Keysight EEsof EDA
W1918 LTE-Advanced Baseband Verification Library

Data Sheet

Baseband PHY Libraries for SystemVue

KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Offering the Fastest Path from Algorithms to R&D Verification

Key benefits:

- Accelerate your Physical Layer (PHY) design process with a superior modeling environment
- Save time with a trusted, independent IP reference from Keysight
- Validate BB & RF integration early, reducing project risk
- Reduce functional verification and NRE in R&D, with a streamlined process
- Fill strategic gaps using simulation, such as missing hardware and MIMO effects for early throughput testing
- Interoperate with test equipment, while the standard itself is still evolving
- Re-use the same Keysight IP and test assets throughout process

The W1918 LTE-Advanced Baseband Verification Library saves time, reduces engineering effort and accelerates the maturity of 4G baseband PHY designs for next-generation 3rd Generation Partnership Project (3GPP) Long Term Evolution LTE-Advanced systems. It enables system architects, algorithm developers and baseband hardware designers to investigate, implement and verify their Layer 1 signal processing designs in the presence of meaningful RF and test signals. The library gives the user piece of mind that a physical layer (PHY) meets or exceeds real-world performance requirements from the European Telecommunications Standards Institute (ETSI).

The W1918 LTE-A Baseband Verification Library is a Layer 1 simulation reference library option for Keysight SystemVue. The blockset, reference designs, and test benches assist the design and verification of next-generation communication systems, by providing configurable physical layer waveforms and data for 3GPP Releases 8/9 (LTE) and 10-13 (LTE-Advanced). The library is useful for simulation-based exploration of challenging algorithms, up to 8x8 MIMO throughput verification, and can be easily integrated with Keysight signal sources and analyzers.

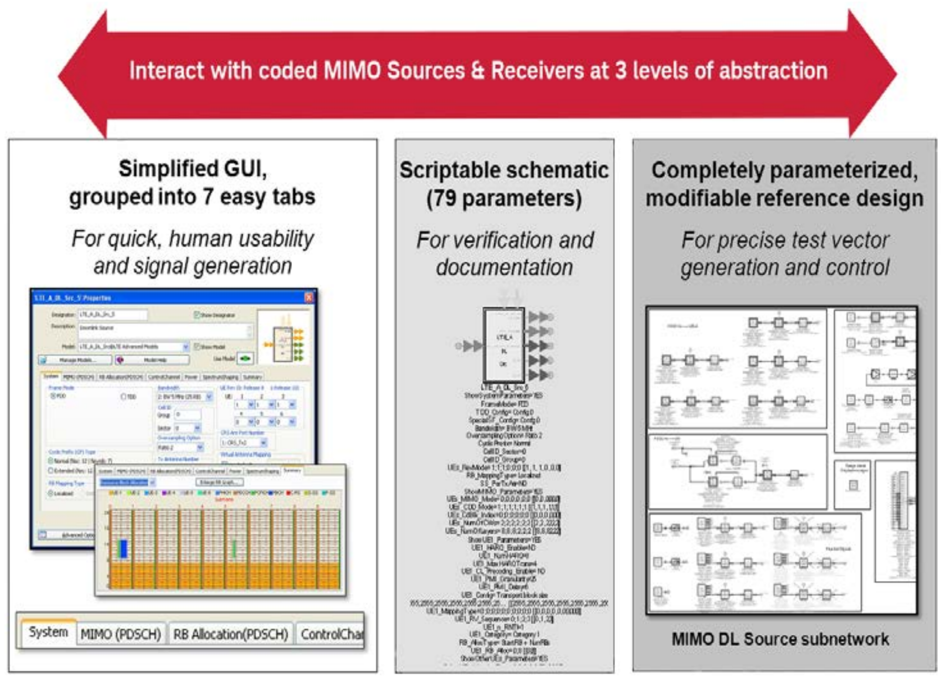


Figure 1. The W1918 LTE-Advanced Baseband Verification Library offers pre-packaged reference sources and receivers with a choice of three levels of user interfaces, as shown in this LTE-A MIMO downlink source example.

Features

- Working simulation-based baseband reference designs for UE & eNodeB
- Open, parameterized block diagrams allow exploration and customization inside the signal processing chain
- Compare your internal test vectors against a trusted IP reference
- Use Keysight simulation blocks to:
  - Supply missing functions/models
  - Create complete Layer 1 scenarios
  - Add MIMO, fading, interferences
  - Simulate BER/Throughput
  - Interoperate with real test

Configuration

The W1918 LTE-Advanced Baseband Verification Library can be added as an option to any SystemVue environment or bundle.

The W1918 LTE-A library is a superset of the W1910 LTE library, and includes it. It adds algorithm models for LTE-Advanced, making a complete library that supports 3GPP releases 8-13, including Narrowband Internet of Things (NB-IoT).

The W1918 library is itself included in the W1907 5G Forward Verification Library Bundle, along with modelsets for 2G, 3G, MIMO Channel, and the new pre-5G library. If you are considering moving toward 5G, then the W1907 bundle is an excellent value, assisting compatibility across multiple generations of standards, not just 4G.

The W1918 is especially well-suited to work with other SystemVue libraries, such as the W1715 MIMO Channel Builder, the W1716 Digital Pre-Distortion Builder. It can also be used by system architects to customize test benches for use with Keysight ADS VTB personalities: W2388 LTE VTB (LTE only), W2390 LTE-A VTB (LTE-A only, not including LTE). Finally, the W1918 LTE-A library interoperates with Keysight Signal Studio personalities for LTE- A (N7624B, N7625B), as well as Keysight 89600 VSA personalities 89601B-BHG and 89601-BHH.

C++ source code for the W1918 LTE-A library is available as a premium service product “W1912BEL Baseband Exploration Library”. Please contact your local Keysight sales representative for more information about SystemVue “exploration” libraries.

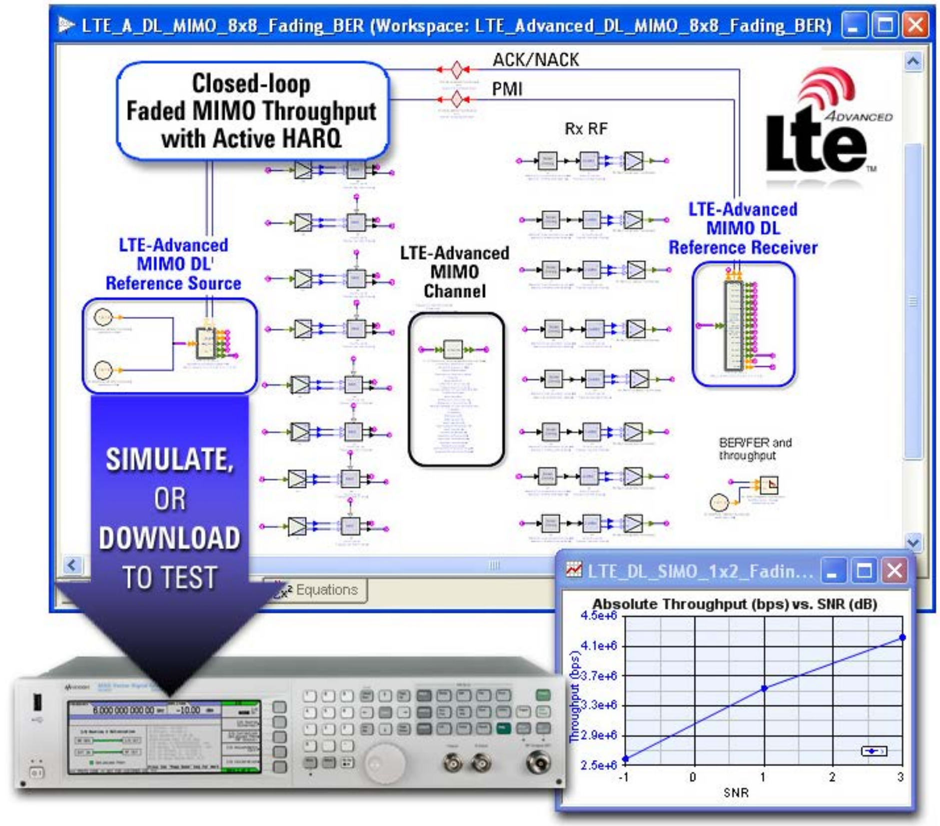


Figure 2. SystemVue’s LTE-Advanced reference library provides support for 3GPP Releases 8-11, and integrates with Keysight test equipment for early R&D design validation.

Table 1. W1918 LTE-Advanced Baseband Verification Library Overview

W1918 LTE-Advanced library includes:	Release 8/9 LTE	Release 10-13, NB-IoT LTE-Advanced
Compiled dataflow simulation blocks	139 parts	113 parts
C++ “exploraton” source code	Optional, add-on	Optional, add-on
Packaged MIMO Sources/receivers, w/GUI	10 ref designs	6 ref designs
Testbenches/reference exmples	18 examples	18 examples
Works with existing instrument H/W	Yes	Yes
Works with Keysight 89600 VSA and SignalStudio software personalities	Yes, also generates “.setx” files	Yes
Works with Keysight W1716 DPD	Yes	Yes
Works with Keysight W1715 MIMO Channel	Yes	Yes

Note: Support for Release 8/9 is also available as part of the SystemVue W1910 LTE baseband verification library.

Technical Specifications - LTE-Advanced (3GPP Releases 10-13)

LTE-Advanced Downlink baseband sources and receivers

- FDD and TDD
- Up to 8 TX and 8 RX antennas
- Localized and Distributed RB mapping
- Transmission Modes TM1-4, and 6-9, including closed-loop TM4 TDD/FDD in DL
- Virtual antenna mapping, the mapping matrix can be configured
- Release 10 PDSCH transmission and Release 8 PDSCH transmission in the downlink source
- Support for 256 QAM modulation and extended cyclical prefix (both UL, DL)
- Closed-loop HARQ simulation by employing Dynamic Data Flow (DDF) and Matrix Data Type. Each codeword have one individual HARQ feedback loop.
- PDSCH
  - Full coding and decoding procedures for DL-SCH with or without HARQ retransmission
  - Three RB (resource block) allocations (StartRB+NumRBs, RB indices (1D), RB indices (2D))
  - Three transport block allocations (MCS index, transport block size and target code rate)
- Physical signals
  - Cell-specific reference signals
  - UE-specific reference signals (port 5, 7-14)
- Synchronization signals, including primary and secondary synchronization signals
- Control channels
  - Full procedures for PCFICH, PHICH, PDCCH and PBCH, including information bits generation and channel coding
  - CSI reference signals (port 15-22)
- Downlink power allocation according to TS36.213
- Receiver baseband algorithm
  - Support downlink timing and frequency synchronization, including:
    - Cross-correlation with two received P-SCH
    - Auto-correlation with local P-SCH
    - Two stages for timing synchronization: raw and fine synchronization
    - Integer and fractional frequency synchronization
- Linear, MMSE-2D channel estimation including MMSE and MMSE-IRC for spatial multiplexing (DL)
- ZF (Zero Forcing) and ML (maximum likelihood) decoding for spatial multiplexing
- Alamouti decoding for transmit diversity
- Received soft bits combining for HARQ retransmission
- Soft turbo decoder with specified iteration number

The W1918 LTE-Advanced Baseband Verification Library is based on 3GPP LTE Release 13 (June, 2016). Keysight library updates are issued regularly to remain compatibility with the evolution of the standard.

- 3GPP TS 36.211 v13.2.0, “Physical Channels and Modulation,” June 2016.
- 3GPP TS 36.212 v13.2.0, “Multiplexing and Channel Coding,” June 2016.
- 3GPP TS 36.213 v13.2.0, “Physical Layer Procedures,” June 2016.

Technical Specifications - LTE-Advanced (3GPP Releases 10-13) (Continued)

LTE-Advanced Uplink baseband source and receivers

- FDD and TDD
- Up to 4 Tx antennas and 4 Rx antennas
- Cluster SC-FDMA
- Simultaneous PUSCH and PUCCH transmission
- Maximal ratio combining (MRC) method for receiver diversity
- Adaptive Modulation and Coding (AMC)
- Coordinated Multi-point (CoMP, or Dynamic Point Selection)
- Closed-loop HARQ simulation by employing Dynamic Data Flow (DDF) and Matrix Data Type
- PUSCH
  - Full coding and decoding procedures for UL-SCH with or without HARQ retransmission
  - PUSCH Hopping
  - Full multiplexing modes for PUSCH
    - UL-SCH Data and control multiplexing (as in 5.2.2 of 36.212)
    - Uplink control information only without UL-SCH data (as in 5.2.4 of 36.212)
  - Three RB (resource block) allocations (StartRB+NumRBs, RB indices (1D), RB indices (2D))
  - Three transport block allocations (MCS index, transport block size and target code rate)
  - DMRS for PUSCH
- PRACH
  - Preamble sequence generation and baseband signal generation
  - PRACH demodulation and detection
- PUCCH transmission
  - PUCCH Format 1, 1a, 1b, Shorten 1, Shorten 1a, Shorten 1b, 2, 2a, 2b, and 3
  - PUCCH modulation and demodulation, coding and decoding
  - DMRS for PUCCH
- Sounding Reference Signal (SRS) transmission
- Uplink power allocation
- Receiver baseband algorithm
  - Uplink timing and frequency synchronization
  - Linear and MMSE channel estimation
  - Soft turbo decoder with specified iteration number

Recent enhancements:
- 256 QAM (UL, DL)
- Support for Extended Cyclical Prefix (UL, DL)
- Support for closed-loop TM4 TDD/FDD (DL)
- MMSE and MMSE-IRC for spatial multiplexing (DL receiver)

Carrier aggregation

- Carrier aggregation examples are provided, including both contiguous and non-contiguous carrier aggregation

Technical Specifications - LTE-A NB-IoT (3GPP Release 13)

Narrowband IoT Downlink baseband sources and receivers

- Operation mode
  - Stand- alone operation
  - Guard band operation
  - In-band operation
- Up to 2 Tx and 2 Rx antennas
- Narrowband Physical Channels:
  - NPBCH (physical broadcast channel)
  - NPDSCH (physical downlink shared channel)
- Narrowband Physical Signals:
  - NRS (Narrowband Reference Signal)
  - NPSS/NSSS (primary and secondary synchronization channels)
- NPDSCH and NPBCH Channels
  - Channel Coding, Scrambling
  - Layer mapping, Precoding, Modulation
- NPDSCH repetition
- Spectrum Shaping
  - Configurable filter and window
- Receiver baseband algorithm
  - Support downlink timing and frequency synchronization
  - Auto detection of CellID sector and group
  - Linear, MMSE-2D channel estimation
  - Viterbi decoder and CRC check

Narrowband IoT Uplink baseband sources and receivers

- Single-tone with 3.75 kHz and 15 kHz subcarrier spacing
- Multi-tone (3, 6, 12 tones) with 15 kHz subcarrier spacing
- Narrowband Physical Channels:
  - NPUSCH (Narrowband Physical Uplink Shared Channel)
- Narrowband Physical Signals:
  - NDMRS (demodulation reference signal)
- NPUSCH format 1 and 2, NPUSCH repetition
- NPUSCH gap transmission in source signal generation
- NPUSCH Channel
  - Channel Coding, Scrambling
  - Layer mapping, Transform Precoding
  - SC-FDMA baseband signal generation
  - Phase alignment for signal tone
  - BPSK, QPSK modulation
- Receiver baseband algorithm
  - Support uplink timing and frequency synchronization
  - Linear, MMSE-2D channel estimation
  - Viterbi decoder and CRC check
- HARQ transmission

NB-IoT test bench examples:

- LTE_Advanced_NBIoT_DL_BER.wsv
- LTE_Advanced_NBIoT_DL_Instruments.wsv
- LTE_Advanced_NBIoT_DL_Tx.wsv
- LTE_Advanced_NBIoT_UL_BER.wsv
- LTE_Advanced_NBIoT_UL_Instruments.wsv
- LTE_Advanced_NBIoT_UL_Throughput.wsv
- LTE_Advanced_NBIoT_UL_Tx.wsv

Technical Specifications - LTE (3GPP Release 8/9)

LTE Downlink baseband MIMO sources and MIMO receivers

Downlink sources

- FDD-LTE and TDD-LTE
- Transmission modes TM1-4, and 6-8
- Both Localized and Distributed RB mapping
- Closed-loop HARQ simulation by employing Dynamic Data Flow (DDF) and Matrix Data Type
- Each codeword have one individual HARQ feedback loop
- Closed-loop MIMO precoding for PDSCH, as described in 8.2.1.4 (Closed-loop spatial multiplexing) of 36.101
- Provides native downlink EVM measurements that are algorithmically compatible with Keysight 89600 VSA software
- PDSCH
  - Full coding and decoding procedures for DL-SCH with or without HARQ retransmission
  - Three RB (resource block) allocations (StartRB+NumRBs, RB indices (1D), RB indices (2D))
  - Three transport block allocations (MCS index, transport block size and target code rate)
- Physical signals
  - Cell-specific reference signals
  - Synchronization signals, including primary and secondary synchronization signals
  - UE-Specific Reference signals (port 5, port 7, port 8)
  - Positioning Reference signals (port 6) and PMCH transmission
- Control channels
  - Full procedures for PCFICH, PHICH, PDCCH and PBCH, including information bits generation and channel coding, and MBSFN reference signals
- Downlink power allocation according to TS36.213
- Coded downlink signal sources provided for 1, 2, or 4 antenna ports

The W1910 LTE Baseband Verification Library is based on 3GPP LTE Release 8/9 (March 2010). This LTE library is also included as part of the larger W1918 LTE-Advanced library, which also adds Releases 10-13.

- 3GPP TS 36.211 v9.1.0, “Physical Channels and Modulation”, March, 2010.
- 3GPP TS 36.212 v9.1.0, “Multiplexing and Channel Coding”, March, 2010.
- 3GPP TS 36.213 v9.1.0, “Physical Layer Procedures”, March, 2010

Downlink receivers

- Downlink receiver solutions are provided for
  - 1 antenna, 2 antennas and 4 antennas
  - SISO (1x1), SIMO (1x2,1x4)
  - MIMO (2x2, 4x2, 4x4)
- Downlink HARQ performances meet the requirements defined in 8.2 Demodulation of PDSCH (Cell-Specific Reference Symbols) of TS36.101
- Control channel demodulation and decoding
- Auto generation of .setx configuration file for LTE personalities of Keysight 89600 VSA software

Technical Specifications - LTE (3GPP Release 8/9) (Continued)

Downlink receiver baseband algorithms

- Downlink timing and frequency synchronization, including
  - Cross-correlation with two received P-SCH
  - Auto-correlation with local P-SCH
  - Two stages for timing synchronization: Raw and fine synchronization
  - Integer and fractional frequency synchronization
- Linear, MMSE-2D channel estimation, also the channel estimation for EVM measurement (defined in TS36.101) is provided
- Maximal ratio combining (MRC) method for receiver diversity
- ZF (Zero Forcing) , MMSE (minimum mean square error) and ML (Maximum likelihood) decoding for spatial multiplexing
- Alamouti decoding for transmit diversity
- Received soft bits combining for HARQ retransmission
  - Soft turbo decoder with specified iteration number

Technical Specifications - LTE (3GPP Release 8/9) (Continued)

LTE Uplink baseband sources and receivers

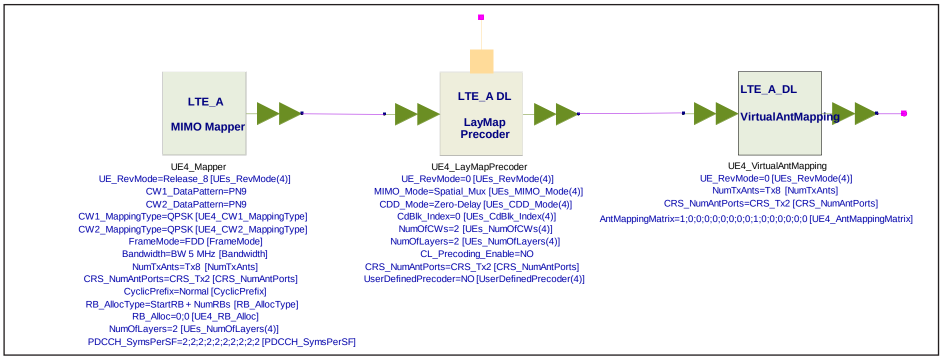
- FDD-LTE and TDD-LTE
- Uplink receivers with 1, 2 and 4 antenna ports
- Maximal ratio combining (MRC) method for receiver diversity
- Closed-loop HARQ simulation by employing Dynamic Data Flow (DDF) and Matrix Data Type
- Provides Uplink EVM measurements that are algorithmically compatible with Keysight 89600 VSA software v11.20
- PUSCH
  - Full coding and decoding procedures for UL-SCH with or without HARQ retransmission
- PUSCH Hopping
  - Full multiplexing modes for PUSCH
  - UL-SCH Data and control multiplexing (as in 5.2.2 of TS36.212)
  - Uplink control information only without UL-SCH data (as in 5.2.4 of TS36.212)
  - Three RB (resource block) allocations (StartRB+NumRBs, RB indices (1D), RB indices (2D))
  - Three transport block allocations (MCS index, transport block size and target code rate)
  - DMRS for PUSCH
- PRACH
  - Preamble sequence generation and baseband signal generation
  - PRACH demodulation and detection
- PUCCH
  - PUCCH Formats 1, Shorten 1, 1a, Shorten 1a, 1b, Shorten 1b, 2, 2a and 2b.
  - Channel coding for control information bits on PUCCH
  - DMRS for PUCCH
- Sounding Reference Signal (SRS)
  - SRS as defined in 5.5.3 of TS36.211
  - SRS as defined in 8.2 of TS36.213
- Uplink power allocation
- Control information decoding
- Uplink receiver solutions are provided for
  - 1 antenna
  - HARQ SISO (1x1)
  - Non-HARQ SISO (1x1)

Uplink receiver baseband algorithm

- Uplink timing and frequency synchronization
- Linear and MMSE channel estimation
- Soft turbo decoder with specified iteration number

W1918 Baseband Block Set

The W1918 LTE-Advanced Baseband Verification Library for SystemVue provides roughly 250 simulation reference blocks for LTE and LTEAdvanced. In addition, lower-level primitives have been combined into 14 fully-coded MIMO UL/DL source and receiver reference designs with a tabbed user interface. Use them as algorithmic references to compare test vectors at any point in the signalprocessing chain, or to complete a working PHY.



LTE-Advanced simulation models (W1918 only)

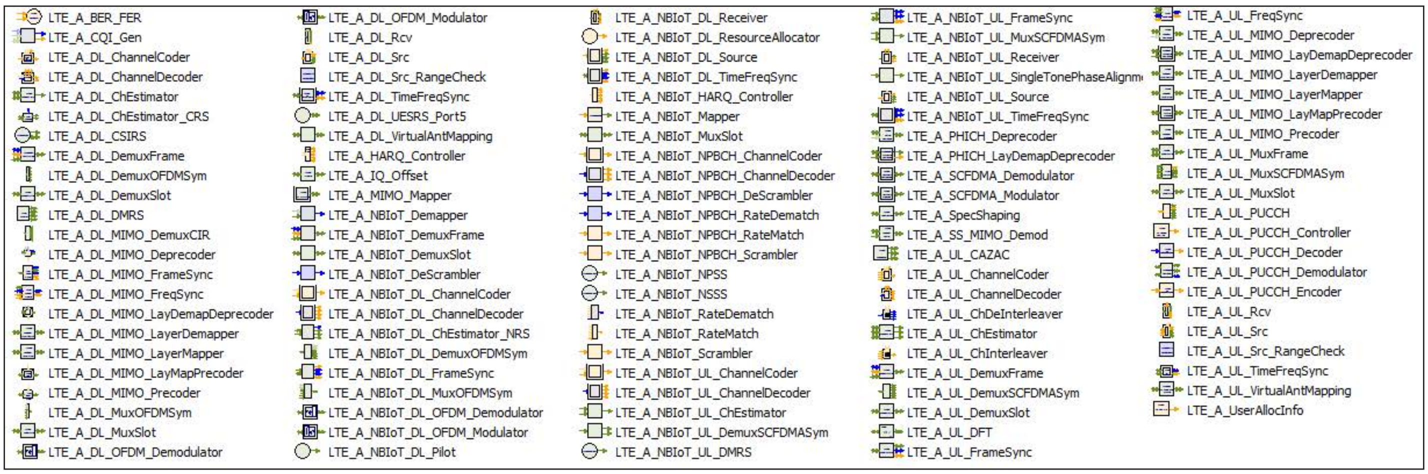


Figure 3. The W1918 LTE-Advanced baseband verification library provides these 113 simulation blocks and 4 MIMO UL/DL source and receiver reference designs, along with NarrowBand Internet of Things (NB-IoT) support, for Releases 10-13 (June 2016).

LTE simulation models (W1918 and W1910)

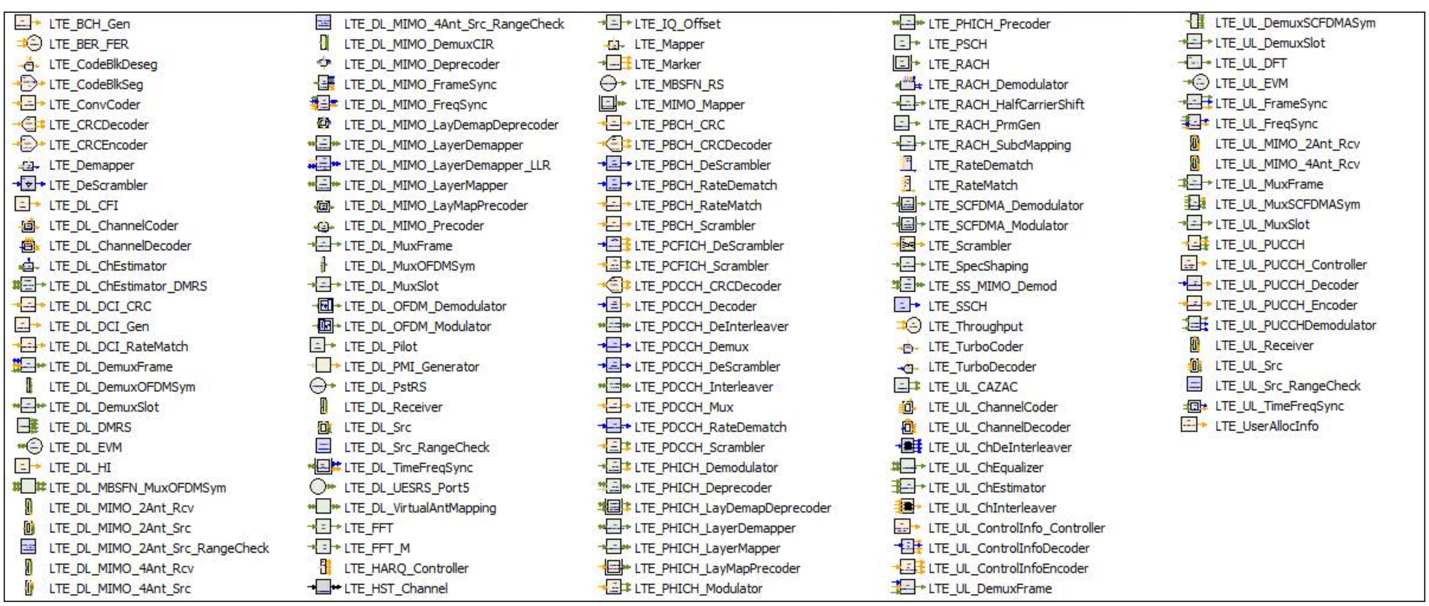


Figure 4. Both the W1918 (LTE-Advanced) and W1910 (LTE) baseband verification libraries provide these 139 simulation blocks and 10 MIMO UL/DL source and receiver reference designs for Releases 8 and 9. (March 2010).

LTE-Advanced Test bench Samples

Available LTE-Advanced test bench samples:

- LTE_Advanced_DL_AMC.wsv
- LTE_Advanced_DL_Contiguous_CA_MXG_Gen.wsv
- LTE_Advanced_DL_ETM.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput_IRC_RX.wsv
- LTE_Advanced_DL_MIMO_8x8_Throughput.wsv
- LTE_Advanced_DL_NonContiguous_CA_MXG.wsv
- LTE_Advanced_DL_SISO_BER.wsv
- LTE_Advanced_DL_SISO_DPS.wsv
- LTE_Advanced_DL_Tx.wsv
- LTE_Advanced_PUCCH_Decoding.wsv
- LTE_Advanced_UL_AMC.wsv
- LTE_Advanced_UL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_UL_MIMO_4x4_Throughput.wsv
- LTE_Advanced_UL_SISO_BER.wsv
- LTE_Advanced_UL_Tx.wsv

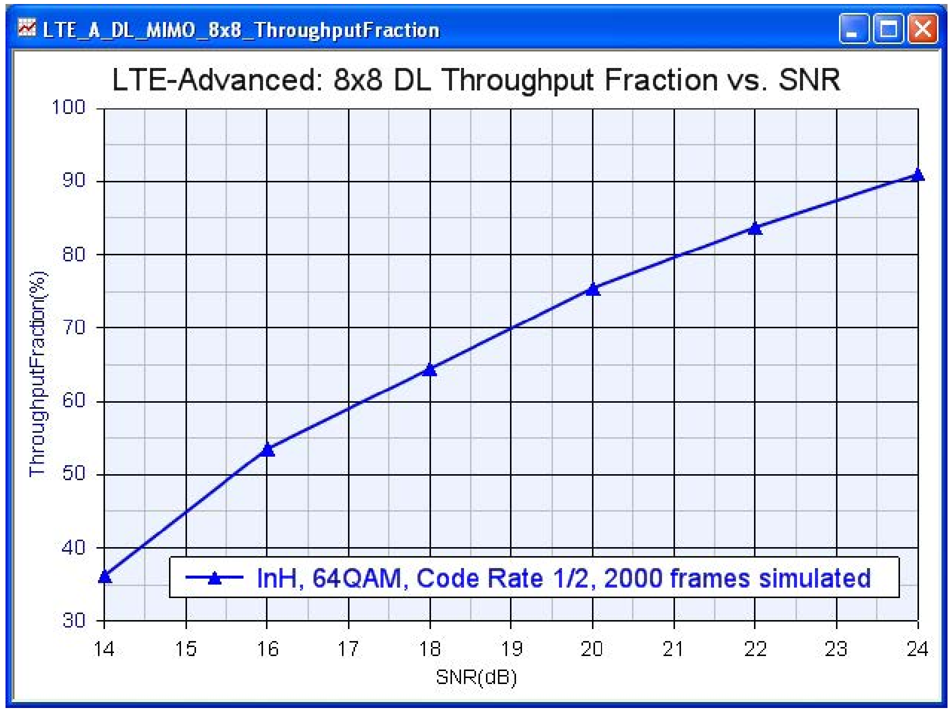


Figure 5. This 8x8 MIMO downlink transmitter example calculates the closed-loop throughput fraction for an LTE Advanced downlink transmitter with an 8-layer MIMO. Since 2000 frames of LTEAdvanced data for 8 MIMO channels represents a large number of simulated bits, these long verification simulations can be scripted and run automatically, for more convenience.

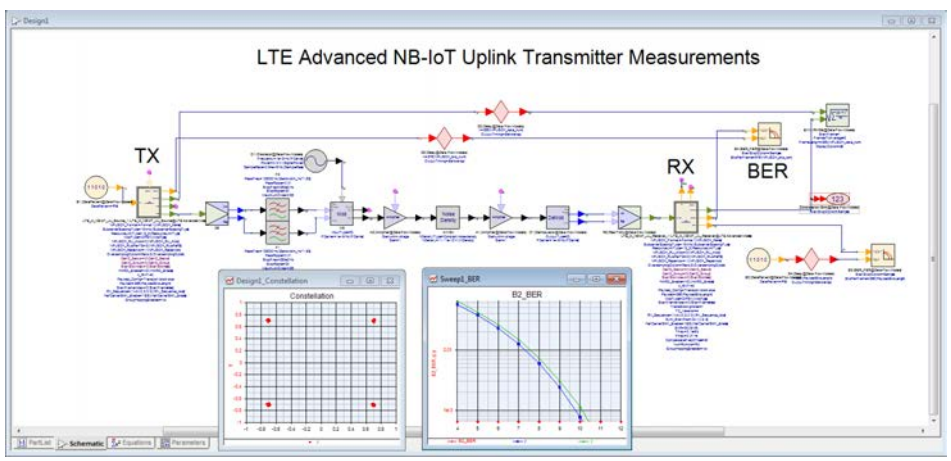


Figure 6. Support for NB-IoT (Release 13) allows wireless designers to validate designs that use the lighter packet structure needed for M2M “internet of things”, including devices that wake up infrequently to interact with the macrocell network.

LTE-Advanced Test bench Samples (Continued)

Available LTE-Advanced test bench samples:

- LTE_Advanced_DL_AMC.wsv
- LTE_Advanced_DL_Contiguous_CA_MXG_Gen.wsv
- LTE_Advanced_DL_ETM.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput_IRC_RX.wsv
- LTE_Advanced_DL_MIMO_8x8_Throughput.wsv
- LTE_Advanced_DL_NonContiguous_CA_MXG.wsv
- LTE_Advanced_DL_SISO_BER.wsv
- LTE_Advanced_DL_SISO_DPS.wsv
- LTE_Advanced_DL_Tx.wsv
- LTE_Advanced_PUCCH_Decoding.wsv
- LTE_Advanced_UL_AMC.wsv
- LTE_Advanced_UL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_UL_MIMO_4x4_Throughput.wsv
- LTE_Advanced_UL_SISO_BER.wsv
- LTE_Advanced_UL_Tx.wsv

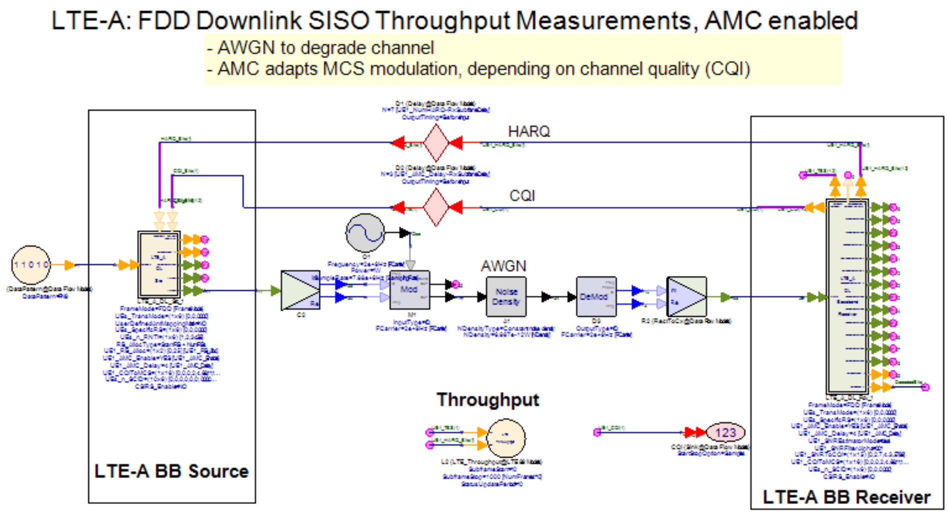


Figure 7. This Adaptive Modulation Coding (AMC) example shows how LTE-Advanced throughput adapts to changing channel conditions (S/N Ratio) during the simulation, allowing optimum throughput based on the CQI.

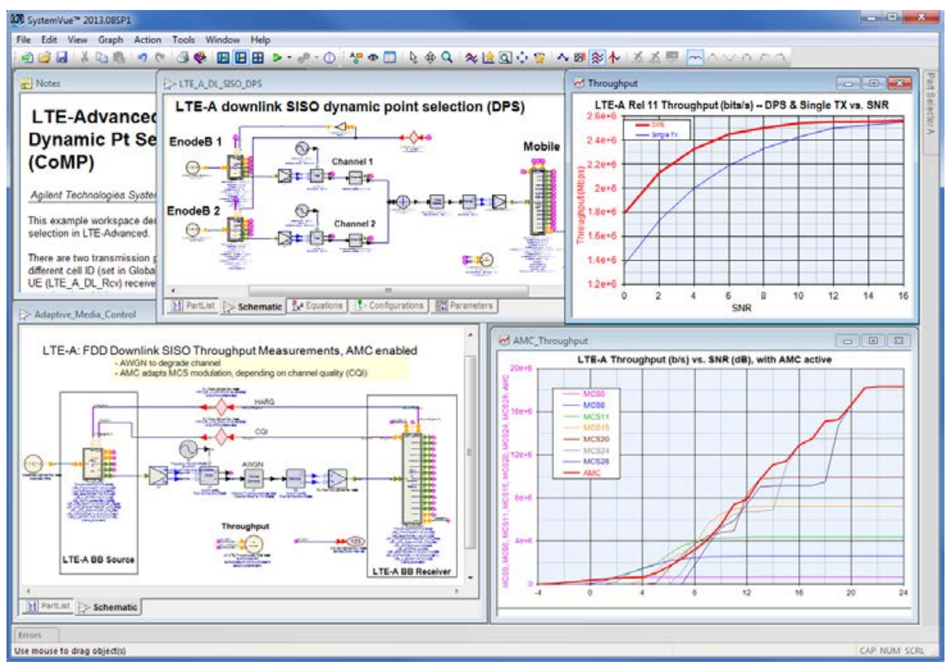


Figure 8. Dynamic AMC results from the schematic in Figure 7. At high SNR, the throughput is optimized. The figure also shows Dynamic Point Selection (DPS), a technique for Coordinated Multi-Point (CoMP) analysis.

LTE-Advanced Test bench Samples (Continued)

Available LTE-Advanced test bench samples:

- LTE_Advanced_DL_AMC.wsv
- LTE_Advanced_DL_Contiguous_CA_MXG_Gen.wsv
- LTE_Advanced_DL_ETM.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_DL_MIMO_2x2_Throughput_IRC_RX.wsv
- LTE_Advanced_DL_MIMO_8x8_Throughput.wsv
- LTE_Advanced_DL_NonContiguous_CA_MXG.wsv
- LTE_Advanced_DL_SISO_BER.wsv
- LTE_Advanced_DL_SISO_DPS.wsv
- LTE_Advanced_DL_Tx.wsv
- LTE_Advanced_PUCCH_Decoding.wsv
- LTE_Advanced_UL_AMC.wsv
- LTE_Advanced_UL_MIMO_2x2_Throughput.wsv
- LTE_Advanced_UL_MIMO_4x4_Throughput.wsv
- LTE_Advanced_UL_SISO_BER.wsv
- LTE_Advanced_UL_Tx.wsv

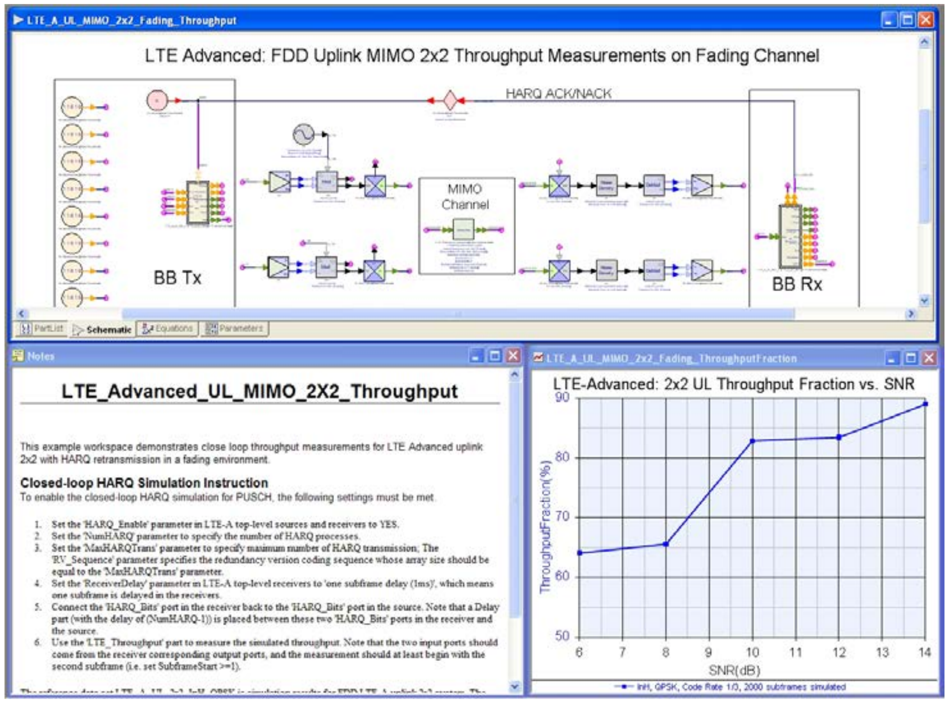


Figure 9. This closed-loop 2x2 MIMO example profiles the data throughput percentage vs. SNR, for an LTE-Advanced uplink transmitter with active HARQ feedback. SystemVue's proprietary "dynamic datalow" simulation engine makes dynamic radio reconfiguration possible during the simulation, while maintaining timing and carrier frequency information for accurate RF effects.

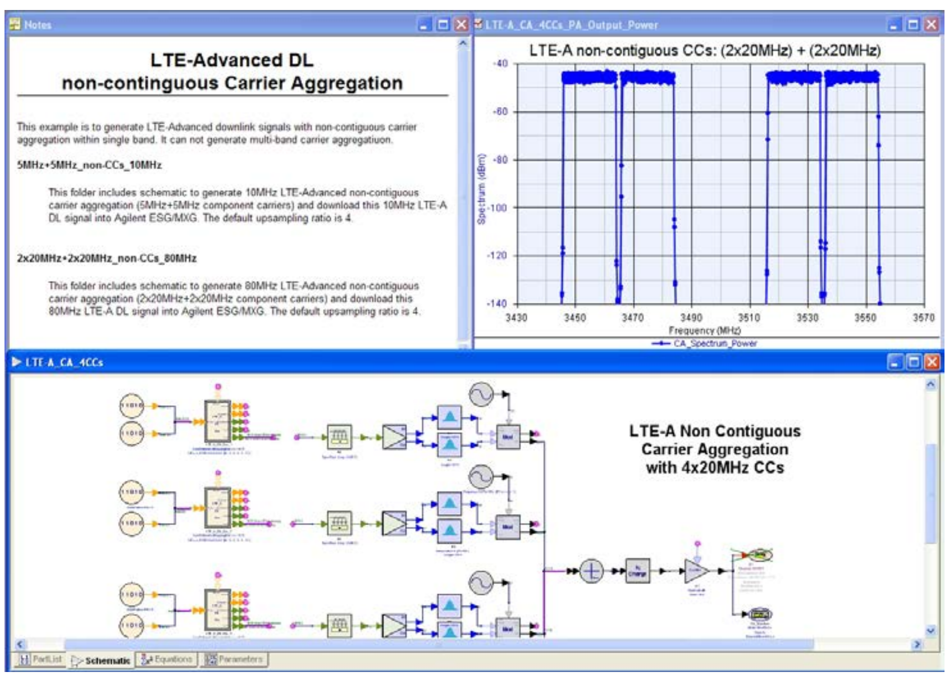


Figure 10. Non-Contiguous Carrier Aggregation (CA) is demonstrated in this example, by combining 4 Component Carriers (CC) that are each 20-MHz bandwidth. Nonlinear RF/Analog impairments can be added to this system, creating EVM and throughput degradations more typical of loaded cells and interference-limited operation.

LTE Test bench Samples

Available LTE test bench examples:

- C-Code Generation
- 3GPP_LTE_CFR_EVM.wsv
- 3GPP_LTE_ControlInfo_ChannelCoding.wsv
- 3GPP_LTE_DL_ChannelCoding.wsv
- 3GPP_LTE_DL_ETM.wsv
- 3GPP_LTE_DL_MIMO_Throughput.wsv
- 3GPP_LTE_DL_SISO_BER.wsv
- 3GPP_LTE_DL_Tx.wsv
- 3GPP_LTE_DL_Tx_Beamforming.wsv
- 3GPP_LTE_DL_TxEVM.wsv
- 3GPP_LTE_SignalDownload.wsv
- 3GPP_LTE_UL_BER.wsv
- 3GPP_LTE_UL_ChannelCoding.wsv
- 3GPP_LTE_UL_PRACH_Detection.wsv
- 3GPP_LTE_UL_SIMO_Throughput.wsv
- 3GPP_LTE_UL_SISO_Throughput.wsv
- 3GPP_LTE_UL_TX.wsv
- 3GPP_LTE_UL_TxEVM.wsv

Note:
The W1918 LTE-Advanced Baseband Verification Library for SystemVue is a superset of the W1910 LTE Baseband Verification Library and includes both LTE and LTE-Advanced support.

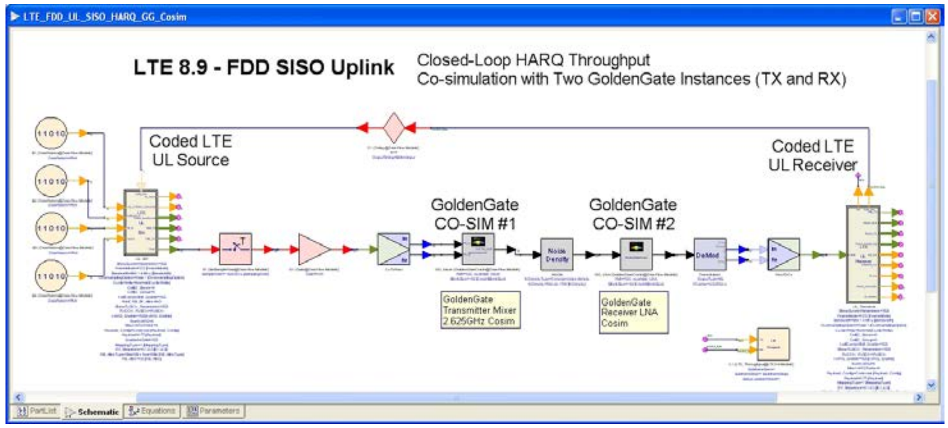


Figure 11. This LTE Throughput simulation includes live co-simulations with Keysight GoldenGate for two CMOS RFIC transceiver components. These are not behavioral models; the true envelope-level dynamic behavior can be verified down to the transistor level in a meaningful, standard-compliant test. This is useful for both the System Architect verifying the overall PHY performance, and also for the RFIC circuit designer prior to tape-out of the wafer.

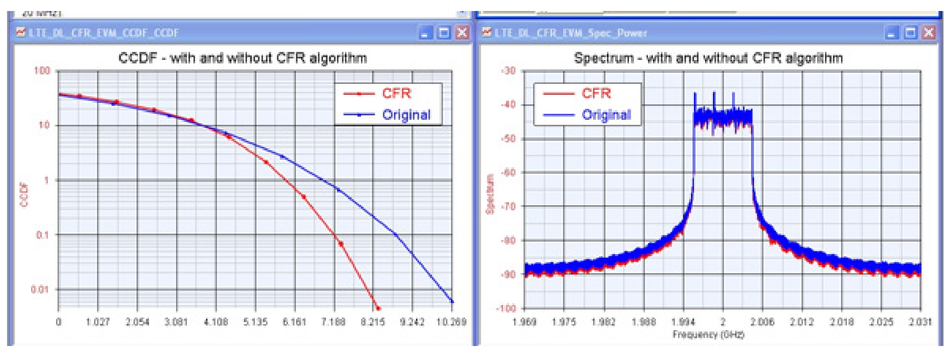


Figure 12. This LTE example evaluates a possible Crest Factor Reduction (CFR) algorithm by plotting the spectrum, CCDF, and other figures of merit for a configurable LTE DL source. Other LTE measurements, such as EVM vs. subcarrier and other channel-specific metrics, are also available. For full analytical power regarding the signal itself, simply co-simulate from SystemVue into the Keysight 89600 VSA software, and use the visualization capabilities of the instrument personality to explore the effects of algorithms and impairments even further.

LTE Test bench Samples (Continued)

Available LTE test bench examples:

- C-Code Generation
- 3GPP_LTE_CFR_EVM.wsv
- 3GPP_LTE_ControlInfo_ChannelCoding.wsv
- 3GPP_LTE_DL_ChannelCoding.wsv
- 3GPP_LTE_DL_ETM.wsv
- 3GPP_LTE_DL_MIMO_Throughput.wsv
- 3GPP_LTE_DL_SISO_BER.wsv
- 3GPP_LTE_DL_Tx.wsv
- 3GPP_LTE_DL_Tx_Beamforming.wsv
- 3GPP_LTE_DL_TxEVM.wsv
- 3GPP_LTE_SignalDownload.wsv
- 3GPP_LTE_UL_BER.wsv
- 3GPP_LTE_UL_ChannelCoding.wsv
- 3GPP_LTE_UL_PRACH_Detection.wsv
- 3GPP_LTE_UL_SIMO_Throughput.wsv
- 3GPP_LTE_UL_SISO_Throughput.wsv
- 3GPP_LTE_UL_TX.wsv
- 3GPP_LTE_UL_TxEVM.wsv

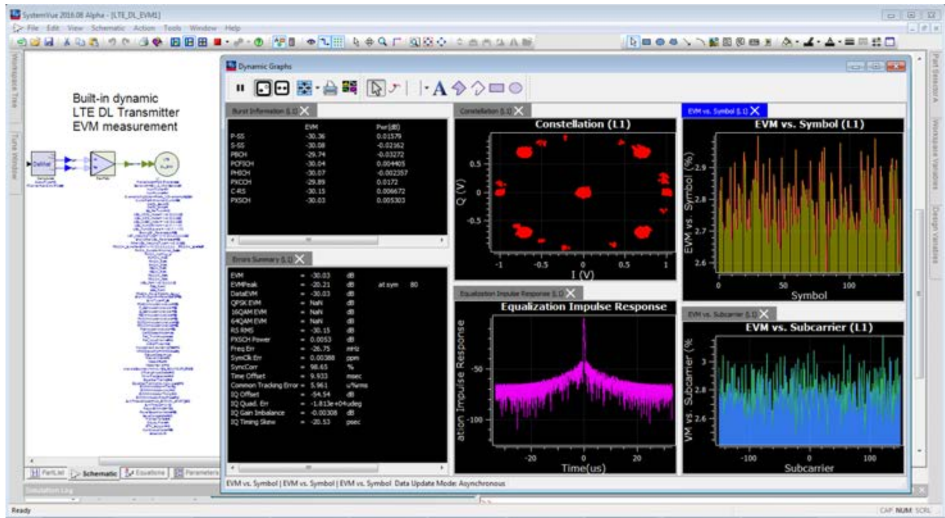


Figure 13. SystemVue's W1910/W1918 LTE reference receivers now provide dynamic signal quality measurements, without the use of external software or personalities.

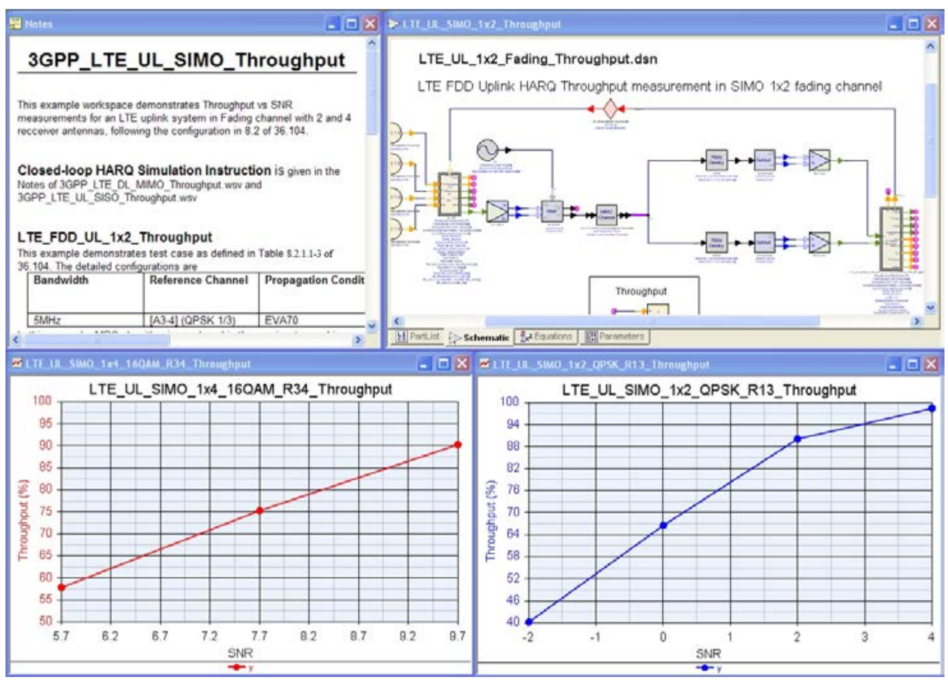


Figure 14. SystemVue 2009 introduced the "Dynamic Datalow" simulation capability to enable true, faded throughput measurements. Dynamic Datalow allows the data rate, and therefore the radio modulation format, to change dynamically during the simulation, while maintaining the timing and carrier frequency information needed for accurate RF and channel effects. This quasi-MAC behavior achieves both simulation behavior and physical layer accuracy that many other datalow and event-driven simulators cannot manage simultaneously.

LTE Test bench Samples (Continued)

Available LTE test bench examples:

- C-Code Generation
- 3GPP_LTE_CFR_EVM.wsv
- 3GPP_LTE_DL_ChannelCoding.wsv
- 3GPP_LTE_DL_ETM.wsv
- 3GPP_LTE_DL_FDD_TestCase.wsv
- 3GPP_LTE_DL_MIMO_Throughput.wsv
- 3GPP_LTE_DL_SISO_BER.wsv
- 3GPP_LTE_DL_Tx.wsv
- 3GPP_LTE_DL_TxEVM.wsv
- 3GPP_LTE_SignalDownload.wsv
- 3GPP_LTE_UL_BER.wsv
- 3GPP_LTE_UL_ChannelCoding.wsv
- 3GPP_LTE_UL_PRACH_Detection.wsv
- 3GPP_LTE_UL_SIMO_Throughput.wsv
- 3GPP_LTE_UL_SISO_Throughput.wsv
- 3GPP_LTE_UL_TX.wsv
- 3GPP_LTE_UL_TxEVM.wsv

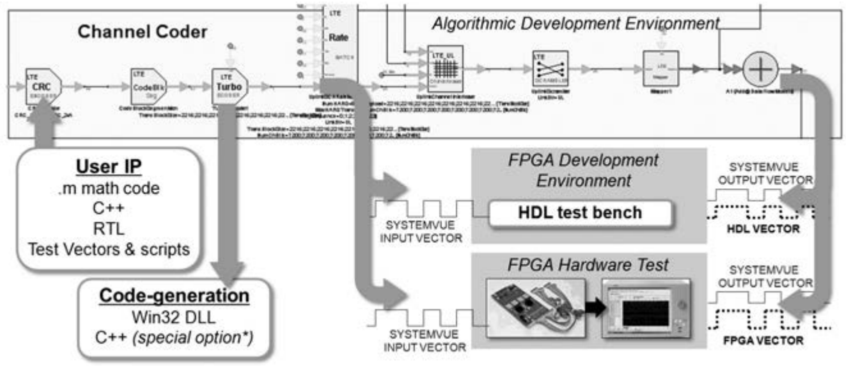


Figure 15. This LTE Channel Coding example exposes the internal signal processing chain, allowing for test vector generation and comparison from any node in the system. This facilitates easy scripting and verification of user algorithms.

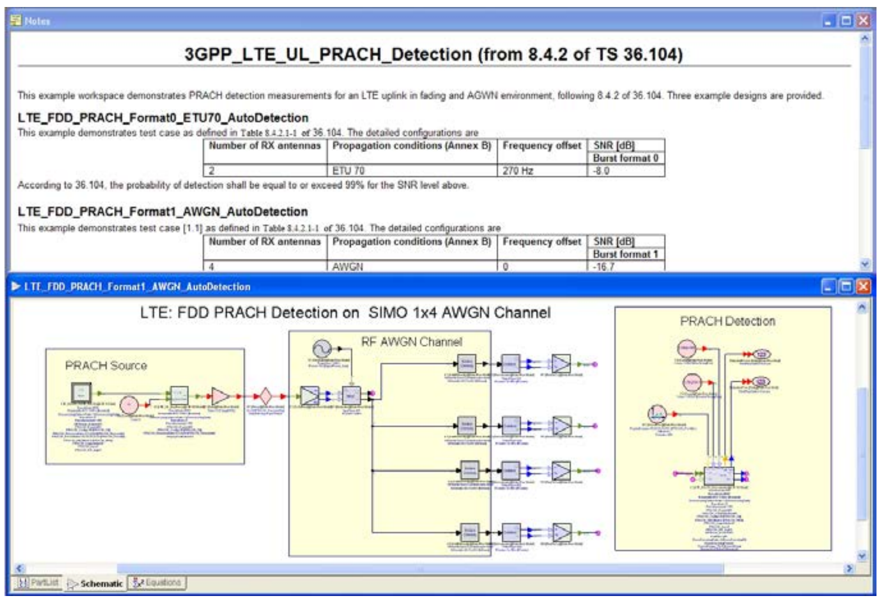


Figure 16. This LTE example runs a standards-based Physical Random Access Channel (PRACH) Detection test that is specified in TS 36.104 of the 3GPP LTE 8.9 standard. The PRACH channel should be detected more than 99% of the time under certain specified conditions, such as S/N ratio. Prebuilt test benches like these save scripting and verification time for the engineer who must validate raw algorithms against the LTE standard.

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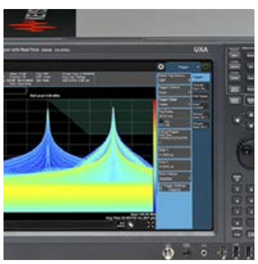


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