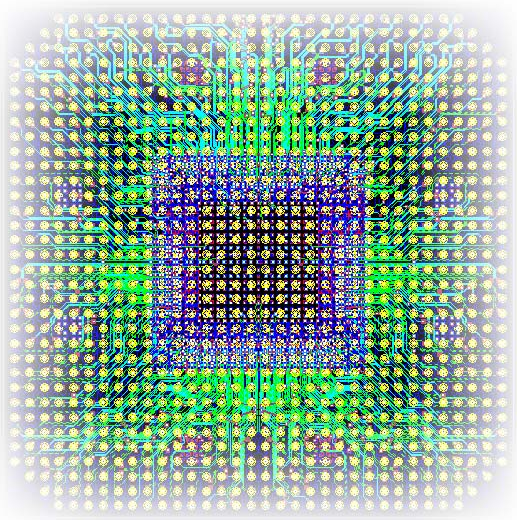
Extended Performance in 2006

- Conquers existing problems faster and more effectively
- Gives you confidence that your design will work right, the first time.

Simulator improvements

64-bit OS support

Other core improvements to PDE, Data Display, Layout, Simulators



Momentum –

Continued enhancements for complex metallization

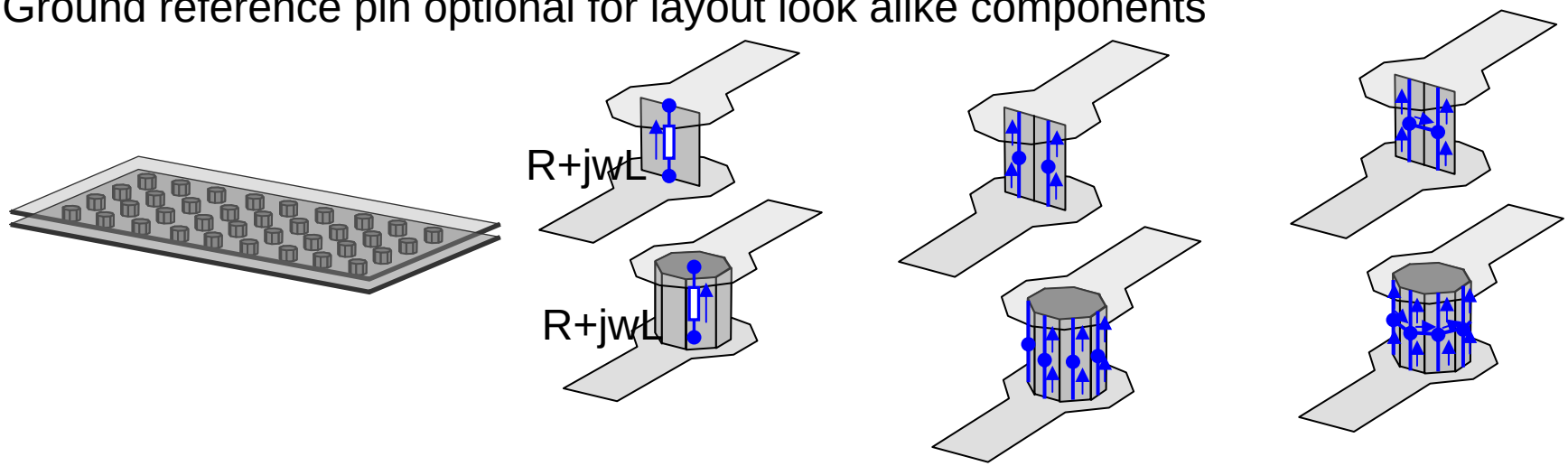
Improved Via modeling

- Lumped via model
- 2D via model (pre-ADS2006A model)
- 3D distributed model

64-bits solver handles larger problems

Enhanced port editing

Ground reference pin optional for layout look alike components

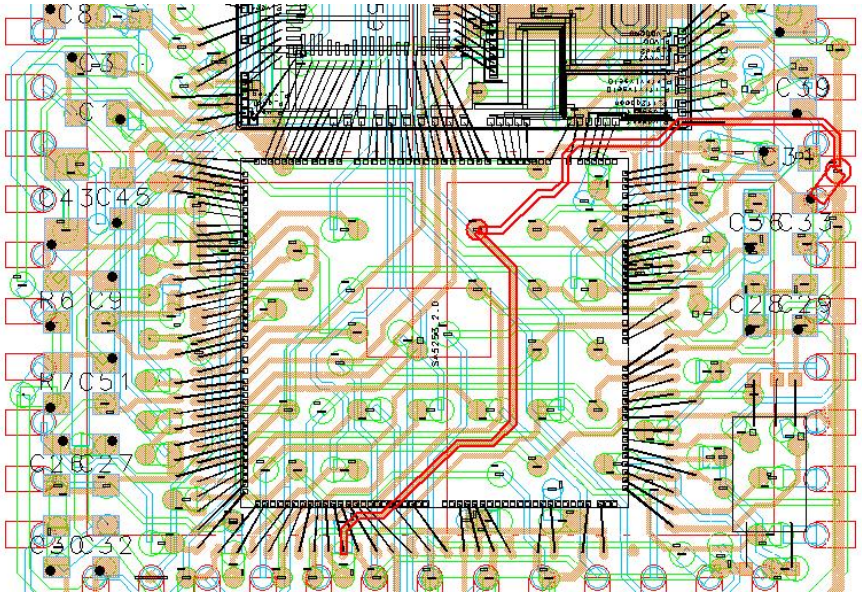


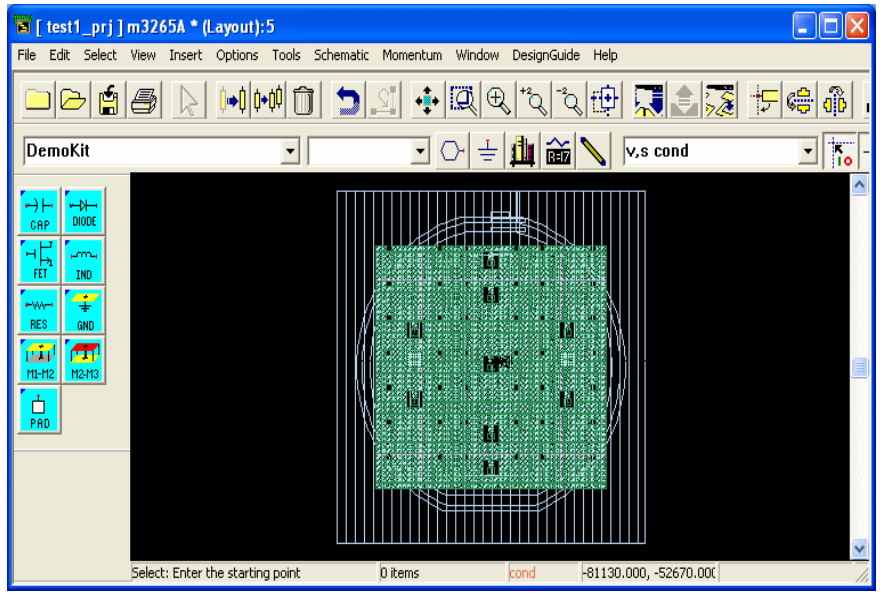
Layout – Performance gains with the new Physical Connectivity Engine (PCE)

Significant performance gain for PCE for large designs.

ADS 2005A could be slow when opening a large design for the first time → 2006A: almost no overhead for the connectivity engine

2005A User Interface to disable the connectivity engine was difficult
→ 2006A: easy “Preference” setting, but not necessary to disable



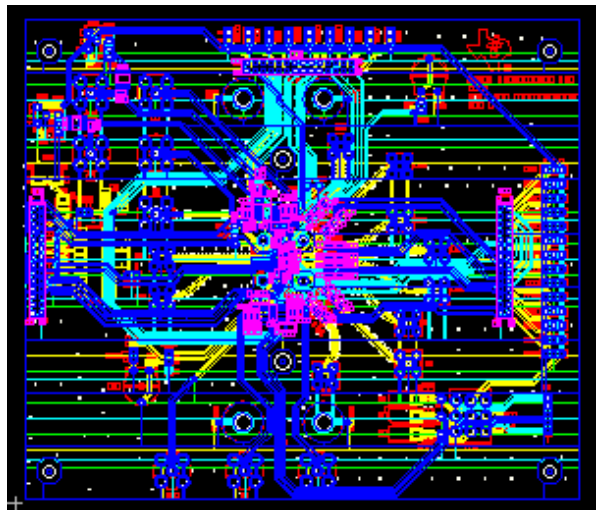


Layout – Performance gains with connectivity

Flatten design

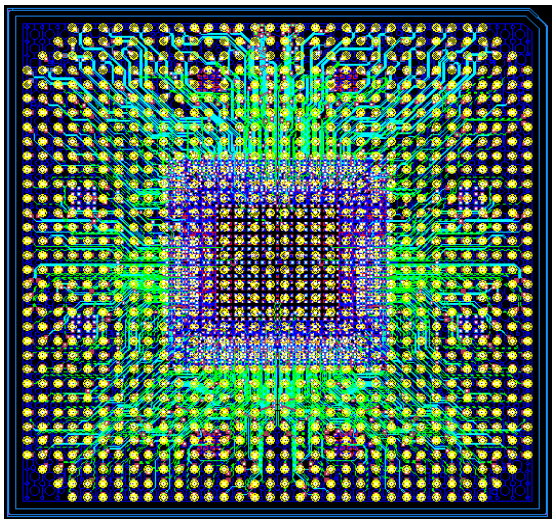
2006A Load time: **1.5sec** (0.5sec if PCE OFF)

2005A Load time*:* 5sec



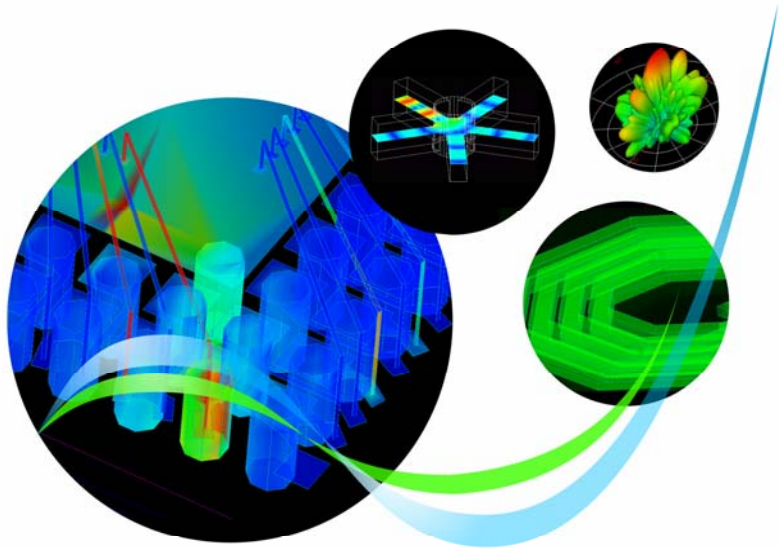
BGA Package

Load time : **8X** faster in ADS2006A as compared to ADS2005A



Design	Connectivity off *(load time)*	Connectivity on, 2006A	Connectivity on, 2005A
1	< 1 sec	< 1sec, 52MB	2.3sec, 69MB
2	4 sec	5sec, 52MB	20sec, 216MB
3	30 sec	35sec, 67MB	load failed
4	5 sec	6sec, 55MB	16sec, 110MB
5	12 sec	12sec, 53MB	15sec, 69MB
6	22 sec	23sec, 54MB	>>120 sec, 300MB
7	72 sec	78sec, 130MB	1200sec, 630MB
8	9 sec	12sec, 13MB	17sec, 40MB

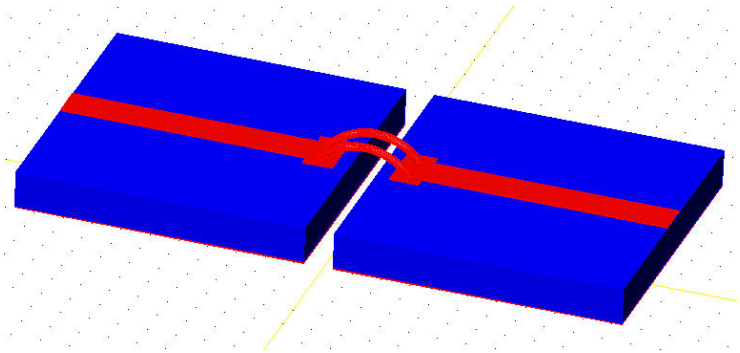
Electromagnetic Design System (EMDS)

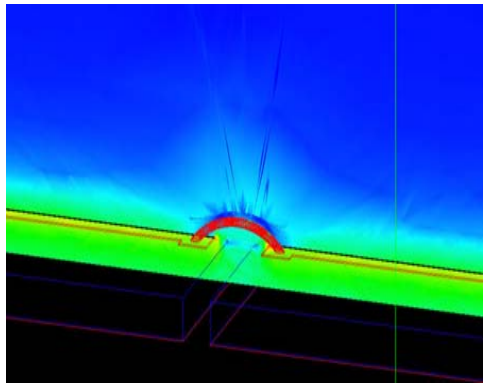


For engineers designing:

- **Vias**
- **Packages**
- **Wire-bonds**
- **Transitions to connectors**
- **High-frequency interconnects**
- **Un-intentional antennas**

EMDS – Agilent's 3D Full Wave EM simulator

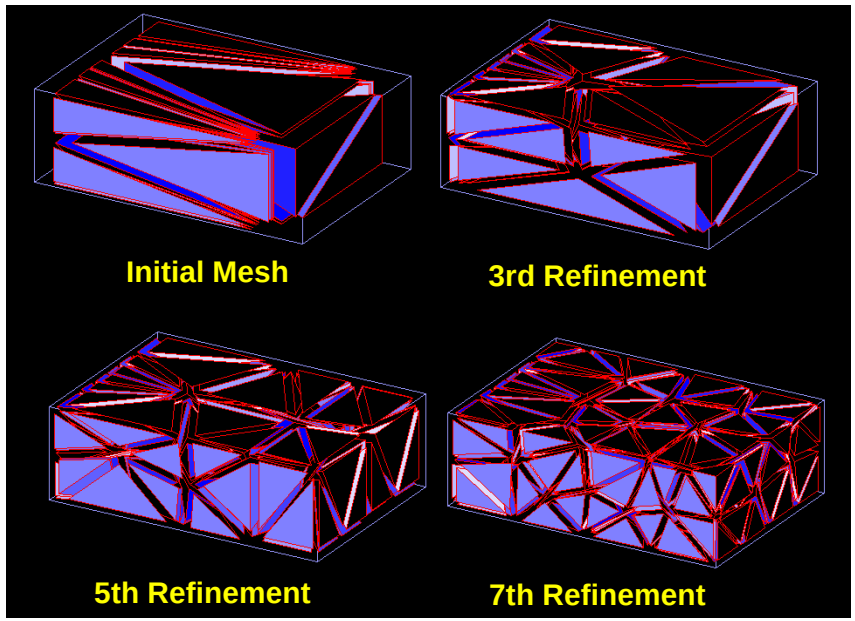




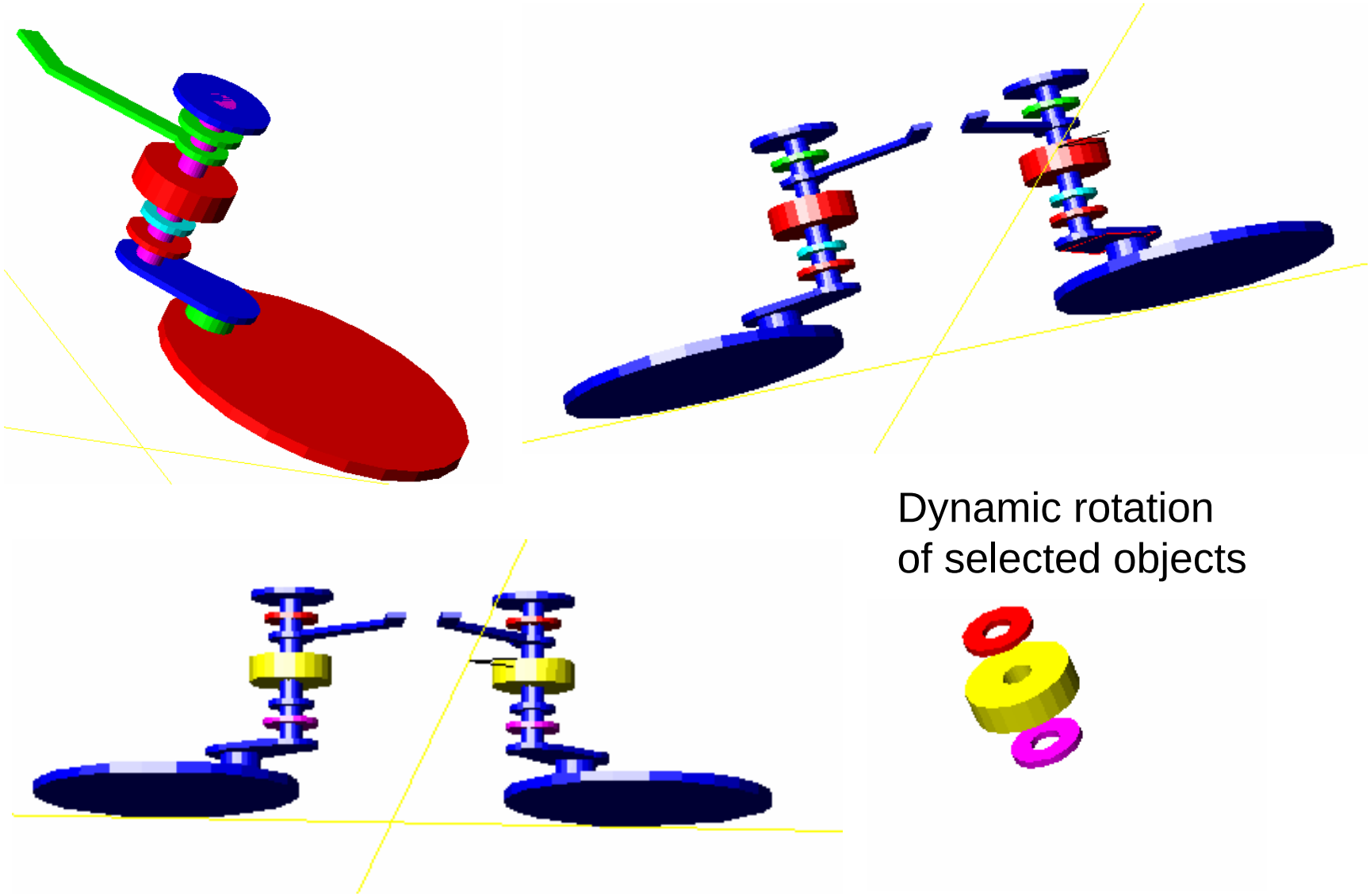
Fast and accurate electromagnetic simulation of arbitrary 3D passive components using FEM

Simulated data

- S-parameters
- Electric and magnetic fields
- Multi-mode impedance and propagation constants

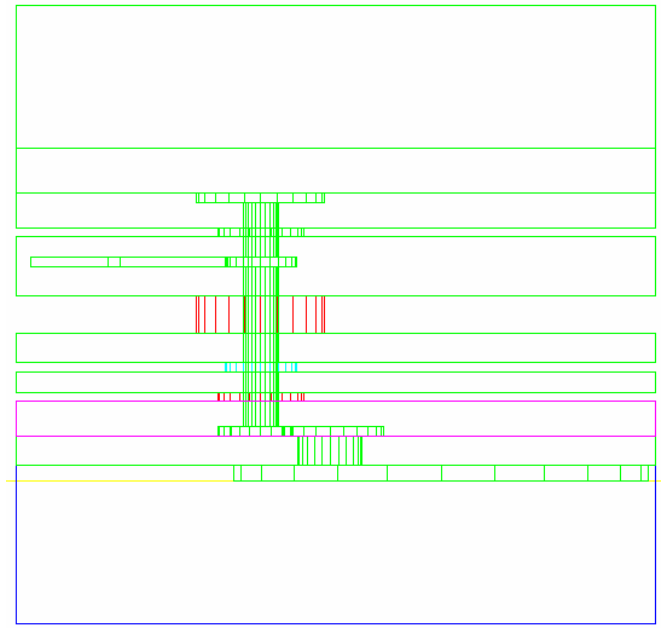


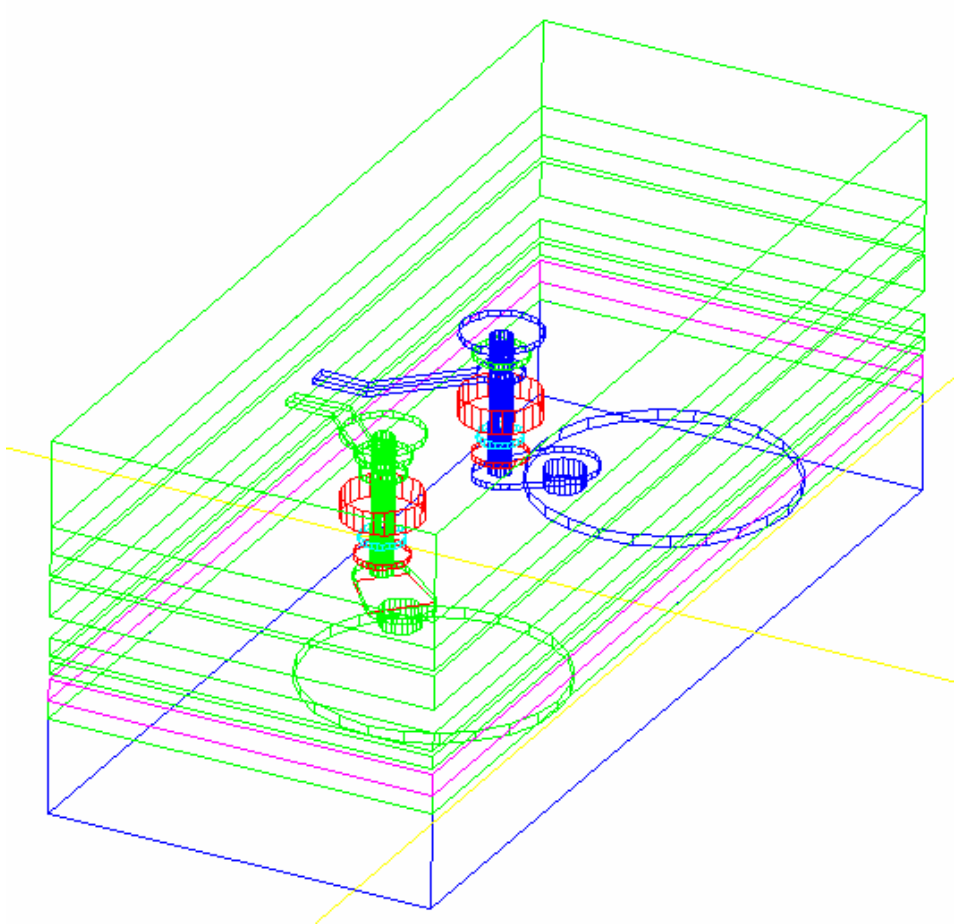
Differential Via Modeling Using EMDS



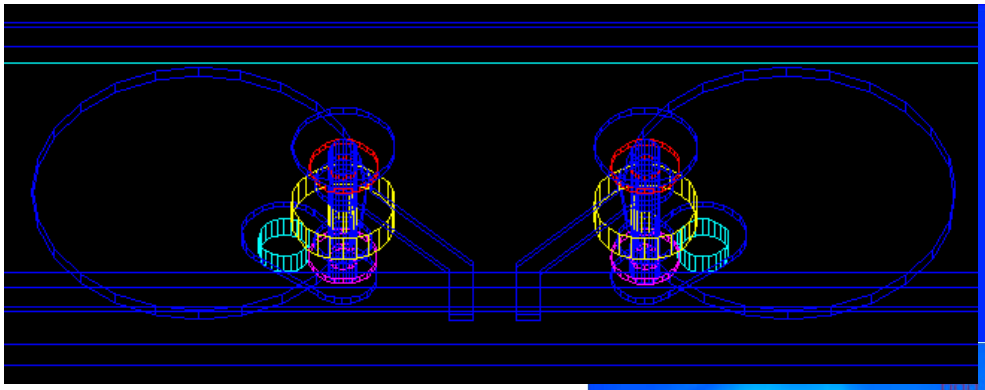
Dynamic rotation
of selected objects

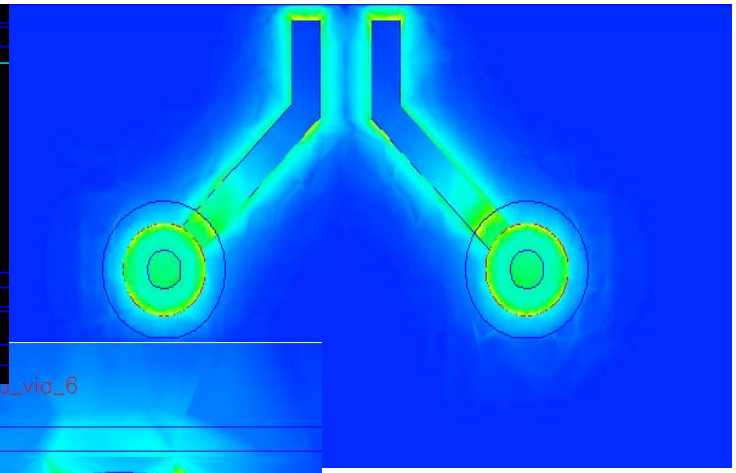
Cross-Sectional View with Dielectric Layers Defined

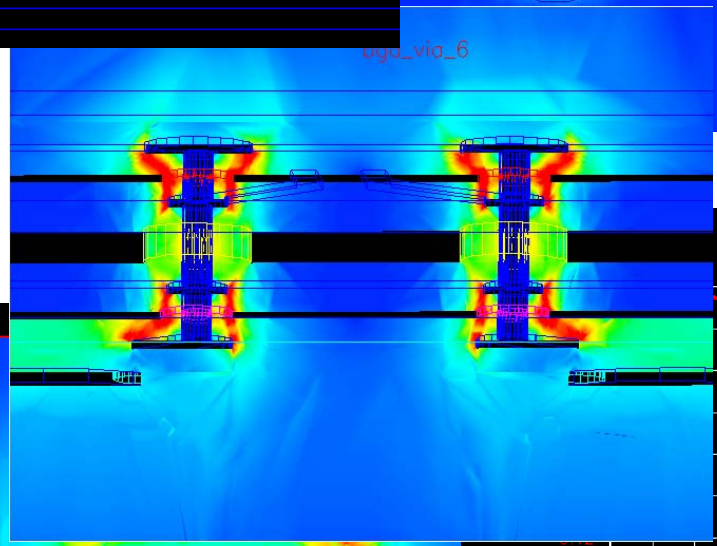


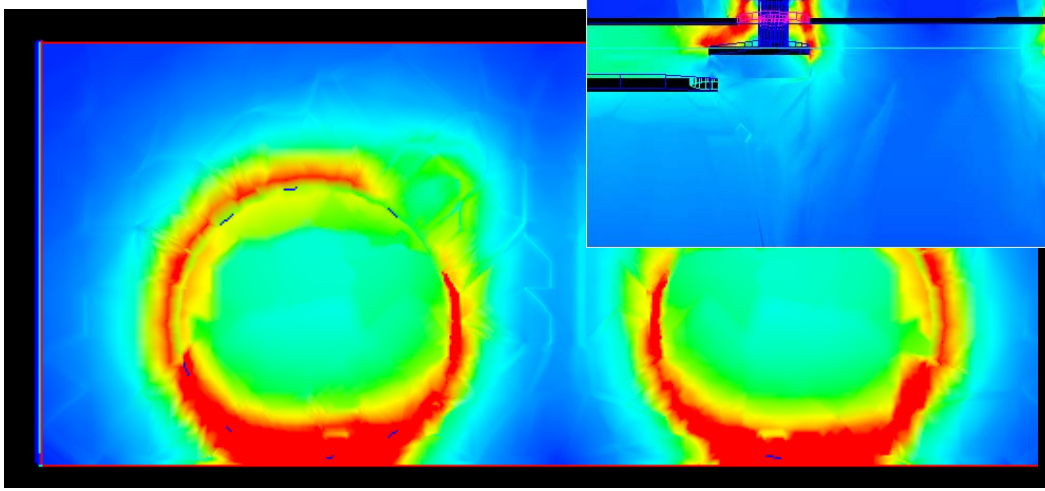


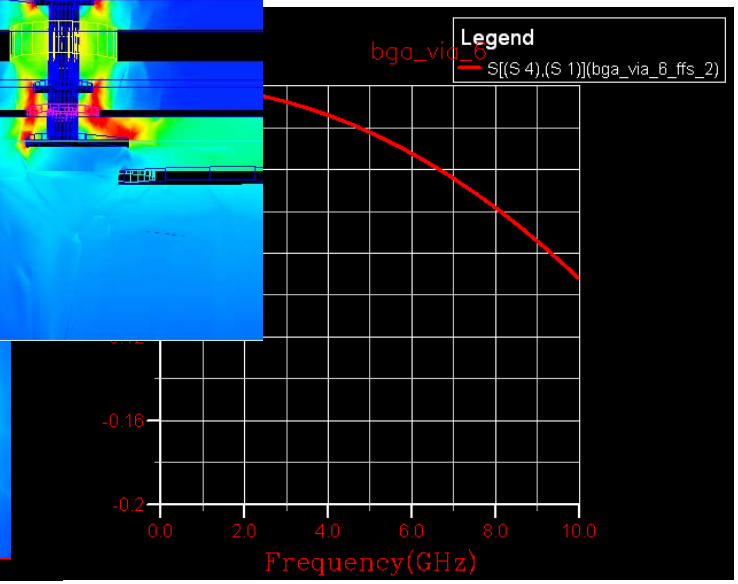
Data Visualization





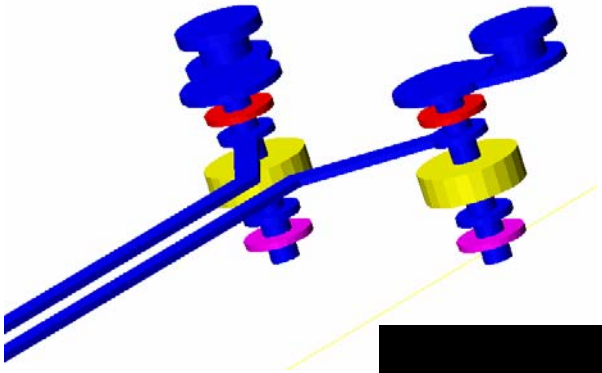


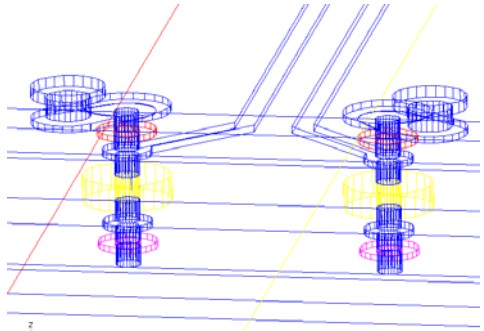


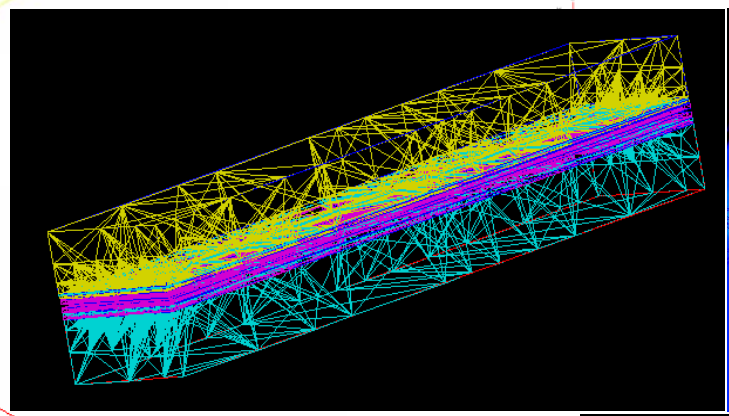


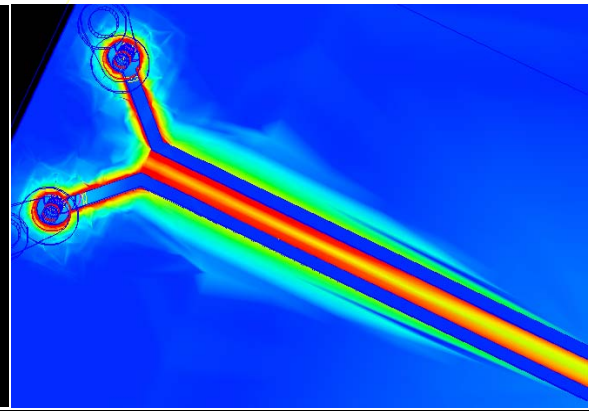
Agilent Technologies

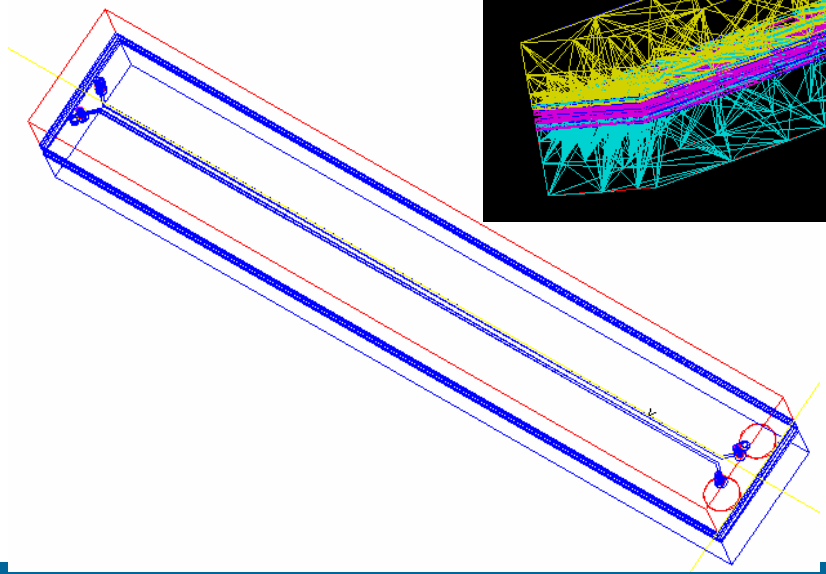
HyperBGA Differential Trace Analysis using EMDS

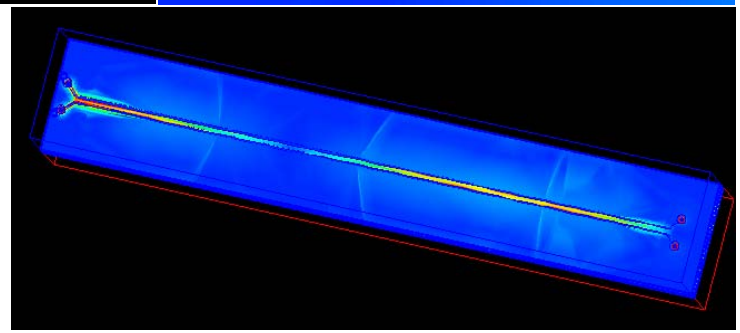






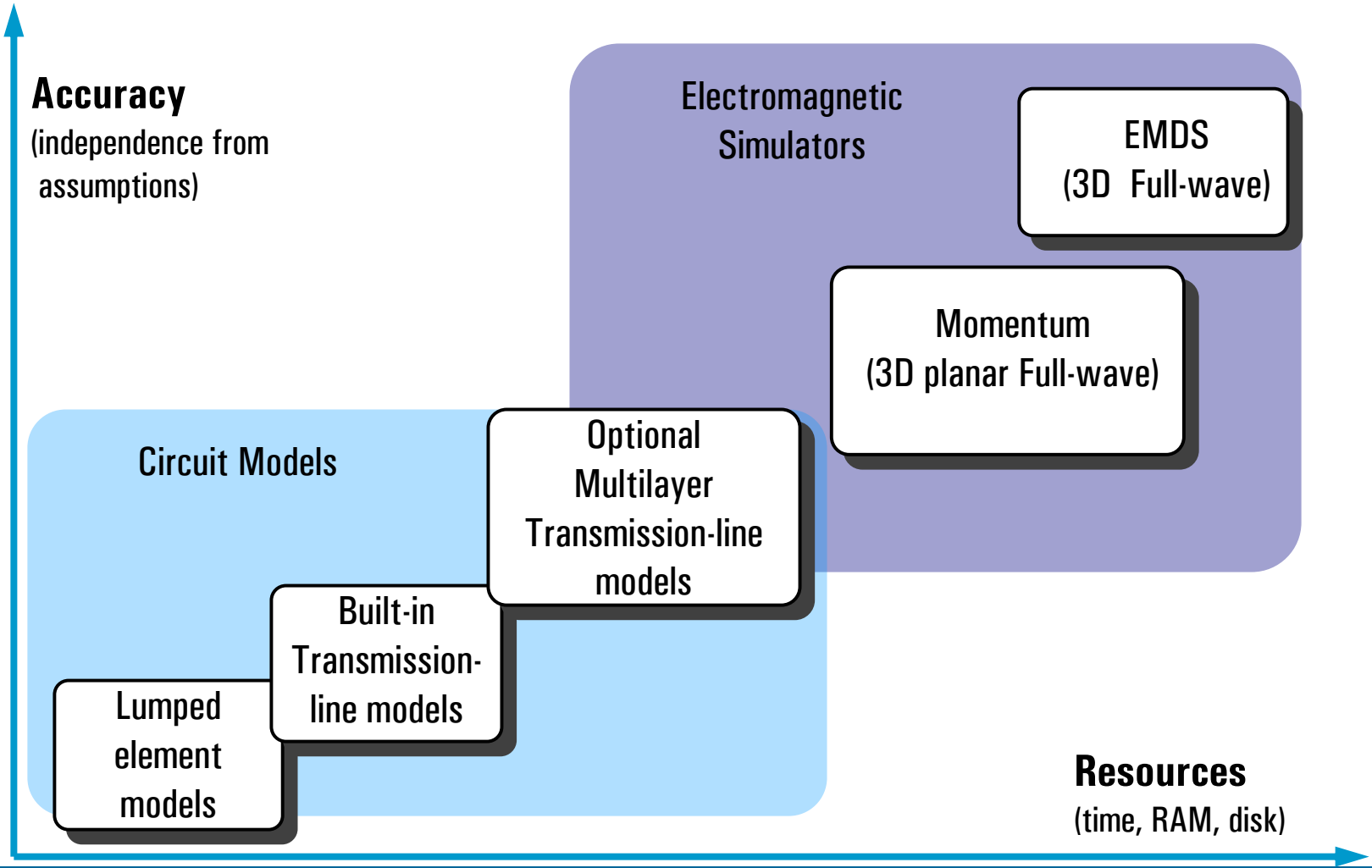






Where you need Momentum and where EMDS?

Continuum of Speed vs. Accuracy



What's in ADS for High Speed Digital

"Expands SI Horizon"

1. **Leading Simulation Technology**
   solves new problems and
   gives you a design advantage
2. **Accurate Models**
   conquer existing problems so
   you are confident that designs
   will work the first time.
3. **Accessibility & Flow Integration**
   within your Design Flow puts Agilent
   tools closer to the design problems
4. **Usability and Quality**
   frees your creativity and makes the most of your effort

DesignCon 2007

Subject to approval

- Calibration Techniques for 4-port and 12-port Differential PCB Structures *by Heidi Barnes et el.- Verigy Inc.*

- DDJ(Data Dependent Jitter) Predictor Implemented on Agilent ADS(Advanced Design System) *by LEO Li - Agilent Technologies*

- Dynamic Transient Load Emulator: The Power Validation of a Network Processor Package *by Straty Argyrakis- CISCO*

- Determining Jitter and Voltage Margin Compliance in Equalized High-Loss Systems using S-parameter, Behavioral, and Circuit-Level Models *by Tom Dagostino et el.– Teraspeed Consulting Group LLC*

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