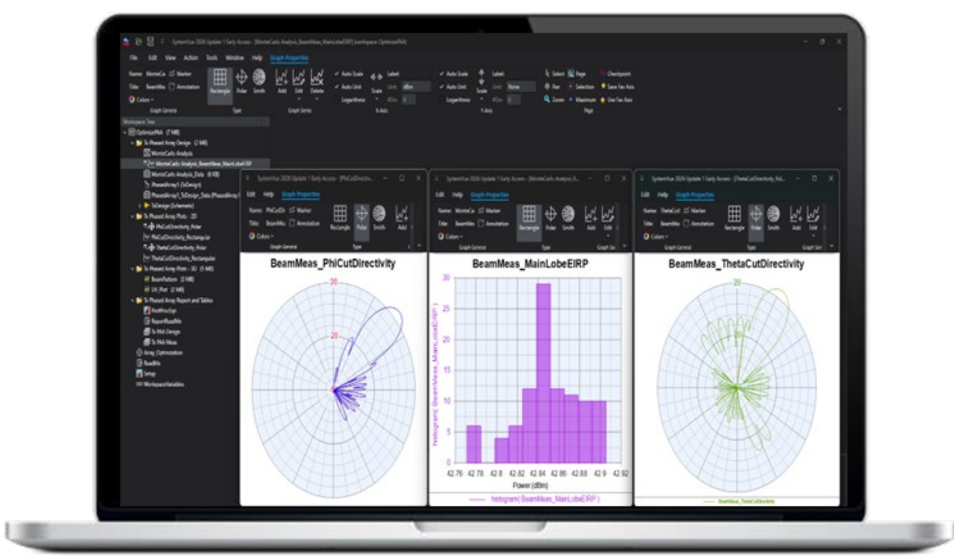
RF System Design (SystemVue)

Scalable RF Digital Twin Modeling for Advanced Wireless and Aerospace Systems

Introduction

RF System Design (SystemVue) provides a scalable RF digital twin platform for the design, optimization, and validation of advanced wireless, satellite, radar, phased array, and Aerospace & Defense systems. Modern RF systems require accurate modeling of RF impairments, phased-array beamforming, propagation environments, nonlinear hardware behavior, and complex baseband processing across multiple domains. Traditional spreadsheet-based analysis and disconnected simulation tools cannot efficiently address the complexity of emerging wireless systems.

SystemVue combines RF, DSP, phased-array, propagation, and AI/ML workflows within one collaborative simulation environment. The platform integrates measurement-correlated RF models, hardware-aware behavioral modeling, realistic channel propagation, and advanced visualization capabilities to enable end-to-end RF digital twin workflows. With scalable Windows and Linux support, Python automation APIs, and seamless integration with Keysight instruments and EDA solutions, SystemVue enables engineers to validate system performance earlier, reduce design risk, and accelerate time-to-market.



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Why RF System Design Teams Choose SystemVue

RF System Design (SystemVue) provides a scalable RF digital twin platform for the design, optimization, and validation of advanced wireless, satellite, radar, phased array, and Aerospace & Defense systems. As 5G Advanced and emerging 6G technologies introduce unprecedented levels of complexity, engineers must accurately model interactions between RF impairments, nonlinear hardware behavior, phased-array beamforming, dynamic propagation environments, AI-native processing, and complex baseband algorithms across multiple domains. Traditional spreadsheet-based analysis and disconnected point tools can no longer efficiently predict real-world system performance or support rapid design-space exploration.

SystemVue addresses these challenges through an integrated cross-domain simulation environment that combines RF, antenna, propagation, DSP, and AI/ML workflows into one unified platform. Powered by the next-generation RF analysis engine, SystemVue enables high-fidelity behavioral modeling, measurement-correlated RF simulation, Multi-Independent Parameter (MIP) modeling, equation-based S-parameters, and scalable phased-array analysis for realistic RF digital twin development.

Integrated support for Linux and Windows environments, Python automation APIs, hardware-in-the-loop workflows, and seamless interoperability with ADS, RFPro, STK, EXata, PropSim, WaveJudge, VSA, and Keysight instrumentation enables collaborative development and hardware-aware validation throughout the product lifecycle.

By combining realistic RF impairments, phased-array effects, propagation dynamics, and measurement-driven behavioral models into one scalable environment, SystemVue helps engineers reduce design risk, accelerate system validation, optimize performance, and significantly shorten time-to-market for next-generation RF and wireless systems.

Core Simulators

RF System Design (SystemVue) combines multiple simulation technologies into one integrated environment for RF and baseband system development. The platform enables engineers to efficiently analyze system behavior across frequency-domain and time-domain workflows while supporting scalable design exploration for increasingly complex wireless and Aerospace & Defense applications.

Core technologies include the Data Flow simulation engine for DSP and baseband processing, the Spectrasys II RF analysis engine for high-fidelity RF behavioral modeling, advanced Phased Array Analysis for beamforming and antenna system simulation, and the WhatIF frequency planner for rapid spurious and frequency-conversion analysis. Together, these engines provide a flexible framework for evaluating system architectures, optimizing performance, and analyzing interactions between RF, signal processing, antennas, and propagation environments.

This technical overview highlights the major simulation engines, integrated workflows, and application libraries available in SystemVue, demonstrating how the platform enables efficient development and validation of advanced wireless, satellite, radar, phased array, and RF system architectures.

Data Flow

The Data Flow engine provides efficient time-domain simulation for mixed RF and baseband systems and can operate independently or together with the Spectrasys II RF and Phased Array Analysis engines within a unified cross-domain workflow. It enables accurate modeling and analysis of digital signal processing (DSP), communications algorithms, adaptive processing, and hardware-aware system architectures for advanced wireless, radar, satellite, and Aerospace & Defense applications.

Optimized for systems with dynamic and time-varying behavior, Data Flow allows engineers to evaluate interactions between RF impairments, signal processing algorithms, phased-array architectures, and propagation effects within realistic end-to-end simulation environments. The platform supports rapid design exploration, algorithm verification, hardware implementation analysis, and AI/ML-assisted workflows, enabling designers to optimize system performance against complex design requirements and KPIs.

Data Flow is based on Synchronous Data Flow (SDF), one of the most mature and efficient computation models within the data flow paradigm. Building upon this foundation, Timed Synchronous Data Flow (TSDF) extends the framework to support sampled discrete-time representations of continuous-time and mixed-domain signals. This architecture enables scalable and efficient simulation of complex multi-rate systems while maintaining strong correlation between baseband processing and RF system behavior.

RF Analysis

Spectrasys II is the next-generation RF analysis engine within SystemVue, designed for scalable RF digital twin workflows and high-fidelity behavioral RF system simulation. The engine combines advanced spectral propagation analysis with root-cause diagnostics to enable accurate modeling of complex wireless, satellite, phased-array, radar, and Aerospace & Defense systems.

Spectrasys II supports both behavioral and measurement-correlated modeling while tracking bidirectional spectral propagation throughout the RF architecture. The engine maintains a detailed record of signal spectra, nonlinear distortion products, spurious responses, leakage paths, and noise contributions, enabling engineers to quickly identify the sources and propagation mechanisms of RF impairments within large and complex systems. Interactive budget diagrams, cascaded RF measurements, and advanced visualization tools provide insight into system-level performance and architecture tradeoffs.

Built on a modern modular RF architecture, Spectrasys II introduces Multi-Independent Parameter (MIP) modeling, equation-based S-parameters, polymorphic RF components, and MDIF-driven workflows for realistic modeling of frequency-, bias-, power-, and temperature-dependent device behavior. The platform also supports advanced measurement-driven behavioral models such as Dynamic Gain Models (DGM) and hardware-correlated nonlinear RF workflows.

Compared to spreadsheets, conventional line-up analysis tools, and traditional nonlinear circuit simulation techniques, Spectrasys II significantly improves simulation speed while maintaining high RF fidelity. The engine efficiently models broadband noise, nonlinear spectral regrowth, phase noise propagation, signal leakage, multiple signal paths, active impedance effects, and wideband RF interactions without requiring computationally intensive convergence-based nonlinear simulations.

By combining high simulation efficiency with realistic RF impairment modeling and hardware-aware validation, Spectrasys II enables engineers to accelerate RF architecture exploration, optimize system performance, reduce design risk, and improve correlation between simulation and measured hardware behavior.

WhatIF Frequency Planner

WhatIF is an advanced RF frequency planning and spurious analysis environment designed to rapidly identify optimum intermediate frequencies (IFs) and spurious-free operating regions for complex RF architectures. By automating the traditionally time-consuming process of spurious analysis, WhatIF enables engineers to reduce RF frequency planning tasks from weeks or days to hours or minutes.

The platform provides interactive visualization of spurious responses across multiple IF candidates on a single graph, allowing designers to quickly evaluate tradeoffs between frequency plans, mixer architectures, bandwidth allocations, and conversion strategies. Engineers can identify spurious-free regions, optimize frequency conversion schemes, and evaluate the impact of mixer specifications and RF impairments across wideband system architectures.

WhatIF calculates spurious products and their amplitudes based on mixer characteristics, local oscillator configurations, system frequencies, harmonic interactions, signal bandwidths, and desired IF bandwidths. The environment supports multi-stage frequency conversion analysis, enabling efficient exploration of complex receiver, transmitter, satellite payload, radar, EW, and phased-array architectures.

Integrated with Spectrasys II workflows, WhatIF provides rapid RF architecture analysis without relying on computationally intensive sweep-based simulations. This significantly accelerates system exploration while improving visibility into spurious mechanisms, leakage paths, harmonic interactions, and RF design tradeoffs early in the development cycle.

Phased Array Analysis

The Phased Array Analysis engine enables scalable RF digital twin simulation for phased-array, massive MIMO, radar, satellite payload, and electronically steered antenna systems. Combined with advanced RF phased-array models, the platform allows engineers to efficiently create, analyze, and optimize highly complex array architectures while accurately modeling RF impairments, beamforming behavior, propagation effects, and antenna interactions.

Although modern phased-array systems may contain hundreds or thousands of RF signal paths, SystemVue's intelligent phased-array architecture dramatically simplifies system creation and simulation. Instead of explicitly drawing every RF path, the smart phased-array models automatically replicate RF chains based on splitter and combiner stages throughout the architecture. This enables compact and intuitive schematic representation regardless of array size, significantly reducing design complexity, simulation setup time, and the risk of modeling errors associated with manually constructed large-scale arrays.

The platform supports realistic modeling of phased-array effects including active impedance interactions, mutual coupling, beamforming quantization, calibration errors, nonlinear RF impairments, adaptive beam steering, and hybrid beamforming architectures. Integrated propagation and RF impairment modeling allow engineers to evaluate realistic system-level performance under dynamic operating conditions.

Phased Array Analysis provides a comprehensive set of predefined measurements and visualization tools for system evaluation and optimization, including:

- 2D and 3D beam pattern visualization
- Coverage map generation
- Beam placement optimization
- EIRP and sidelobe analysis
- Array gain and beam steering evaluation
- OTA system performance analysis
- Interference and coexistence studies

By combining scalable array simulation with realistic RF digital twin workflows, SystemVue enables efficient development and validation of next-generation phased-array systems for 5G Advanced, 6G, radar, EW, NTN, satellite, and Aerospace & Defense applications.

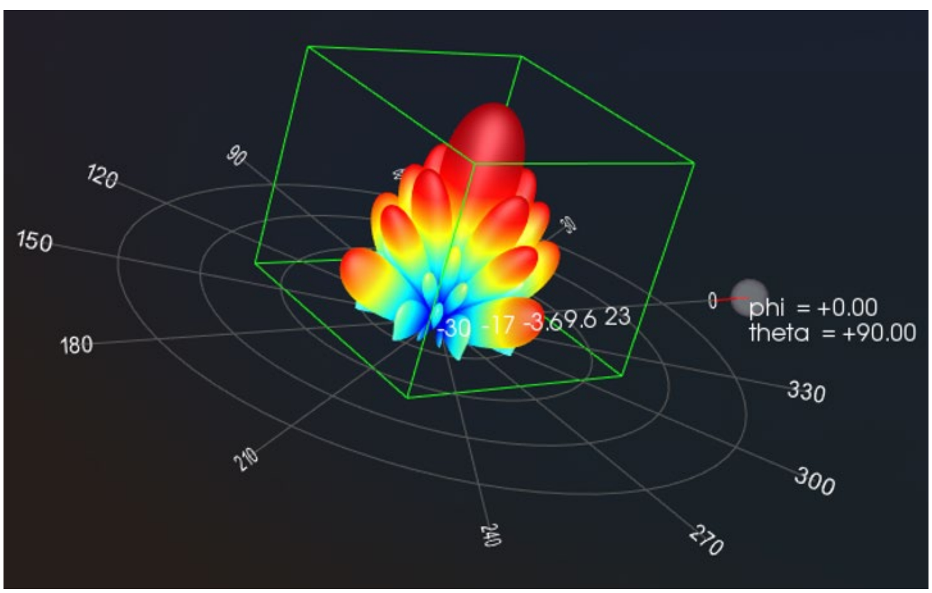

Figure 1. Phased array antenna beam pattern

Integrated Design Environment

RF System Design (SystemVue) provides seamless integration with Keysight software, hardware, and enterprise engineering environments, enabling unified RF digital twin workflows across system architecture, RF design, propagation analysis, network simulation, and hardware validation. These integrated workflows allow engineers to move efficiently between simulation, measurement, and implementation while maintaining strong correlation between modeled and measured system performance.

SystemVue interoperates with a broad ecosystem of Keysight and third-party tools including ADS, RFPro, Signal Studio, Vector Signal Analysis (VSA), WaveJudge, EXata Network Modeling, MATLAB®, Python, Ansys STK, PropSim, Wireless InSite®, and Keysight RF instrumentation. This cross-domain integration enables collaborative development across RF, DSP, antenna, propagation, network, and AI/ML engineering teams.

Integrated design-to-test workflows leverage the same measurement science used in Keysight instrumentation, reducing discrepancies between simulation and hardware validation. Engineers can generate realistic waveforms, export test vectors, correlate measurements with simulation results, and validate RF digital twins using hardware-aware workflows. This significantly accelerates prototype validation, improves design accuracy, and shortens development cycles.

SystemVue also supports scalable automation and workflow customization through Python APIs, headless simulation support, and open interfaces for external orchestration and AI/ML integration.

Data sharing and workflow integration

- Baseband algorithm design and AI/ML workflows (MATLAB®, Python, C++)
- RF and mmWave circuit/EM co-design (ADS, RFPro, RFIC Design, EMPro)
- Scenario, trajectory, and propagation modeling (STK, Wireless InSite®, PropSim)
- Network digital twin and system-level analysis (EXata)
- Hardware-aware validation using Signal Studio, VSA, WaveJudge, X-Apps, VXG, and UXA
- Integration with Keysight RF instrumentation for design-to-test correlation
- Open APIs and Python automation for workflow customization and AI-assisted orchestration
- Linux and Windows collaborative simulation environments

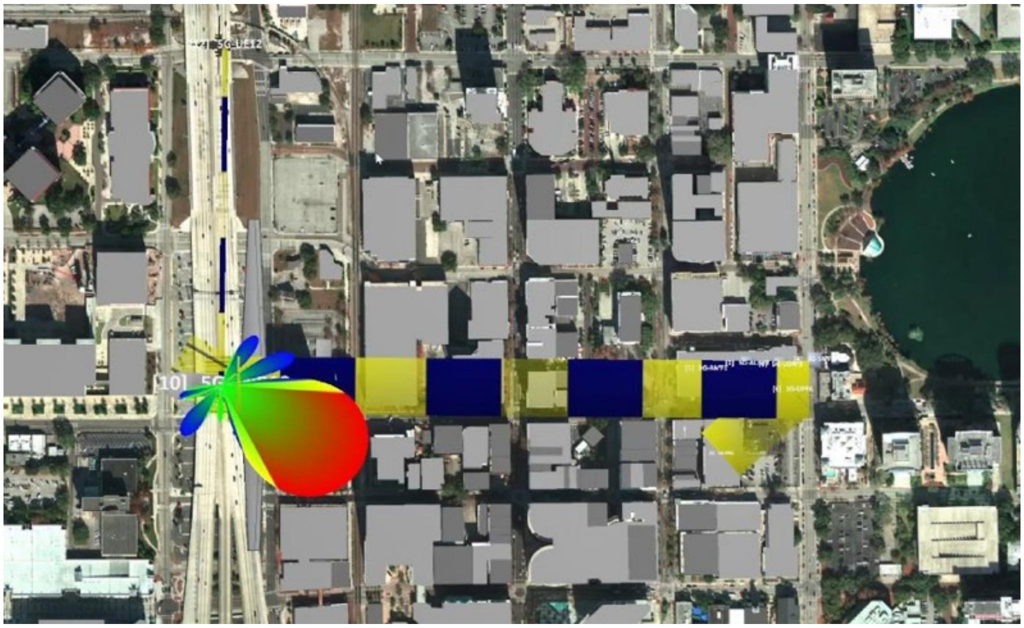

Figure 2. SystemVue Beamforming inside EXata Network Modeling

Tools for the ADS Circuit Designer

System architects are not the only engineers who benefit from RF digital twin and system-level simulation workflows. Through tight integration with Advanced Design System (ADS) and RFPro, SystemVue extends high-fidelity RF system analysis directly into circuit, module, and EM design environments.

By connecting SystemVue system-level workflows with circuit-level RF and electromagnetic design tools, engineers can bridge the gap between architecture exploration and hardware implementation while maintaining strong correlation between system simulation and circuit performance. This integrated environment enables near-circuit-level accuracy for evaluating RF impairments, nonlinear effects, phased-array interactions, beamforming behavior, and wideband modulation performance within realistic system architectures.

Seamless interoperability between ADS and SystemVue allows designers to move efficiently between transistor-level, circuit-level, EM, and system-level analysis, accelerating RF digital twin validation and reducing development risk for advanced wireless, radar, satellite, phased-array, and Aerospace & Defense systems.

RF System Explorer

RF System Explorer (RFSE) extends the power of Spectrasys II RF digital twin technology directly into the ADS design environment, enabling circuit designers to perform high-fidelity RF system analysis early in the design cycle. RFSE combines advanced RF line-up analysis, spectral propagation diagnostics, and behavioral modeling to help engineers quickly identify and resolve performance limitations that are often difficult to detect using conventional circuit simulation techniques alone.

RFSE provides deep visibility into complex RF interactions including spurious generation, harmonic mixing, leakage paths, nonlinear distortion, gain compression, phase noise propagation, and frequency-planning tradeoffs. Interactive budget diagrams, cascaded RF measurements, and graphical root-cause analysis tools allow designers to rapidly evaluate architectural decisions, optimize frequency plans, and assess RF partitioning strategies with strong correlation to system-level performance.

The platform enables engineers to create superior RF architecture earlier in the design process by evaluating realistic RF impairments and system-level interactions before hardware implementation. This early-stage visibility significantly reduces design iterations and accelerates convergence toward optimized RF subsystem designs.

RFSE also streamlines the transition between circuit-level and system-level workflows through the generation of Extracted Behavioral Models (EBMs) directly from ADS circuit designs. These behavioral models can be integrated into larger SystemVue RF digital twin simulations, enabling efficient evaluation of how circuit-level implementations impact overall system performance, beamforming behavior, propagation effects, and key performance indicators.

By tightly coupling ADS circuit simulation with SystemVue system-level analysis, RFSE enables engineers to bridge the gap between RF architecture exploration and hardware realization while improving design accuracy, reducing risk, and accelerating development of advanced wireless, phased-array, radar, satellite, and Aerospace & Defense systems.

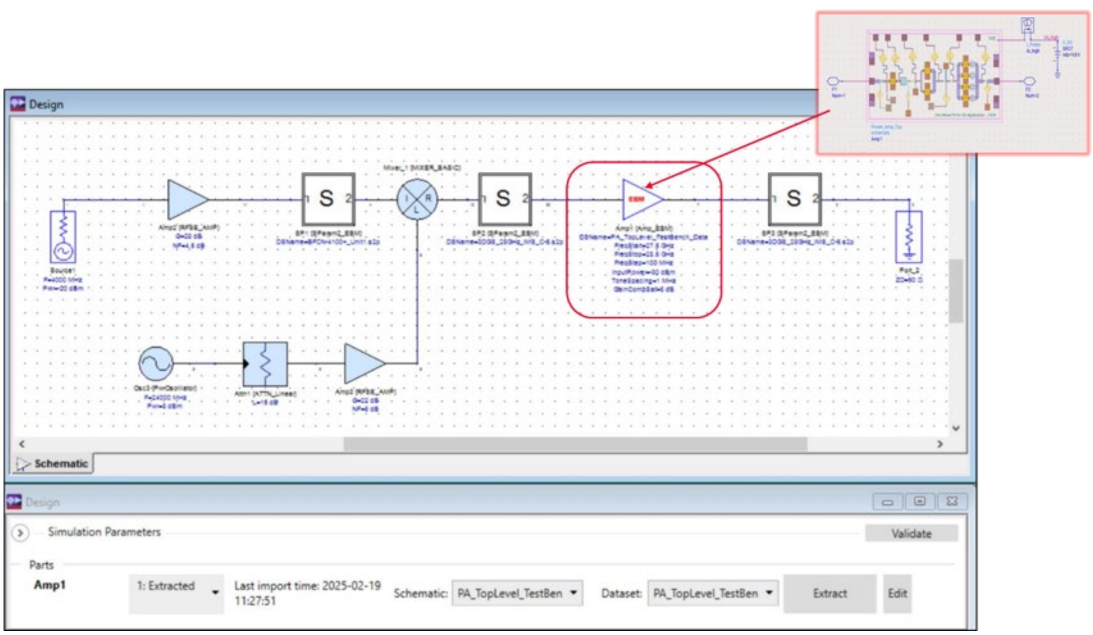

Figure 3. RF System Explorer EBM

DPD Explorer

Digital Predistortion (DPD) is a critical technology for modern wireless, satellite, and phased-array transmitters, enabling highly efficient operation of Power Amplifiers (PAs) while maintaining stringent linearity requirements for 5G Advanced and emerging 6G systems. As signal bandwidths, carrier aggregation complexity, and phased-array interactions continue to increase, accurate modeling of nonlinear PA behavior and memory effects becomes essential for realistic RF digital twin validation.

DPD Explorer is an advanced workflow environment designed specifically for RF and PA designers to accelerate development and optimization of nonlinear RF transmitter architectures. Integrated directly within ADS and powered by SystemVue behavioral modeling technologies, DPD Explorer enables engineers to rapidly evaluate PA linearizability, optimize DPD algorithms, and predict end-user performance metrics such as ACPR, EVM, spectral regrowth, efficiency, and throughput under realistic modulated signal conditions.

The platform leverages the same measurement science and analysis algorithms used in Keysight PNA-X and signal analysis instrumentation, enabling strong correlation between simulation and measured hardware performance. Engineers can rapidly compare simulated and measured PA behavior while reducing dependency on time-consuming hardware iteration cycles.

A key innovation within DPD Explorer is the Dynamic Gain Model (DGM), an advanced behavioral modeling technology designed to accurately capture nonlinear memory effects, dynamic gain behavior, and wideband signal interactions present in modern PA architecture such as GaN Doherty, Envelope Tracking (ET), massive MIMO transmitters, and broadband phased-array systems. DGM enables realistic hardware-aware RF modeling with significantly faster simulation performance compared to traditional nonlinear simulation techniques.

Using compact waveform techniques and measurement-driven behavioral models, DPD Explorer dramatically accelerates DPD optimization and RF transmitter validation workflows while maintaining high modeling fidelity. Designers can efficiently explore tradeoffs between efficiency, linearity, bandwidth, power consumption, and beamforming interactions across complex RF architectures.

By combining ADS circuit-level design with SystemVue RF digital twin technologies, DPD Explorer enables rapid development of next-generation PA and transmitter solutions while reducing design risk, shortening validation cycles, and improving correlation between simulated and measured system performance.

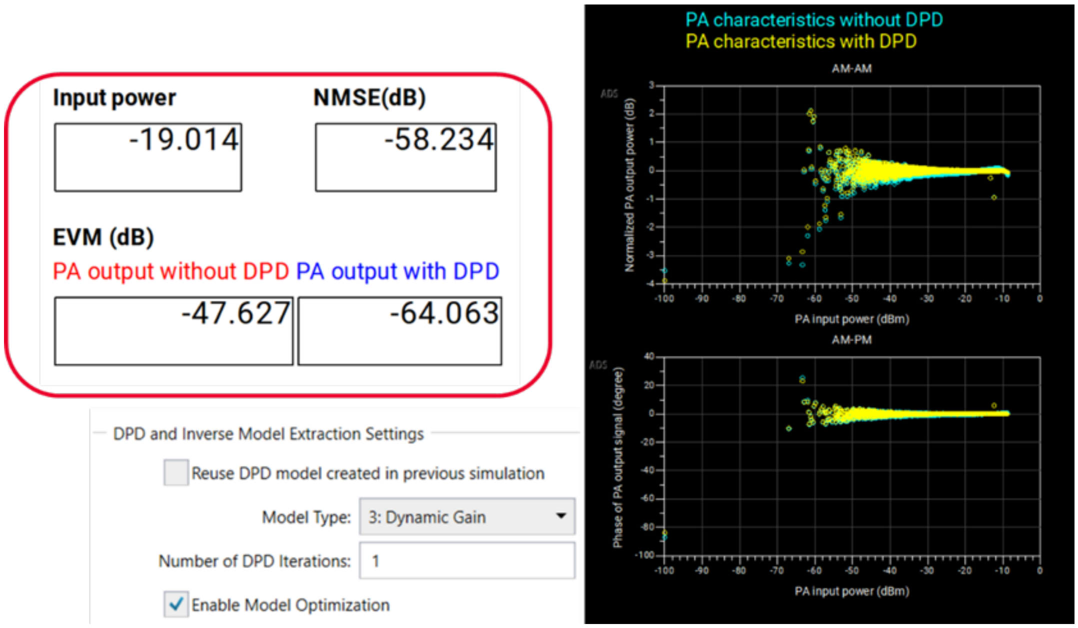

Figure 4. DPD Explorer and EVM measurements in ADS

Modulation Explorer

Modulation Explorer is an advanced RF modulation analysis environment within ADS that enables RF and system designers to efficiently evaluate the impact of RF impairments, nonlinear behavior, and circuit-level implementations on complex modulated signals. By combining circuit simulation with modulation-domain measurements, Modulation Explorer bridges the gap between RF hardware design and real-world communication system performance.

Integrated with ADS and SystemVue technologies, Modulation Explorer provides rapid insight into key wireless performance metrics including Error Vector Magnitude (EVM), ACPR, spectral regrowth, constellation quality, modulation accuracy, throughput, and signal integrity under realistic operating conditions. Engineers can directly analyze how RF impairments such as phase noise, nonlinear distortion, IQ imbalance, LO leakage, compression, and memory effects impact communication link performance across advanced wireless architectures.

The platform supports modern communication standards and wideband modulation schemes used in 5G NR, 5G Advanced, Wi-Fi, satellite communications, phased-array systems, and emerging 6G research. Designers can rapidly evaluate RF front-end architectures using realistic modulated waveforms and hardware-aware behavioral models, enabling earlier visibility into system-level performance tradeoffs.

Modulation Explorer leverages Keysight measurement science and integrates closely with Signal Studio, Vector Signal Analysis (VSA), WaveJudge, and Keysight RF instrumentation to ensure strong correlation between simulation and measured hardware behavior. Using the same modulation analysis algorithms deployed in Keysight test equipment, engineers can establish trusted design-to-test workflows and reduce discrepancies between simulation and lab validation.

By integrating modulation-domain analysis directly into ADS circuit design workflows, Modulation Explorer enables faster optimization of RF transmitters, receivers, phased arrays, and nonlinear RF subsystems while reducing development risk and accelerating time-to-market for advanced wireless and RF systems.

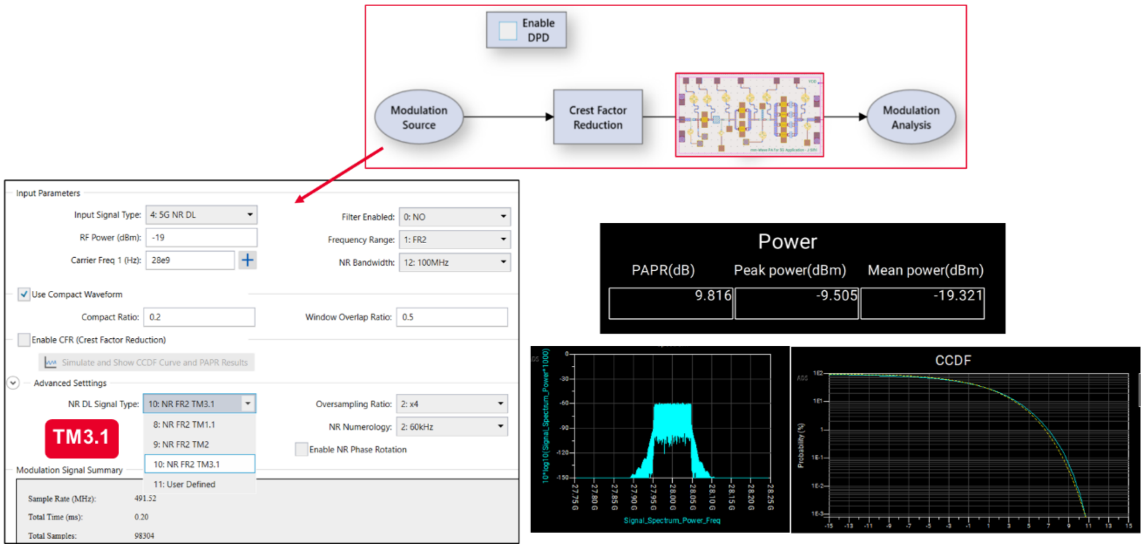

Figure 5. Modulation Explorer in ADS

Virtual Test Benches

Virtual Test Benches (VTBs) extend realistic modulated waveform analysis directly into transistor-level circuit simulation within ADS and RFIC Design (Golden Gate). By combining SystemVue Data Flow technologies with circuit-level simulation environments, VTBs enable engineers to validate RFIC, PA, transceiver, and mixed-signal designs using realistic communication waveforms and system-level performance metrics early in the development cycle.

A VTB is created within the SystemVue Data Flow environment and serves as a reusable validation framework for circuit designers working inside ADS or RFIC Design. These test benches combine realistic waveform generation, RF impairments, DSP processing, modulation analysis, and measurement algorithms into an integrated workflow that allows transistor-level circuits to be evaluated under real-world operating conditions.

VTBs enable designers to analyze critical KPIs such as EVM, ACPR, spectral regrowth, throughput, phase noise sensitivity, IQ imbalance, nonlinear distortion, and modulation accuracy directly at the circuit implementation level. This allows engineers to understand how circuit-level behavior impacts overall communication system performance before hardware fabrication.

Integrated design-to-test workflows leverage the same measurement science used in Keysight instrumentation, improving correlation between simulation and laboratory validation. Engineers can efficiently evaluate advanced wireless, satellite, phased-array, and 5G/6G RFIC architectures using realistic standards-based waveforms and hardware-aware system validation methodologies.

By tightly coupling system-level waveform analysis with transistor-level circuit simulation, VTBs significantly improve collaboration between system architects and circuit designers, reduce design iterations, accelerate verification, and enable earlier detection of performance limitations across complex RF and mixed-signal system.

AI/ML Integration

As wireless communications evolve toward 5G Advanced and emerging 6G systems, AI-native air interfaces and intelligent radio architectures are becoming foundational technologies for future networks. Industry research and 3GPP evolution toward Release 20 and beyond are increasingly focused on applying Artificial Intelligence (AI) and Machine Learning (ML) to optimize beamforming, channel estimation, spectrum utilization, interference mitigation, resource allocation, and adaptive wireless processing.

SystemVue provides an advanced AI/ML integration framework that accelerates development, validation, and benchmarking of AI-driven wireless algorithms within realistic RF digital twin environments. The platform enables engineers to combine RF, DSP, phased-array, propagation, and AI/ML workflows in one unified simulation environment, allowing AI-assisted wireless algorithms to be evaluated under realistic hardware and channel conditions.

At the core of this capability is the built-in AI_ML_Interface, which enables seamless integration of AI/ML models into SystemVue simulation workflows. The interface supports industry-standard ONNX and TensorFlow model formats, allowing engineers to import and execute externally trained neural networks directly within RF and baseband simulations. This enables realistic benchmarking of AI-enhanced wireless algorithms against conventional communication system implementations.

Engineers can generate realistic synthetic RF datasets for neural network training, import externally trained AI/ML models, benchmark AI-based approaches against conventional algorithms, and evaluate system-level impacts on KPIs such as EVM, SINR, throughput, latency, beamforming accuracy, and spectral efficiency. Example workflows include AI-assisted CSI compression, adaptive beamforming, intelligent channel estimation, RF impairment compensation, and AI-driven radio optimization.

The AI/ML framework integrates seamlessly with Python-based workflows and external AI ecosystems, enabling orchestration with popular machine learning environments and data science tools. Open Python APIs and headless automation support scalable experimentation, rapid design-space exploration, and AI-assisted optimization workflows for advanced wireless, phased-array, NTN, radar, RIS, and ISAC applications.

By providing a common development environment for RF engineers, DSP architects, communication system designers, and AI/ML specialists, SystemVue fosters cross-domain collaboration and accelerates innovation. This integrated workflow reduces development cycles, improves hardware-awareness of AI algorithms, and significantly shortens time-to-market for next-generation AI-native wireless systems.

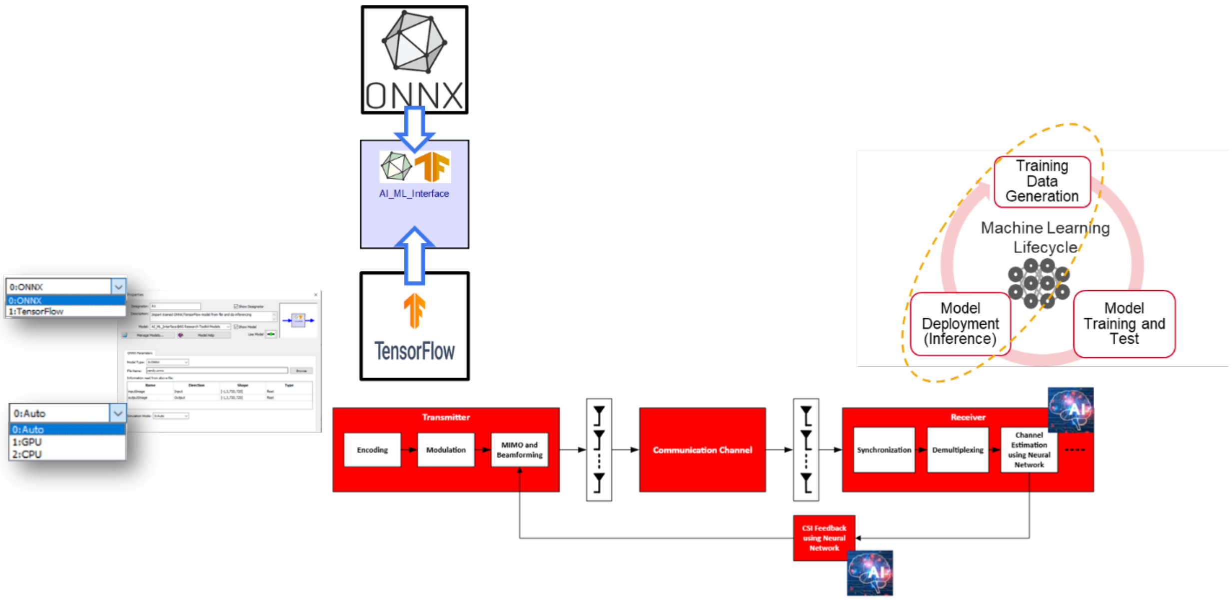

Figure 6. AI/ML Models and SystemVue

Wireless Libraries

SystemVue provides an extensive set of application-focused libraries that accelerate development of advanced wireless, satellite, radar, phased-array, and Aerospace & Defense systems. These libraries enable engineers to rapidly prototype, validate, and optimize complex RF digital twin architectures using realistic waveforms, RF impairments, phased-array effects, propagation models, and standards-based signal processing workflows.

The platform supports advanced technologies including massive MIMO, phased-array beamforming, 5G Advanced, emerging 6G research, NTN, ISAC, RIS, radar, EW, Wi-Fi, satellite communications, and broadband RF systems. Engineers can leverage built-in specification-compliant processing blocks, high-fidelity RF behavioral models, and standards-based reference designs while also integrating custom MATLAB®, Python, C++, ONNX, and TensorFlow-based IP directly into SystemVue simulations.

SystemVue includes comprehensive verification and exploration libraries covering:

- 5G NR and 5G Advanced
- Emerging 6G waveform research
- Radar and EW systems
- NTN and satellite communications
- Wi-Fi 7 and Wi-Fi 8 transceiver design
- DVB-S2/S2X and broadband satellite links
- Wireless connectivity and digital modem architecture
- UWB, Ambient IoT, and low-power wireless systems

The Verification Libraries provide compiled transmitters, receivers, reference designs, RF impairments, channel models, and standards-aligned PHY implementations optimized for high simulation performance and hardware-aware validation. These libraries enable engineers to generate, analyze, and validate complex PHY waveforms and test vectors while evaluating system performance metrics such as EVM, SINR, throughput, spectral efficiency, beamforming accuracy, and latency.

Integrated design-to-test workflows support seamless co-design and validation with Keysight test equipment, VSA, Signal Studio, WaveJudge platforms, and hardware development systems.

The Exploration Libraries extend these capabilities through open and customizable PHY development environments that provide editable source code, reference algorithms, and detailed standards documentation. Engineers can rapidly evaluate alternative air interfaces, develop proprietary algorithms, compare open-standard implementations, and integrate custom AI/ML-enhanced signal processing workflows into RF digital twin simulations.

By combining high-performance compiled models with flexible user extensibility, SystemVue libraries enable rapid innovation, accelerate standards research, simplify algorithm development, and reduce the complexity of validating next-generation wireless and RF systems.

Complete SystemVue library descriptions are available online at: www.keysight.com/find/system-design-libraries

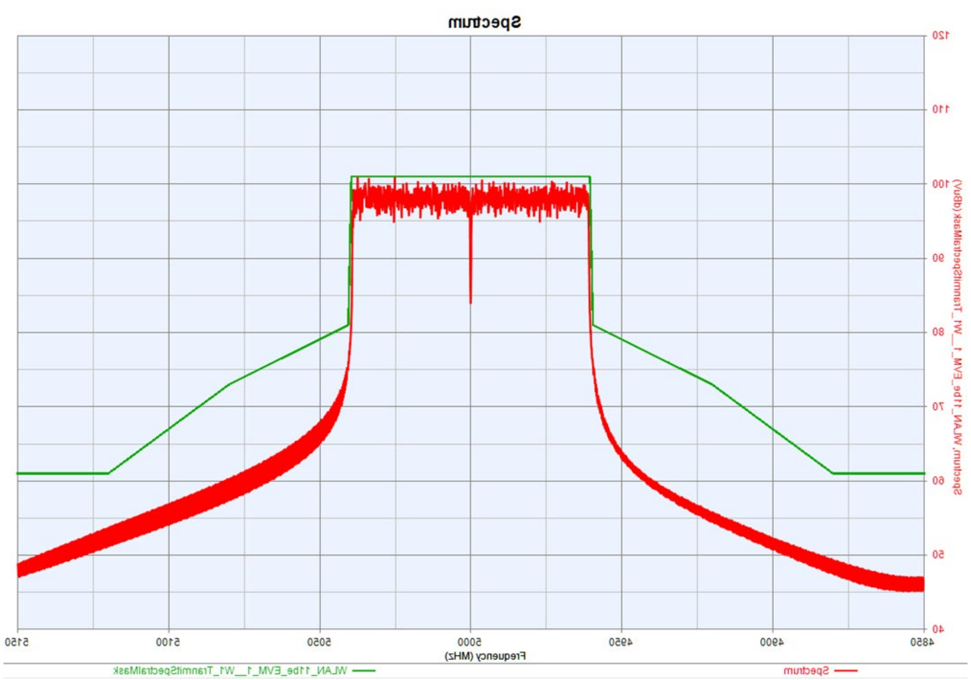

Figure 7. Wi-Fi 7/8 Spectrum Emission Mask

Radar

The Aerospace & Defense (A&D) Designer in SystemVue provides a scalable RF digital twin environment for the analysis, optimization, and validation of advanced radar, Electronic Warfare (EW), satellite, sensing, and mission-level RF systems. Combining high-fidelity RF modeling, phased-array analysis, realistic propagation environments, and advanced visualization technologies, the platform enables engineers to rapidly evaluate complex A&D scenarios with greater realism and efficiency.

The A&D Designer integrates an intuitive scenario-based editor, advanced RF simulation technologies, and a powerful 3D visualization environment to simplify development of highly complex RF systems and operational scenarios. The A&D Editor enables engineers to efficiently configure platforms, trajectories, phased arrays, radar modes, propagation environments, and RF threat scenarios using a streamlined graphical workflow. Complementing this capability, the A&D Visualizer provides immersive 3D visualization of mission environments, beam steering, target motion, platform trajectories, coverage analysis, and RF interactions for improved situational understanding and system validation.

Powered by SystemVue's RF digital twin technologies and integrated A&D libraries, the platform supports realistic modeling of RF impairments, nonlinear hardware behavior, phased-array beamforming, propagation effects, Doppler, interference, and dynamic mission environments. Engineers can rapidly explore system tradeoffs, optimize architectures, and validate performance under realistic operational conditions before hardware deployment.

The A&D Designer includes predefined workflows and configurable templates for a broad range of radar, EW, sensing, and communication applications while maintaining full flexibility for custom mission development and advanced research workflows.

Supported applications include:

- Pulsed and Pulsed-Doppler radar architectures
- Multi-static and distributed radar systems with moving land, air, sea, and space platforms
- MIMO and digital-array radar systems
- Electronic warfare and RF threat analysis
- Integrated sensing and communications (ISAC)
- Phased-array radar and adaptive beamforming
- Synthetic Aperture Radar (SAR) and ultra-wideband radar
- FMCW radar systems for automotive and defense applications
- Satellite payload and NTN mission analysis
- Embedded signal generation and hardware-in-the-loop validation workflows

SystemVue supports advanced radar waveform generation and realistic pulse modeling including rise/fall time effects, Pulse Repetition Frequency (PRF) staggering, adaptive waveform control, and dynamic RF impairments to improve fidelity and realism in radar and EW simulations.

Integrated workflows with STK, EXata, RFPro, WaveJudge, Keysight instrumentation, and propagation tools enable mission-level analysis, coverage evaluation, network-aware simulation, and hardware-correlated RF digital twin validation across complex Aerospace & Defense environments.

By combining scalable simulation, realistic RF modeling, phased-array technologies, and mission-level visualization into one integrated platform, the A&D Designer accelerates innovation while reducing development risk and validation time for next-generation Aerospace & Defense systems.

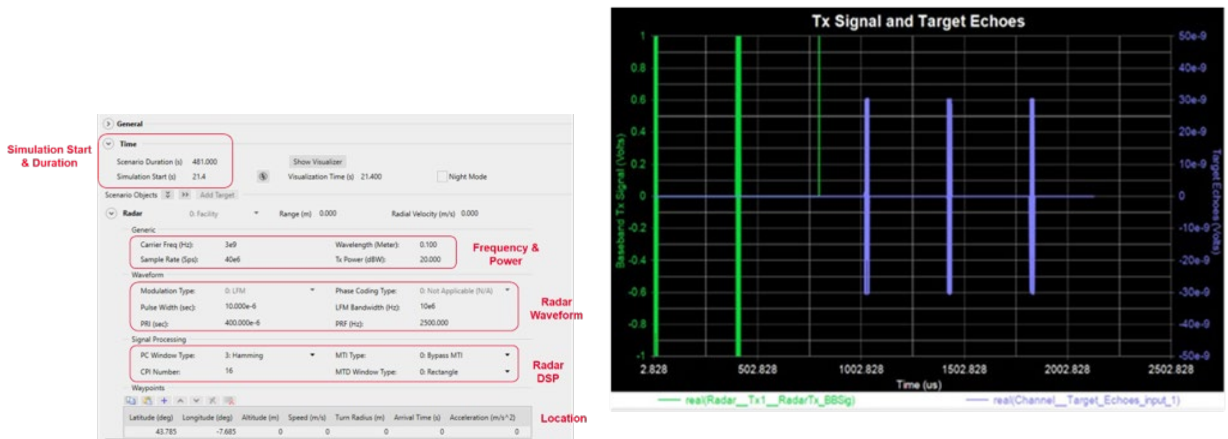

Figure 7. Radar Tx signal and echoes (right) and AD editor (left)

Automotive Radar

SystemVue provides a comprehensive RF digital twin environment for the development, optimization, and validation of advanced automotive radar systems. The platform combines waveform generation, phased-array beamforming, antenna modeling, propagation analysis, RF impairments, target simulation, and signal processing into one integrated workflow, enabling engineers to efficiently develop next-generation radar architecture with higher accuracy and reduced design risk.

The Automotive Radar Library supports end-to-end simulation of modern radar systems including FMCW, MIMO, digital-array, and phased-array radar architectures. Engineers can model realistic transmitters, receivers, antennas, propagation channels, targets, interference environments, and radar signal-processing chains while evaluating critical performance metrics such as range resolution, Doppler accuracy, angular resolution, detection probability, and interference robustness.

SystemVue enables seamless integration between RF, antenna, and signal-processing domains, allowing designers to evaluate realistic radar behavior under dynamic driving environments and complex propagation conditions. The platform supports advanced radar processing techniques including:

- Direction-of-Arrival (DOA) estimation
- Beamforming and adaptive beam steering
- Phase comparison techniques
- MIMO radar processing
- Multi-target tracking
- Radar interference analysis
- OTA and phased-array radar evaluation
- AI-assisted radar processing workflows

The Automotive Radar Library includes practical reference examples and configurable workflows such as FMCW multi-target detection, MIMO radar processing, phased-array radar beam steering, and 3D automotive radar scene visualization. These examples accelerate development and simplify transition from algorithm exploration to prototyping and hardware validation.

Integrated design-to-test workflows allow interfacing with Keysight instrumentation including arbitrary waveform generators, vector signal generators, oscilloscopes, and vector signal analyzers. Engineers can correlate simulation results with measured hardware data, enabling hardware-aware radar validation and improving confidence in real-world system performance.

SystemVue also supports realistic channel and environment modeling through integration with electromagnetic and propagation tools such as Ansys HFSS SBR+, enabling import of channel-response data into automotive radar simulations. This capability enables highly realistic modeling of multipath, reflections, clutter, vehicle interactions, and complex driving scenarios for advanced MIMO and phased-array radar architectures.

By combining scalable RF digital twin technologies, realistic propagation modeling, phased-array simulation, and hardware-correlated validation workflows, SystemVue accelerates development of next-generation automotive radar systems while reducing design iterations, improving system reliability, and shortening time-to-market.

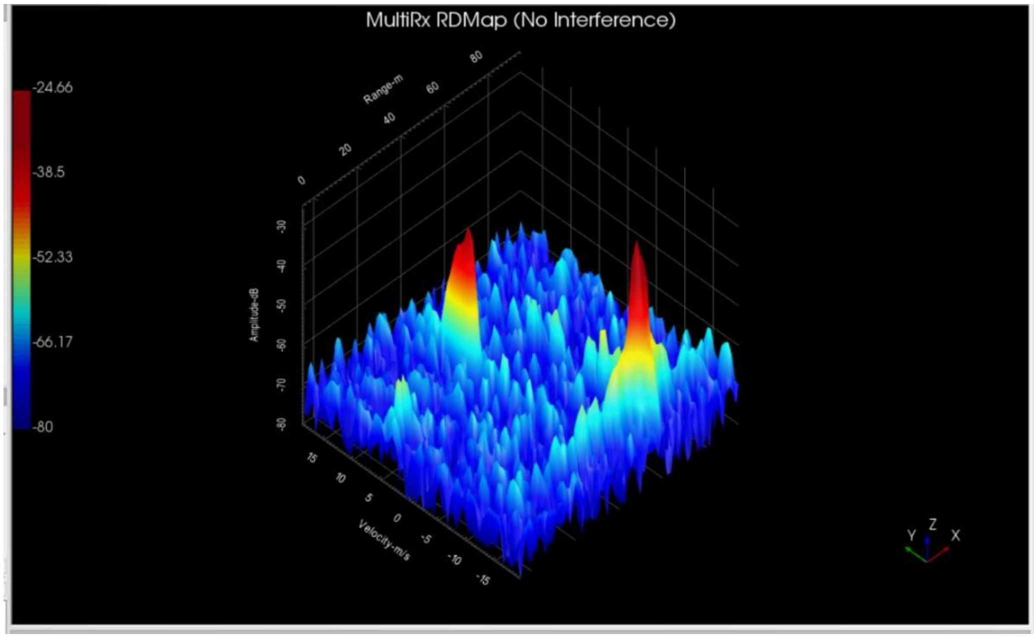

Figure 9. Radar range-doppler plot

Wi-Fi and Connectivity

SystemVue provides a comprehensive RF digital twin environment for the design, optimization, and validation of advanced Wi-Fi and wireless connectivity systems. The Wi-Fi and Connectivity Library combine high-fidelity RF simulation, communications DSP, phased-array analysis, realistic propagation modeling, and hardware-aware validation workflows into one integrated platform for next-generation connectivity chipset and system development. Recent enhancements further expand support for Wi-Fi 7/8, UWB, AI-assisted wireless research, and RF impairment-aware connectivity analysis.

The platform enables end-to-end simulation of complex wireless connectivity architectures, allowing engineers to evaluate RF impairments, nonlinear behavior, coexistence challenges, beamforming performance, modulation accuracy, throughput, latency, spectral efficiency, and power consumption under realistic operating conditions. By integrating RF, baseband, antenna, and propagation analysis within one environment, SystemVue accelerates design exploration while reducing development risk for emerging Wi-Fi and wireless connectivity solutions.

The Wi-Fi and Connectivity Library include standards-based waveform generation, transmitter and receiver reference models, RF impairments, advanced channel models, and DSP algorithms supporting:

- Wi-Fi 7 (IEEE 802.11be)
- Early Wi-Fi 8 (802.11bn) research
- Bluetooth and Bluetooth Low Energy (BLE)
- Zigbee and IEEE 802.15.4

- UWB ranging and positioning systems
- GNSS and navigation data links

SystemVue significantly enhances Wi-Fi 7 and connectivity workflows with new IEEE 802.11be receiver architectures, MIMO receiver pipelines, EVM analysis improvements, up/down sampling support, and Spectrum Emission Mask (SEM) validation for regulatory compliance. The platform now supports realistic Wi-Fi 7 full-band MIMO analysis, synchronization and CFO correction workflows, channel estimation, equalization, phase tracking, and advanced PHY-layer receiver validation.

For UWB and IEEE 802.15.4/4z/4ab systems, SystemVue introduces enhanced ranging and pulse-quality measurements including RRC correlation analysis, spectral-mask validation, pulse-mask verification, timing uncertainty analysis, and advanced EVM workflows. These capabilities help engineers evaluate ranging accuracy, RF distortions, antenna effects, spectral reshaping, interoperability, and regulatory compliance in next-generation positioning systems.

Integrated Digital Predistortion (DPD) workflows and Dynamic Gain Models (DGM) enable realistic evaluation of nonlinear RF transmitters and power amplifiers for high-throughput Wi-Fi and broadband connectivity systems. Engineers can evaluate ACPR, EVM, spectral regrowth, coexistence behavior, and beamforming performance using realistic wideband modulation schemes and hardware-aware RF behavioral models with memory effects.

SystemVue also provides end-to-end design-to-test workflows using Signal Studio for waveform generation and VSA, X-Apps, WaveJudge, and Keysight instrumentation for modulation analysis and hardware correlation. These integrated workflows allow engineers to validate simulation results against measured hardware performance while minimizing discrepancies between design and test environments.

By combining scalable RF digital twin workflows, realistic RF impairment modeling, standards-based validation, AI/ML integration, and hardware-aware test integration, SystemVue enables engineers to accelerate innovation and achieve higher confidence in next-generation Wi-Fi and wireless connectivity designs.

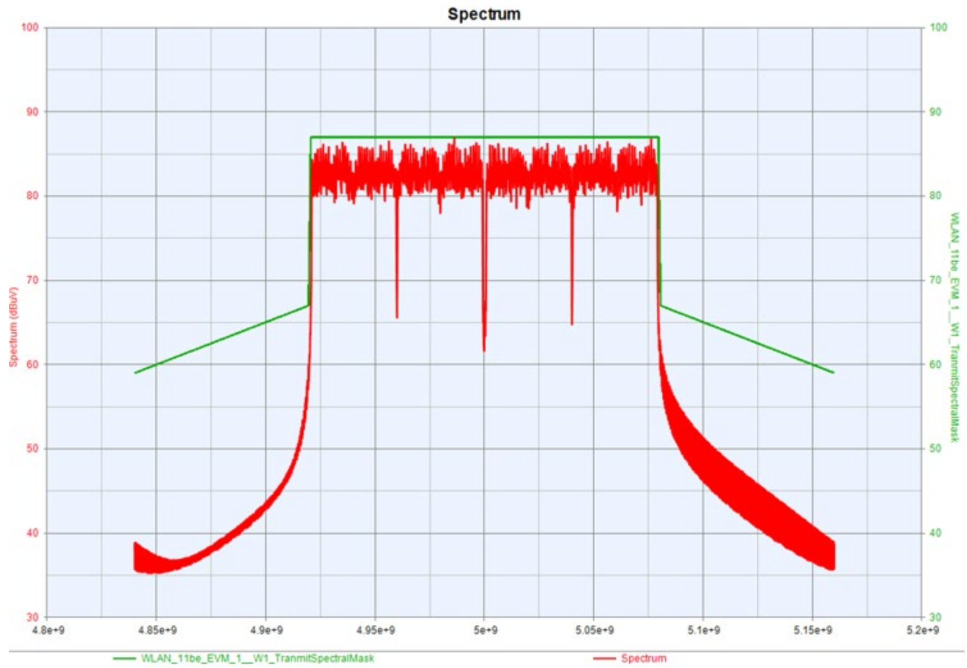

Figure 10. Wi-Fi 7 (802.11be) Spectrum Emission Mask

5G/6G & Cellular Library

SystemVue provides a comprehensive RF digital twin environment for the design, optimization, and validation of advanced cellular, NTN, phased array, and 6G wireless systems. By integrating RF simulation, communications DSP, phased-array analysis, propagation modeling, and AI/ML workflows into one scalable platform, SystemVue enables engineers to accurately evaluate next-generation wireless architecture under realistic operating conditions.

The Cellular Library includes standards-aligned transmitter and receiver reference architectures for LTE Advanced, 5G NR, 5G Advanced, NTN, and emerging 6G research workflows. Engineers can model complete PHY-layer communication systems while evaluating RF impairments, nonlinear hardware behavior, beamforming, propagation effects, coexistence, latency, throughput, spectral efficiency, and power consumption across realistic wireless environments.

SystemVue supports end-to-end simulation workflows spanning baseband processing, RF front-end modeling, phased-array beamforming, antenna integration, propagation channels, and OTA validation. Advanced multi-antenna architectures are supported including digital beamforming, analog beamforming, hybrid beamforming, massive MIMO, and phased-array payload configurations for terrestrial and non-terrestrial networks.

The platform includes standards-based DSP and channel-modeling support for:

- 5G NR PHY-layer channels and waveforms aligned with 3GPP specifications
- 3GPP TS 38.211 Physical Channels and Modulation
- 3GPP TS 38.212 Multiplexing and Channel Coding

- 3GPP TR 38.901 channel models
- 3GPP NTN channel and propagation workflows
- OTA simulation for mmWave and phased-array systems
- Massive MIMO and multi-channel beamforming architectures
- AI-native wireless research and 6G waveform exploration

SystemVue introduces major enhancements for 5G Advanced and emerging 6G research including NTN coverage maps, ISAC, RIS, phased-array enhancements, AI/ML integration, and advanced RF impairment modeling. New NTN capabilities enable realistic modeling of Doppler, delay, fading, phased-array payload beamforming, service-link propagation, RF impairments, and coverage-map generation without requiring external satellite visualization tools.

The platform also provides advanced Integrated Sensing and Communication (ISAC) and Reconfigurable Intelligent Surface (RIS) simulation workflows. Engineers can model mono-static and bi-static sensing systems using 5G NR waveforms while evaluating RF impairments, target detection, beamforming behavior, RIS phase/amplitude quantization, propagation effects, and AI-assisted sensing optimization.

SystemVue further accelerates AI-native wireless research through its built-in AI_ML_Interface, which supports ONNX and TensorFlow model integration directly into wireless system simulations. Engineers can generate realistic RF training datasets, import pretrained neural networks, and benchmark AI-based algorithms against conventional communication methods within realistic RF digital twin environments.

Included AI/ML example workflows support:

- AI-based CSI feedback compression
- Neural-network-assisted channel estimation
- AI-driven beamforming optimization
- AI-assisted wireless receiver processing
- Generation of training datasets for neural-network development

The platform integrates seamlessly with Signal Studio, VSA, WaveJudge, PROPSIM, RFPro, ADS, STK, EXata, and Keysight instrumentation to create unified design-to-test workflows with strong hardware correlation.

By combining scalable RF digital twins, standards-based validation, phased-array simulation, AI/ML integration, and hardware-aware verification workflows, SystemVue enables engineers to accelerate innovation and reduce development risk for 5G Advanced and emerging 6G wireless systems.

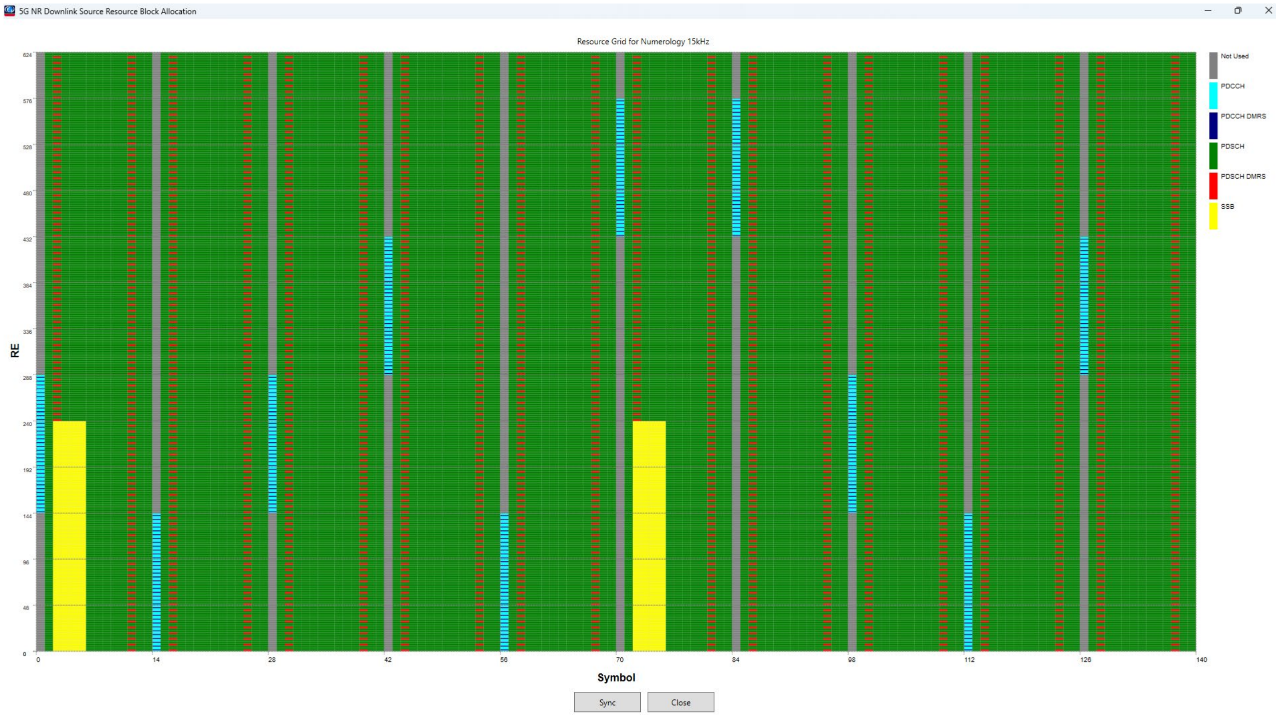

Figure 11. Color-coded representation of a 5G NR downlink signal structure and the physical channels

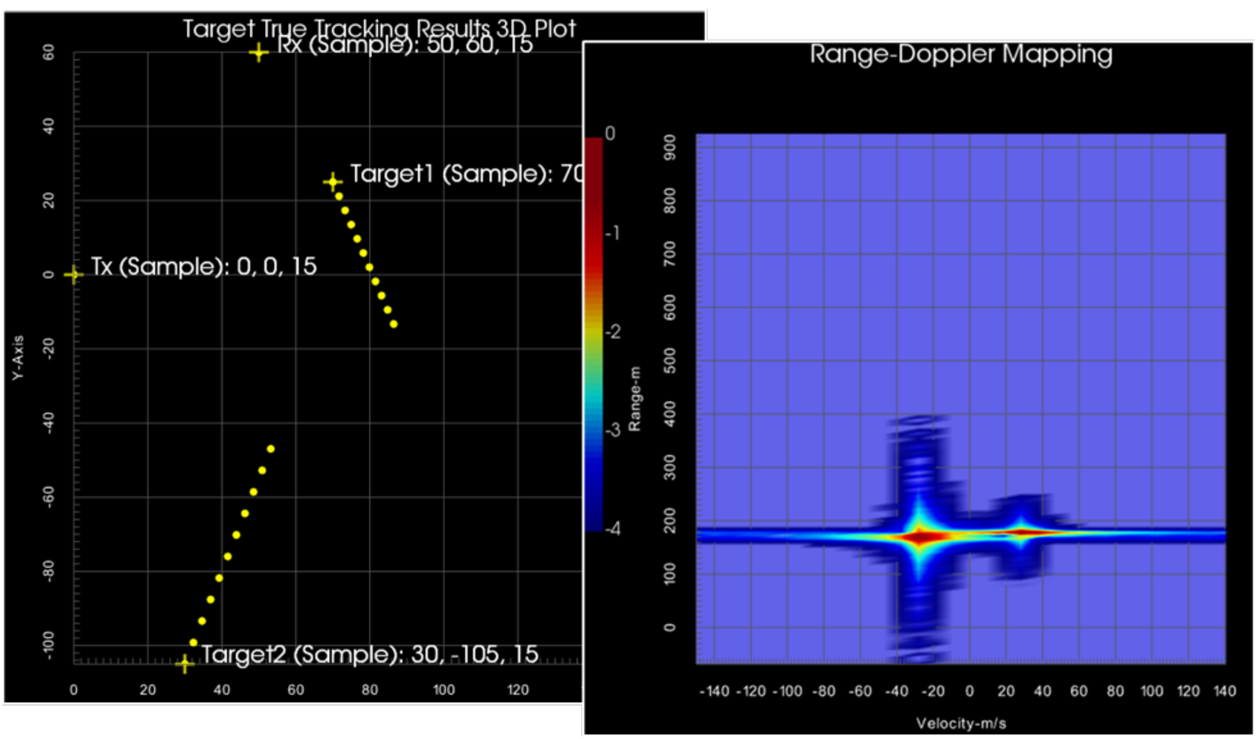

Figure 12. Snapshots of multi-target detection in bi-static ISAC mode

Satellite Communications

SystemVue provides a comprehensive RF digital twin environment for the design, optimization, and validation of advanced Non-Terrestrial Network (NTN) and satellite communication systems. By combining RF simulation, phased-array analysis, propagation modeling, beamforming, baseband processing, and realistic channel impairments into one integrated platform, SystemVue enables engineers to accurately evaluate satellite and NTN architectures before hardware deployment.

The NTN solution is anchored by SystemVue's advanced 5G NR NTN Channel Model capabilities aligned with 3GPP TR 38.811 and 3GPP NTN specifications. These workflows support realistic link-level and system-level simulation of GEO, MEO, LEO, HAPS, and airborne communication scenarios while modeling critical NTN effects such as:

- Large propagation delays
- High Doppler shifts and Doppler drift
- Dynamic satellite trajectories
- Path loss and atmospheric impairments
- Fast fading and mobility effects
- Phased-array payload beamforming
- Service and feeder link propagation channels
- RF impairments and hardware nonlinearities

SystemVue significantly expands NTN capabilities with integrated coverage-map generation, phased-array-enabled satellite payload simulation, RF-aware link-budget analysis, and dynamic trajectory-based system evaluation. Engineers can generate large-area KPI maps such as RSSI and Carrier-to-Noise Ratio (CNR) while evaluating payload beam steering, satellite movement, and user-terminal performance under realistic operating conditions. These workflows now support MATLAB and Python-based visualization and do not require external STK integration for coverage-map generation.

The platform supports end-to-end NTN digital twin workflows including waveform generation, phased-array beamforming, RF payload processing, service-link propagation, UE receiver modeling, and KPI evaluation. This enables rapid design, exploration, and optimization for:

- Direct-to-device broadband
- NB-IoT over NTN
- Satellite payload design
- Regenerative and bent-pipe architectures
- Multi-beam satellite systems
- AI-assisted beam optimization
- 5G Advanced and emerging 6G NTN research

SystemVue also provides advanced DVB-S2/S2X and SatCom workflows with integrated testbenches powered by Keysight Signal Studio and Vector Signal Analysis (VSA) software. These workflows simplify waveform generation, signal analysis, and hardware correlation while enabling consistent measurement science across simulation and laboratory validation environments.

The SatCom Channel Modeling capabilities support realistic simulation across multiple satellite platforms and communication scenarios including GEO, MEO, LEO, and airborne systems. Engineers can evaluate link robustness, throughput, latency, beam coverage, and RF impairments under realistic propagation conditions while integrating phased-array antennas, RF front-end effects, and dynamic mobility.

Tight integration with phased-array analysis, RFPro, ADS, EXata, STK, PROPSIM, WaveJudge, and Keysight instrumentation enables unified mission-level design-to-test workflows with strong hardware correlation. AI/ML integration and Python automation further accelerate optimization of adaptive beamforming, satellite resource allocation, and AI-native NTN architectures.

By combining scalable RF digital twins, realistic propagation and RF impairment modeling, phased-array payload analysis, standards-based validation, and hardware-aware workflows, SystemVue enables engineers to accelerate innovation and reduce development risk for next-generation NTN and satellite communication systems.

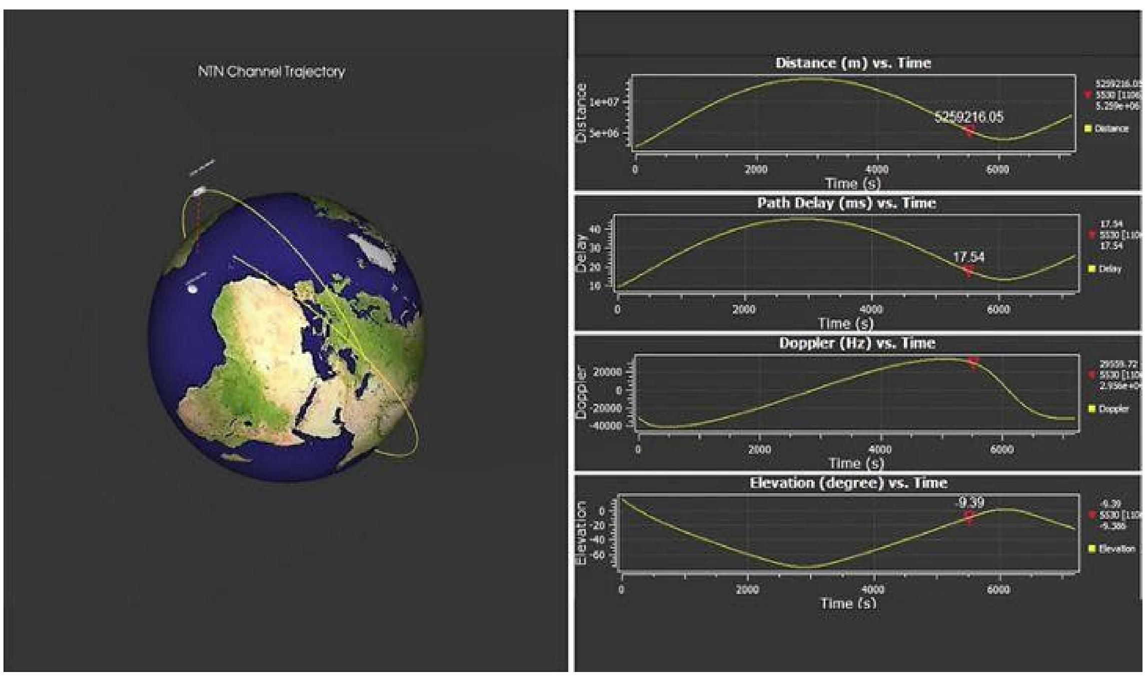

Figure 13. NTN channel trajectory display with playback mode

RF System Library

The RF Design Library in SystemVue provides a comprehensive set of high-fidelity RF behavioral and measurement-based models for Spectrasys II and WhatIF simulations, enabling rapid development and validation of complex RF system architectures. The library includes a broad range of RF components with realistic frequency-dependent and nonlinear behavior, allowing engineers to accurately model complete RF signal chains while accounting for critical impairments and hardware effects.

SystemVue supports advanced RF digital twin workflows through realistic modeling of:

- Gain compression and nonlinear distortion
- Phase noise and oscillator impairments
- Frequency conversion and spurious behavior
- Noise figure and broadband noise propagation
- IQ imbalance and LO leakage
- Memory effects and dynamic nonlinear behavior
- Active impedance and phased array coupling effects
- Temperature- and bias-dependent RF performance

The RF Design Library leverages the advanced Spectrasys II architecture, which introduces modular RF model frameworks, multidimensional RF parameter modeling, equation-based S-parameters, and enhanced measurement-driven behavioral modeling. SystemVue supports Multi-Independent Parameter (MIP) modeling, allowing RF behavior to vary dynamically with frequency, power, bias, temperature, and control conditions using measured or simulated multidimensional datasets.

SystemVue also includes advanced nonlinear modeling technologies such as the Dynamic Gain Model (DGM), enabling highly accurate representation of broadband nonlinear devices including power amplifiers, mixers, and frequency converters with memory effects and signal-dependent behavior.

Optional RF libraries are available from Keysight and industry-leading component vendors including Analog Devices, Mini-Circuits, Qorvo, X-Microwave, and others. Open model interfaces allow engineers to rapidly create custom RF models from datasheets, measurements, or EM/circuit simulation data using:

- S-parameters
- X-parameters
- Sys-parameters
- MDIF datasets
- Equation-based RF models

The RF Design Library integrates seamlessly with phased-array analysis, RFPro, ADS, EM tools, and Keysight instrumentation, enabling unified RF digital twin workflows from architecture exploration to hardware validation. Combined with Spectrasys II and WhatIF technologies, SystemVue delivers scalable, fast, and highly accurate RF system simulation for advanced wireless, NTN, radar, EW, satellite, and Aerospace & Defense applications.

Algorithm Design Library

The Algorithm Design Library in SystemVue provides a comprehensive environment for communications, DSP, and mixed-domain signal-processing simulation. Built on the Data Flow simulation engine, the library enables efficient modeling, analysis, and optimization of advanced wireless, satellite, radar, phased-array, and Aerospace & Defense communication systems using scalable time-domain simulation workflows.

The library includes an extensive set of functional blocks for:

- Communications and PHY-layer processing
- Digital Signal Processing (DSP)
- Mathematical and matrix operations
- Analog and RF behavioral functions
- Adaptive filtering and equalization
- Channel coding and decoding
- Timing and synchronization
- MIMO and beamforming processing
- AI/ML-assisted signal processing
- Sources, sinks, visualization, and measurement analysis

SystemVue supports realistic end-to-end communication system simulation by integrating baseband processing, RF impairments, phased arrays, propagation channels, and hardware-aware behavioral models within one unified environment. Engineers can rapidly prototype, validate, and optimize complex communication architectures while evaluating system-level KPIs such as EVM, BER, throughput, latency, SINR, spectral efficiency, and coexistence performance.

The Digital Modem capabilities support a wide range of communication and waveform development applications including:

- More than 40 digital modulation formats for MilCom and SatCom
- Standards-based 5G NR, LTE, Wi-Fi, and NTN PHY workflows
- Adaptive waveform and multi-carrier system analysis
- OTA simulation for mmWave and phased-array systems
- Massive MIMO and multi-antenna architecture
- Baseband, RF, analog, and hybrid beamforming structures
- AI-assisted communications and receiver algorithms

The platform also supports realistic modeling of synchronization errors, RF impairments, nonlinear hardware behavior, Doppler, fading, interference, and dynamic propagation conditions for accurate RF digital twin validation.

Integrated instrumentation and measurement-analysis components provide seamless connectivity with Keysight 89600 Vector Signal Analysis (VSA), Signal Studio, WaveJudge, X-Apps, and Keysight RF instrumentation. These design-to-test workflows enable engineers to generate realistic waveforms, correlate simulation results with measured hardware performance, and validate communication systems using consistent measurement science across simulation and laboratory environments.

SystemVue further accelerates advanced communications research through support for AI/ML integration, Python automation workflows, and ONNX/TensorFlow-based neural-network inference directly within communication-system simulations. Engineers can generate RF training datasets, evaluate AI-enhanced receivers, and benchmark AI-based algorithms against conventional DSP techniques in realistic wireless environments.

By combining scalable DSP simulation, standards-based communication workflows, realistic RF impairments, phased-array integration, and hardware-aware validation, SystemVue enables engineers to rapidly develop and validate next-generation wireless and communication systems with greater confidence and reduced development risk.

AMI Models

The W4511E AMI Modeling Kit in SystemVue simplifies the development, validation, and deployment of transportable IBIS-AMI models for High-Speed Digital (HSD) and Serializer/Deserializer (SerDes) applications. The kit enables engineers to efficiently create standards-compliant AMI models for advanced serial-link architecture while accelerating signal-integrity analysis and system-level validation workflows.

By combining DSP-centric modeling with executable behavioral architectures, SystemVue enables engineers to rapidly prototype equalization algorithms, channel compensation techniques, clock recovery architectures, adaptive DSP blocks, and high-speed link-processing functions within realistic system environments. The AMI Modeling Kit supports generation of royalty-free IBIS-AMI deliverables for distribution across design teams, customers, and ecosystem partners.

Key capabilities include:

- Rapid creation of standards-compliant IBIS-AMI models
- Executable DSP and SerDes architecture development
- Support for Tx/Rx equalization and adaptive DSP algorithms
- Efficient validation of high-speed serial links and channels
- Royalty-free generation of AMI model deliverables
- Streamlined interoperability across EDA ecosystems

The platform also includes C++ Code Generation Kit, enabling engineers to automatically generate optimized C++ implementations from SystemVue DSP architectures and algorithmic workflows. More than 100 configurable signal-processing blocks can be used to create portable high-performance DSP models for integration into external software environments, embedded systems, and custom communication platforms.

The Algorithm Design capabilities support development of:

- Adaptive equalizers
- Clock and timing recovery
- Channel estimation and compensation
- DSP-based filtering and synchronization
- Multi-rate signal processing
- AI-assisted DSP workflows
- Custom communication and SerDes algorithms

By combining scalable DSP simulation, executable specifications, automated C++ generation, and standards-compliant AMI modeling workflows, SystemVue accelerates high-speed digital system development while reducing integration risk and improving interoperability across modern high-speed communication ecosystems.

Ordering Information and Licensing

For teams performing high-frequency RF design and simulation, SystemVue is licensed in two-part bundles with a design core license and a simulator license. Enterprise installations can optimize licensing based on core access counts and specific simulation capability needs for team members.

Model	Name	Description
W4800B	SystemVue Core	Schematic capture, data plotting, and MATLAB code support
W4801B	SystemVue Core + RF	Adds RF analysis simulation elements with Spectrasys, WhatIF, linear simulation, and RF component model libraries
W4802B	SystemVue Core +Comms/DSP	Adds timed dataflow simulation, with libraries for DSP elements, digital modulation, SerDes, MIMO, and legacy cellular specifications
W4803B	SystemVue Core +Comms/DSP	Allows RF Link to connect timed dataflow analysis RF with accurate, high-fidelity RF system models
W4804B	SystemVue Core + RF +Comms/DSP + Phased Array	Adds advanced Phased Array simulation for both RF and Comms/DSP applications using beamforming
W4811B	SystemVue + Aerospace Defense	Adds all the tools needed to design RF and baseband systems for radar
W4812B	SystemVue + 5G & Cellular	Adds all the tools needed to design RF and baseband systems for 5G

W4813B	SystemVue + Automotive	Adds all the tools needed to design RF and baseband systems for automotive radar
W4814B	SystemVue + Wi-Fi & Connectivity	Adds all the tools needed to design RF and baseband systems for Wi-Fi and connectivity
W4815B	SystemVue + Satellite	Adds all the tools needed to design RF and baseband systems for satellite
W4816B	SystemVue + 5G + NTN Channel	System Design 5G applications plug-in for EXata Network Emulation and Modeling
W4857B	SystemVue + Signal Studio + VSA + DVBS2 / S2X Application Bundle	End-to-end system design solution for DVB-S2/S2X integrating Signal Studio and VSA Software

For teams performing algorithm design in MATLAB, SystemVue simulation engines integrate with MATLAB and Simulink, letting algorithm designers call SystemVue workspaces and libraries directly within the MATLAB environment.

Model	Name	Description
W4806B	SystemVue Algorithm Core	RF and Comms/DSP Schematic capture, data plotting, and MATLAB code support

SystemVue is available on a subscription basis with periods of 6, 12, 24, or 36 months.

Resources

For More Information

Apply for a Free Trial: www.keysight.com/find/system-design-evaluation

Learn more about SystemVue bundles and elements

Or visit these online resources:

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- LinkedIn Users Group: www.keysight.com/find/system-design-linkedin