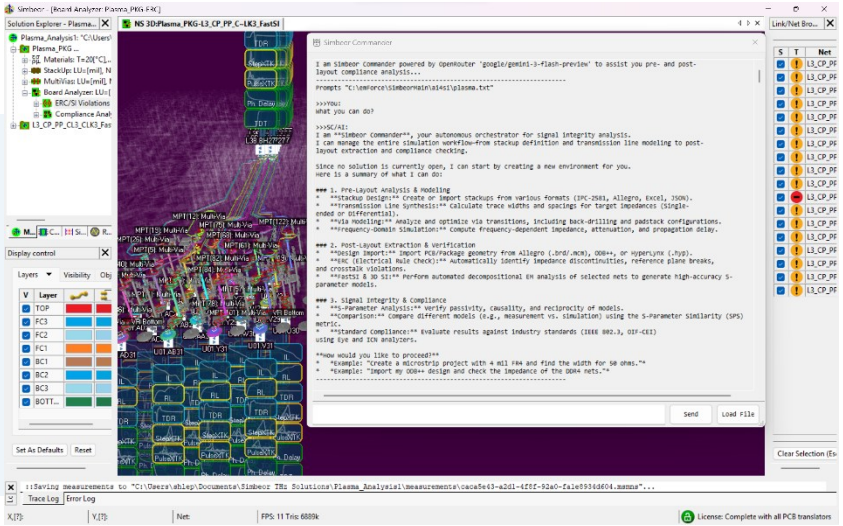
Designing Predictable Interconnects with AI:

Simbeor Software Overview and Live Demo of Simbeor Commander™ & SI Compliance Analyzer™

Recently Implemented Features:

- ***Simbeor Commander™ with AI Agents***
- ***SI Compliance Analyzer™*** *improvements:*
  Automatic Computation of COM
  Improvements of Decompositional Analysis of PKGs and Interposers for Chiplets
  Modeling of Tabbed Traces
- ***Waveguiding Approach to Via Design***



What Is Simbeor?

- Simbeor is an **electromagnetic signal integrity (SI) software platform** designed to help engineers build predictable PCB and packaging interconnects.
- Simbeor combines **validated physics**, **fast solvers**, and **automation interfaces** to support both manual and AI-driven workflows.
- Core Purpose
  - Identify dielectric and conductor roughness models (pre-requisite for accuracy)
  - Simulate and verify interconnect behavior across high-speed protocols (PCIe, UCIe, Ethernet, DDR, USB, etc.)
  - Ensure compliance with standard metrics like COM, IL/RL, ICN, and more
  - Identify and fix signal distortion caused by reflections, losses, and crosstalk

Simbeor: The EM Engine for Agentic SI Workflows

- Simbeor provides a **validated, automation-ready electromagnetic core** that AI agents can reliably call for pre-layout and post-layout SI analysis.
- It is enabling autonomous workflows to make correct decisions without human intervention.
- **Why it fits agentic systems**
  - Solvers validated up to 65 GHz ensure agents operate on trustworthy physics.
  - De-compositional EM analysis breaks complex links into small, independent components—ideal for agent reasoning.
  - JSON-based data structures and SDK APIs align with LLM tool-calling patterns.

Two Modes of Simbeor and AI Integration

- **The "Engineer" Flow (Direct Control)**
  - **Interface:** Simbeor SDK API (Python / C++ / MATLAB), Lua API in Simbeor THz
  - **Protocol:** Direct API use (Intel case) or scripting (HPE case)
  - **Role:** The AI Agent acts as a junior engineer. It calls Simbeor SDK tools or writes scripts to define geometry explicitly and post-layout and processes the results.
  - **Best For:** Custom tools where the agent needs to "hold the mouse."

- **The "Manager" Flow (Intent-Based Orchestration)**
  - **Interface:** Simbeor Commander™
  - **Protocol:** Natural Language (NL) or A2A (Agent-to-Agent) Interface
  - **Role:** The engineer or AI Agent acts as a manager. It sends high-level intent (e.g., "Verify PCIe Gen6 compliance on Net Group A") to Commander.
  - **Mechanism:** The NL and A2A interface allows Commander to autonomously negotiate the task, handle the solvers setup, and return a validated results without the caller needing to know the UI and physics details.
  - **Best For:** Enterprise deployment, automated sign-off, and maximizing token efficiency (offloading the "thinking" to the specialized agent).

The “Engineer” Flow: SI PCB Signoff at Intel

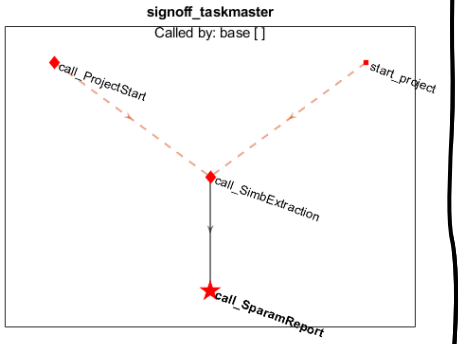
1 Intake

1. Identify what Skill relates to task
2. Check dependencies for that Skill
3. Find starting Node
4. Pull task list from plan

2 Define Flow

1. Collect the Required Inputs
   1. Project name and locations
   2. Board file
   3. Stackup
   4. Nets of interest
   5. Identify the Interface and compliance specifications
   6. Identify the Analysis type
2. Run the Layout analysis with Simbeor
   1. Write the Instructions for the Simbeor tools
   2. Open Simbeor
   3. Run Simbeor Instructions
3. Run the IBIS-AMI analysis with MATLAB
   1. Write the Instructions for the Simbeor tools
   2. Open Simbeor
   3. Run Simbeor Instructions
4. Prepare a report
   1. Get a correct report template
   2. Run Compliance analysis for results (analyze results vs spec)
   3. Generate to PowerPoint

3 Flow Execution



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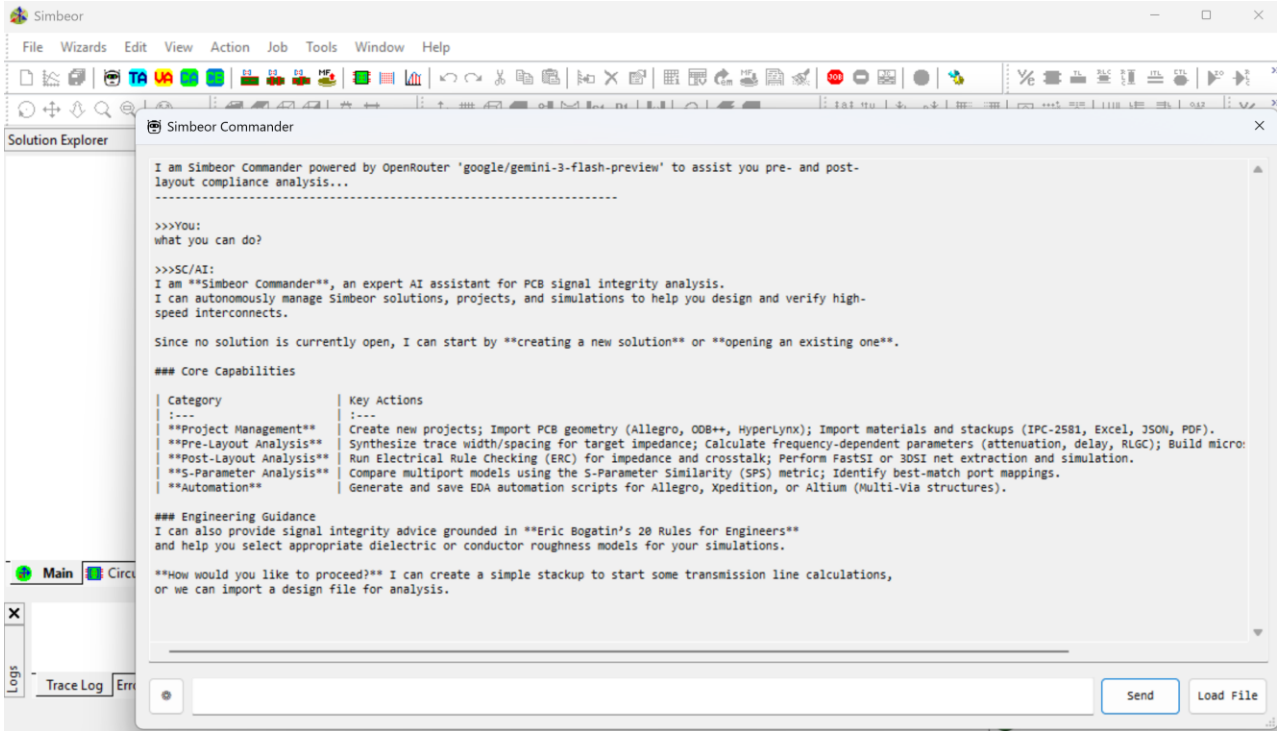
The “Manager” Flow: Simbeor Commander

Demo of pre- and post-layout analysis use:

Stackup import and loss investigation (EvR-1)

Board import and post-layout analysis for PCIe compliance (OCP)

PKG import DDR post-layout compliance analysis (Plasma)



Simbeor is Formally Validated up to 65 GHz

	Case ID	SPS Score 65GHz	SPS Score 52GHz
2	J1J2_MSL_SE_2in	89.67 (Acceptable)	91.47 (Good)
3	J3J4_SL_SE_2in	94.32 (Good)	95.36 (Good)
4	J5J6_SL_SE_2in	94.11 (Good)	95.44 (Good)
5	J7J8_MSL_SE_2in	90.68 (Good)	92.36 (Good)
6	J9J10_SL_SE_8in	93.34 (Good)	94.28 (Good)
7	J11J12_MSL_SE_8in	90.57 (Good)	93.05 (Good)
8	J13J14_SL_SE_60_2in	94.51 (Good)	95.37 (Good)
9	J17J18_SL_SE_60_8in	92.44 (Good)	93.56 (Good)
10	J19J20_SL_SE_40_8in	86.75 (Acceptable)	89.30 (Acceptable)
11	J21J22_SL_SE_CapLaunch	93.27 (Good)	94.33 (Good)
12	J23J24_SL_Beatty_50_25_50	94.34 (Good)	96.41 (Good)
13	J25J26_SL_SE_IndLaunch	93.88 (Good)	94.83 (Good)
14	J27J28_SL_Beatty_50_60_50	94.34 (Good)	96.41 (Good)
15	J31J32_MSL_SE_Via_TooInductive	87.50 (Acceptable)	90.47 (Good)
16	J33J34_MSL_SE_Via_Inductive	87.08 (Acceptable)	90.33 (Good)
17	J35J36_MSL_SE_Via_Matched	87.07 (Acceptable)	90.25 (Good)
18	J37J38_MSL_SE_Via_Capacitive	84.30 (Acceptable)	87.30 (Acceptable)
19	J39J40_MSL_SE_Via_TooCapacitive	80.03 (Acceptable)	83.09 (Acceptable)
20	J41J42_MSL_SL_SE_Via	88.53 (Acceptable)	91.77 (Good)
21	J43J44_SL_SE_BalancedRes	85.11 (Acceptable)	89.66 (Acceptable)
22	J46J47_SL_SE_GradualCoplanar	87.30 (Acceptable)	89.92 (Good)

	Case ID	SPS Score 65GHz	SPS Score 52GHz	SPS Score 32.5GHz
23	J48J49_MSL_SL_ViaFieldPath	87.68 (Acceptable)	90.17 (Good)	
24	J50J51_SL_SE_WhiskerStubs	90.82 (Good)	94.78 (Good)	
25	J52J53_MSL_SE_Cap_Cutout	78.36 (Inconclusive)	84.31 (Acceptable)	
26	J54J55_MSL_SE_Cap_NoCutout	70.54 (Inconclusive)	78.81 (Inconclusive)	
27	J58J59_SL_SE_RadialStub_50	86.66 (Acceptable)	92.83 (Good)	
28	J60J61_SL_SE_RadialStub_84	82.35 (Acceptable)	87.97 (Acceptable)	
29	J62J63_MSL_ViaResonator	80.78 (Acceptable)	85.09 (Acceptable)	92.86 (Good)
30	J64J67_MSL_SE_ViaXtalk	75.98 (Inconclusive)	80.90 (Acceptable)	
31	J69J72_MSL_Diff_2in	89.16 (Acceptable)	90.86 (Good)	
32	J73J76_SL_Diff_2in	92.92 (Good)	94.54 (Good)	
33	J77J80_MSL_Diff_6in	89.19 (Acceptable)	92.97 (Good)	
34	J81J84_SL_Diff_6in	92.81 (Good)	93.85 (Good)	
35	J85J88_Diff_Beatty	88.21 (Acceptable)	91.49 (Good)	
36	J89J92_Diff_PlaneCutout	87.00 (Acceptable)	90.10 (Good)	
37	J97J104_Diff_ViaTrans_Coupled	82.60 (Acceptable)	85.10 (Acceptable)	92.9 (Good)
38	J109J112_MSL_SL_Zaxis_Xtalk	69.20 (Inconclusive)	74.90 (Inconclusive)	87.75 (Acceptable)
39	J113J114_SL_SE_CapLaunch	87.14 (Acceptable)	93.42 (Good)	
40	J115J116_SL_SE_IndLaunch	88.36 (Acceptable)	94.51 (Good)	
41	J117J118_SL_SE_Whiskers_84	82.79 (Acceptable)	93.90 (Good)	
42	J119J122_MSL_SE_ViaXtalk_L2	76.86 (Inconclusive)	82.18 (Acceptable)	

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CMP-70 Validation Platform from Wild River Technology

Simberian Electromagnetic Solutions

Why Agentic Systems Need Simbeor

- Agentic workflows fail when the underlying tools are slow, inconsistent, require expert setup and not validated.
- **Simbeor solves these bottlenecks.**
- **Key advantages for autonomous systems**
  - **Deterministic execution** — agents get consistent results across runs.
  - **Fast EM turnaround** — de-compositional analysis + distributed computing.
  - **No UI dependencies** — everything scriptable or NL/A2A-driven.
  - **Always available** — no queueing or license bottlenecks (Enterprise License).
  - **Physics-based validation** — agents avoid hallucinated or heuristic SI decisions.

Summary: Simbeor as the Agent-Ready EM Platform

- Simbeor is the **physics engine** that makes agentic/autonomous SI analysis possible.
- **Validated** solvers up to 65 GHz → trustworthy agent decisions.
- **De-compositional EM** → perfect for agentic decomposition and parallelization.
- **Simbeor Commander™** → intent-based orchestration for high-level agents.
- **SDK** → low-level control for tool-calling agents.
- **Scalable** → supports 10–448 Gbps design flows and enterprise automation (PCB and PKG in Simbeor v. 2026.01).

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 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 based on Y or S-parameters (7 solvers)
  - **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

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

- **Simbeor Commander™** - uses LLM to automate analysis and enables Agentic Workflow
- **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
- **Compliance Browser™** - unified interface to observe results of Fast SI, 3D SI and LNA analyses and create reports
- **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
- **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)
- **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…

Simbeor Applications

- Universal Signal Integrity Analysis (**Simbeor only**)
  - **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 **(automated in Simbeor 2025.01)**
  - 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, Crosstalk 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

Use of Simbeor in Design Process

- **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 and exploration – t-line synthesis/analysis for all PCB/packaging applications (**now with Simbeor Commander**)
  - Broadband viahole optimization for all types of links (use of 3DML and 3TDF solvers and optimization)
  - Impedance, loss, mode conversion, reflection (vias) and cross-talk control during pre-layout process

- **Automatic post-layout de-compositional electromagnetic analysis** or PCB/packaging interconnects – now with Simbeor Commander
  - Complete link analysis: S-parameters, compliance metrics, TDR/TDT, eye diagrams, pulse response, **COM**,…
- **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
- **Build AI Assistants for Agentic Workflow with Simbeor SDK**

Simbeor SDK – Create AI Agents

- Simbeor SDK is dynamic link libraries with API in C language for programming or scripting in C/C++, Matlab and Python with **data structures in JSON** (facilitate communication with LLMs)
- 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…
  - **access and post-processing of post-layout extraction results**
  - **Machine Learning (ML)** – training or complimenting machine learning algorithms…
  - **Build AI Agents –** for Agentic Workflow – examples are provided…

Simbeor SI Compliance Analyzer

- **Unique one-stop solution for interactive or automated compliance validation**
- **LNA** – pre-layout and multi-board compliance validation
- **ERC (**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 or FSI**: 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

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

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
  - **Enables Agentic Workflow** with Simbeor Commander™ and Simbeor SDK
- **Easy to Use** – tools with integrated intuitive interface, well documented SDK with examples and multiple kits
  - **Human language interface** provided in Simbeor Commander™
- **Scalable** – interfaces to all components in C, Matlab, Python for pre-layout analysis and optimization, post-layout compliance analysis automation with Lua, **JSON interface for LLMs**

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Electromagnetic Signal Integrity Software to Design Predictable PCB/Packaging Interconnects

To learn more, visit www.simberian.com

Simbeor Commander™ — AI-powered signal integrity.