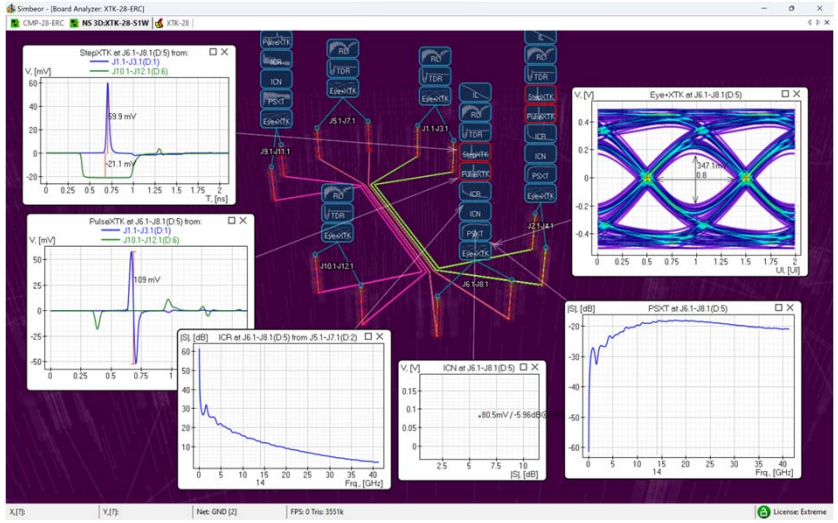
Simberian Electromagnetic Solutions

# Simbeor

## Electromagnetic Signal Integrity Software to Design Predictable PCB/Packaging Interconnects

*Recently Implemented Features:*

- *SI Compliance Analyzer: ERC, FSI, 3DSI, LNA modes…*
- *Post-layout analysis automation with Lua scripting…*
- *New capabilities in Simbeor SDK for AI (JSON)…*
- *De-embedded vertical ports for BGA and connectors…*
- *Absorbing boundary conditions in Simbeor 3DML*



# Problem

- Data rates in PCB interconnects are increasing in all signaling protocols (PCIe, DDR, GDDR, Ethernet, USB, SAS, InfiniBand, CEI, OIF, 5G,…)
- Most of those high-speed signaling standards have one-lane data rates over 6 Gbps and some up to 448 Gbps with signal spectrum in microwave and even millimeter wave bandwidth
- **Signal distortion by reflections, dissipation, and crosstalk can cause interconnect performance degradation or even failure**
- To avoid it, signal integrity compliance analysis and possible interconnect optimization is required (rules of thumb or un-qualified software cannot be used)
- **Simbeor software is the ideal solution for that – it is electromagnetic compliance verification tool for PCB/PKG interconnects**

# Predictable Interconnects Design

- Identify broadband **dielectric and conductor roughness models** with Simbeor software or ask PCB vendor to do it - such models are essential for accuracy
- Evaluate the **localization and reference integrity** with Simbeor software and fix it - some interconnects may be not localized and, thus, unpredictable in general.
- Identify **modifications of stackup structure, trace width and shape, and via drill diameter** or ask PCB vendor about expected adjustments during manufacturing - Simbeor provides simple interface to account for such adjustments in the analysis.

*The chances of interconnect failure will be dramatically reduced if the analysis software is systematically validated (**sink or swim approach**).*

# Simbeor SI Compliance Analyzer

- **Unique one-stop solution for interactive or automated compliance validation**
- Electrical Rule Checking: 2D Field Solver + Fast Via Models
  - Model-based SI link defect checking – localization, reference and impedance continuity, crosstalk
  - Interactive analysis of links in fraction of a second or thousands of links with automation
- Fast SI: De-composition + 2D Field Solver + Fast Via Models
  - Basic signal integrity analysis: crosstalk, losses, delay and skew for relatively slow signals (<10 Gpbs, >100 ps rise time)
  - Interactive analysis of links in seconds or hundreds of links with automation
- 3D SI – De-composition + Field Solver (2D or 3D) + 3D Full Wave EM
  - Advanced Signal Integrity Analysis of PCB/Packaging Interconnects (unlimited data rates, accuracy depends on geometry, materials and link localization)
  - Interactive analysis of links in minutes or hundreds of links with automation
- LNA – pre-layout and multi-board compliance validation

All types of analyses are automated in Simbeor THz with Lua and interface to Matlab and Python!

# Multi-Pass Compliance Validation

1. Pass Reference Integrity and Localization (ERC & if necessary 3DTF)
2. Pass Trace Impedance Continuity (ERC & FSI)
3. Pass Crosstalk (ERC, FSI & 3DSI)
4. Pass Insertion and Reflection Loss (3DSI)
5. Pass COM or BER (3DSI with local coupling)

Move to the next item only IF the previous level is PASSED

# Simbeor Applications

- Universal Signal Integrity Analysis
  - **Material model identification, de-embedding, S-parameters quality assurance...**
  - Simulation-based advanced Electrical Rule Checking (ERC)
  - Pre-layout and automated post-layout analysis with 3D EM models
  - S-parameters, Losses, Reflections, Crosstalk, TDR/TDT, Eye Diagram, Single Bit or Symbol Response (SBR or SSR), Pulse Response
  - Viaholes, component pads geometry and complete link tuning optimization
- SerDes Channel Design (Serial Interconnects)
  - Standard Compliance Metrics (SCM - IL, RL, ILD, PSXT, MDXT, ICR, ICN): Simbeor only
  - Channel Operating Margin (COM) – Simbeor with Matlab
  - Bit Error Rate (BER) with IBIS AMI – Simbeor with PyBERT, or Matlab + SI Toolkit, or ADS Core + HSD Ckt Sim, or HyperLinx LineSim + IBIS-AMI
- DDRx Interface Design (Parallel Interconnects)
  - Impedance, Reflections and Delay: Simbeor only
  - Analysis with IBIS models: BB SPICE or S-parameters extraction in Simbeor and Matlab + SI Toolkit, or ADS Core + Mem. Designer, HyperLynx LineSim for analysis with IBIS models

# Simbeor Main Advantages

- **Accurate** - ensured with validation projects – just some validation projects are published at www.simberian.com
- **Productive** – fast de-compositional EM analysis + domain decomposition + distributed computing
- **Easy to Use** – tools with integrated intuitive interface, well documented SDK with examples and multiple kits
- **Scalable** – interfaces to all components in C, Matlab, Python for pre-layout analysis and optimization, post-layout compliance analysis automation with Lua

# Simbeor Solvers and Algorithms

- **Simbeor SFS** – unique quasi-static field solver for large t-line cross-sections (any planar cross-section)
  - MoM, supports all dispersive isotropic material and roughness models
  - Used for S-parameters computation or creates Tabulated W-element models for transmission line
- **Simbeor 3DML** – full-wave 3D analysis tool for multi-layered geometries
  - Hybrid solver: Method of Lines + Trefftz Finite Elements + Method of Simultaneous Diagonalization (de-embedding)
  - Analysis of discontinuities and transmission lines with high-frequency (non-TEM) dispersion and anisotropy (any planar cross-section), interconnects with meshed planes
- **Simbeor 3DTF** – full-wave 3D analysis with Trefftz finite elements for discontinuities and non-TEM transmission lines, interconnects with meshed planes (high bandwidth memory applications), interconnects on ICs, PI problems,…
- **Simbeor 3DML and 3DTF** solvers are accelerated with domain decomposition and parallelized locally and with distributed computing (includes cloud computing framework)
- Fast EM solver for low-reflection via geometry synthesis or via delay evaluation (**fast via models** with infinite planes)
- **Linear Network Solvers** – unique port-based analysis
  - 7 solvers for FD and TD analysis of multiport networks based on Y or S-parameters – sparse solvers for extremely large networks
  - **Complete link analysis, material parameters identification, test fixture extraction and de-embedding capabilities**
- **Rational Compactor** – converts discrete S-parameter models into frequency-continuous rational macro-models – generate BB SPICE models for any network described with S-parameters
- **Copper Helper** – set of proprietary algorithms for fast PCB/packaging geometry processing, visualization and SI/PI model building (multiple orders of magnitude faster then any commercial analog)

All solvers and algorithms are available in Simbeor THz as well as in Simbeor SDK!

# Simbeor Tools

- **Touchstone Analyzer™** – S-parameters plotting, quality assurance and macro-modeling (available in SDK)
- **Transmission line wizard** – fast synthesis of any single-ended and differential line geometry (strip, micro-strip, CPW, CBCPW,…, available in SDK)
- **Via Analyzer™** – fast synthesis of via-holes and launches geometry (available in SDK)
- **Multi-layered Geometry Editor** for pre and post-layout analyses
- **Linear Network Editor** to draw multiport networks (link path models)
- **SiTune™** – via, t-line geometry, linear network optimization, material model identification (available in SDK)
- **Eye Analyzer™** - measurements on eye diagram (available in SDK)
- **ICN Analyzer™** - for Integrated Cross-talk Noise (ICN) computation (available in SDK)
- **Board Analyzer™** - tools for unique post-layout de-compositional electromagnetic analysis
  - **DeComposer™** - automatic decomposition for post-layout analysis of coupled and skewed links into t-lines and discontinuities with precise handling of reference discontinuities
  - **SI Compliance Analyzer™** - unified interface for model-based ERC, Fast SI, 3D SI and LNA analyses
- **Violation Browser™** - viewer for ERC violations from SI Compliance Analzyer and EMSAT (IBM) rule checkers
- **SPP Analyzer™** – material model identification with TDT or short pulse measurements (IBM)
- **T-Resonator Analyzer™** – extraction of loss tangent with T-resonator (available in SDK)
- **SDK Kits for Matlab** – AdvMaterialKit, MLKit, TLineKit, SIPlotKit, ViaDevKit, AdvXTalkKit, FEW_Kit, AdvViaKit…

All tools are integrated in Simbeor THz and all are available in Simbeor SDK (except BA)!

# Simbeor SDK

- Simbeor SDK is dynamic link libraries with API in C language for programming or scripting in C/C++, Matlab and Python
- It provides access to all Simbeor solvers and all tools, except Board Analyzer, and can be used for…
  - **material model identification** – single case or extraction of statistical models
  - **design automation** – scripted EM analysis, geometry synthesis, complete link analysis…
  - **AI and machine learning** – training or complimenting machine learning algorithms and use in AI Agents…
  - **integration into other EDA tools** (such as Stack Manager in Altium Designer)
  - **access and post-processing of post-layout extraction results**

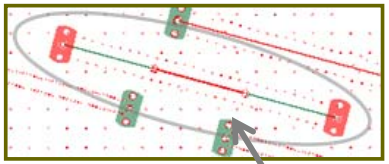
# Typical Use of Simbeor

- **Dielectric and conductor roughness** model identification (4 methods) – to ensure accuracy of interconnect analysis
- **Pre-layout de-compositional electromagnetic analysis** or PCB/packaging interconnects
  - Stackup design – t-line synthesis/analysis for all PCB/packaging applications (no restriction)
  - Viahole design for low-speed applications (based on fast EM solver, coming up)
  - Broadband viahole optimization for serial or point-to-point links (use of 3DML and 3TDF solvers and optimization, coming up)
  - Impedance, loss, mode conversion, reflection (vias) and cross-talk control during layout process

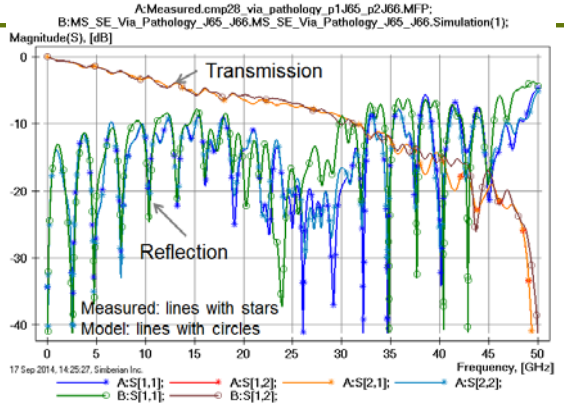
- **Automatic post-layout de-compositional electromagnetic analysis** or PCB/packaging interconnects – the Holy Grail of the post-layout analysis
  - Complete link analysis: S-parameters, compliance metrics, TDR/TDT, eye diagrams, pulse response,…
- **Post-layout analysis automation with Lua**, to ensure compliance and consistency of design iteration
- **Scripting in C/C++/Matlab/python** for pre-layout design automation, material identification and machine learning

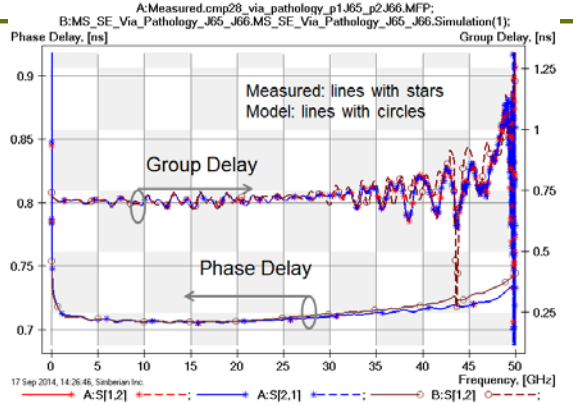
# Simbeor is formally validated up to 50 GHz

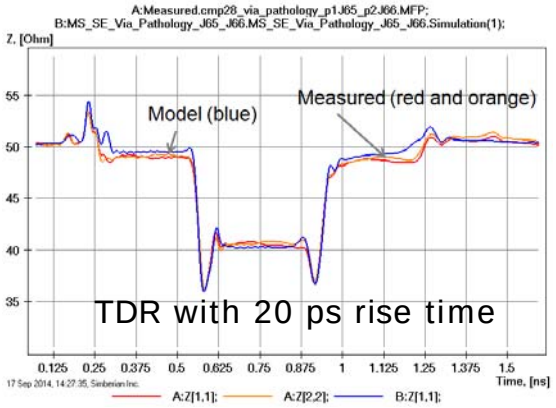
EXAMPLE

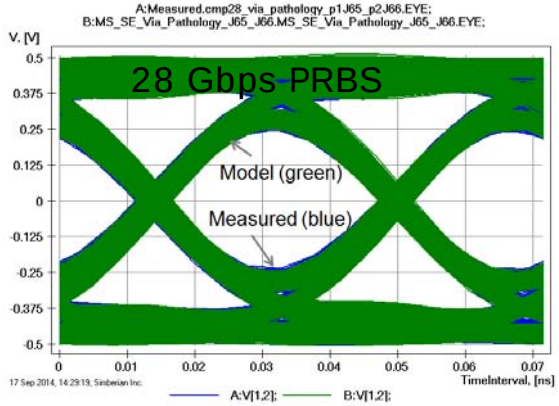


*CMP-28 Channel Validation Platform from Wild River Technology LLC*




See Webinar #4. Complete description of CMP-28/32 platforms with all results is available at **http://www.simberian.com/Presentations/CMP-28_Simbeor_Kit_Guide.pdf**

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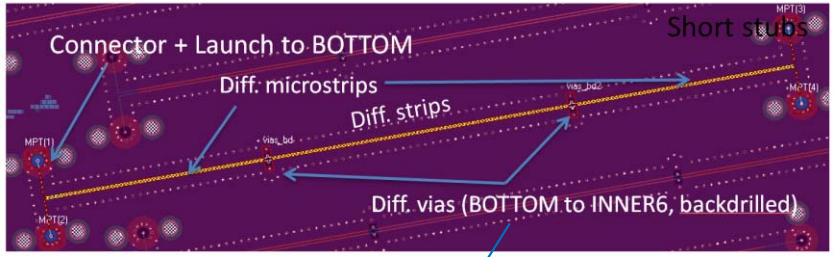
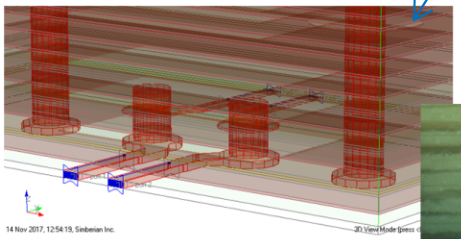
# Example of systematic validation with EvR-1 test board from Infinera

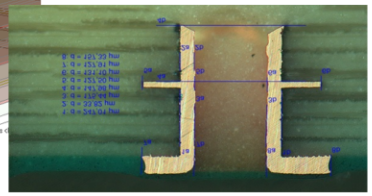
1.1 in microstrips – vias – 1.5 in strips – vias – 1.1 in microstrips

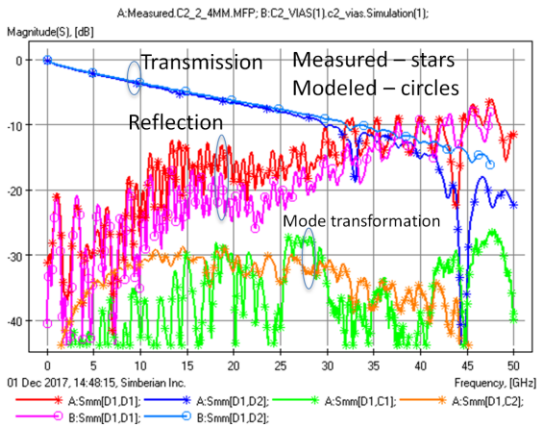


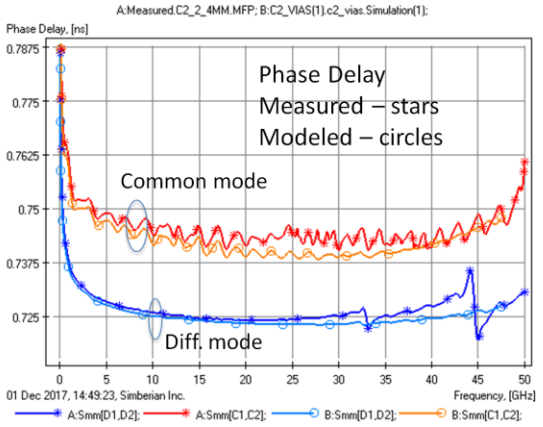

Backdrilled vias model

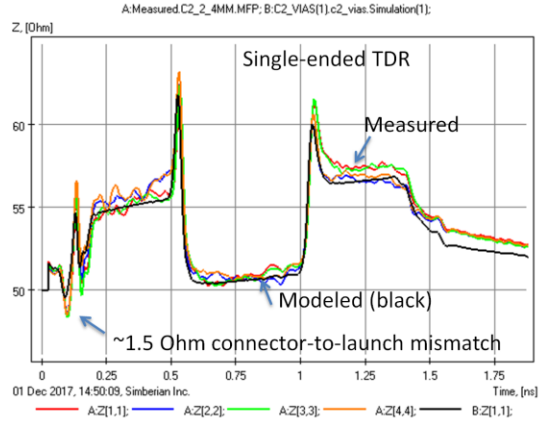


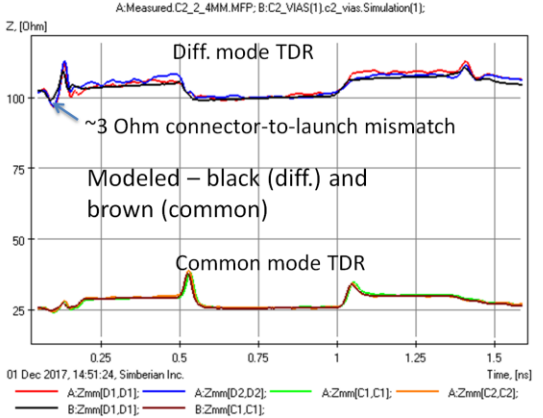
De-compositional EM analysis
Shape and size of all traces and backdrilling position are adjusted…






Complete report #2018_01 at
http://www.simberian.com/AppNotes.php

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# Why use Simbeor?

- The most cost-effective electromagnetic signal integrity software on the market – see prices at https://www.simberian.com/OrderForm.php
- Provides systematic “sink or swim” approach to design predictable interconnects
- Algorithms are systematically validated with measurements up to 50 GHz!
- Unique algorithms for material models identification – must be the basis of systematic approach to design predictable interconnects
- Advanced and verifiably accurate models of transmission lines
- Unique EM models for flexible interconnects and periodic structures
- Unique macro-modeling capabilities for consistent FD and TD analyses of networks with t-lines and S-parameter models (seamless FD<->TD analyses)
- Unique de-embedding capabilities (part of LNS)
- Advanced and verifiably accurate models of discontinuities (vias, pins,…)
- Unique de-compositional capabilities for chip-to-chip link analysis




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# Simbeor

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To learn more, visit www.simberian.com

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