

PRODUCT BRIEF

Comprehensive Test Platform for Assessing Product Performance in Multipath Environments

- The industry's first MIMO channel emulator
- Satisfies the needs of multiple departments - research, engineering, and quality assurance
- Used by leading infrastructure, device and chipset vendors, operators, test labs & universities

ACE™ MX - MIMO Channel Emulator for Broadband Wireless

Emerging carrier-grade 3G/4G wireless access promises speeds of 100 to 350 Mbps for delivery of high-speed data, video and voice services. High throughput delivery for LTE and WiMAX is achieved using orthogonal frequency-division multiplexing (OFDM) and advanced antenna techniques such as Multiple-Input, Multiple-Output (MIMO). MIMO performance depends on the radio channels in which it operates, and accurate and repeatable lab characterization of RF environmental effects such as multipath and fading is critical for reliable testing of conformance, performance and interoperability of the systems. Testing such conditions can only be achieved through the use of channel emulation.



The ACE MX is a state-of-the-art channel emulator, purpose-built to support MIMO transmissions and architected to meet the demanding RF needs of OFDM based systems. The ACE MX product line combines industry-leading channel emulation capabilities in a comprehensive design to deliver a range of configurations for MIMO and/or SISO system testing, with uni- and bi-directional configurations.

The Azimuth ACE MX delivers:

- Rapid Set-up and Automation
- Unparalleled Ease-of-Use
 - Unmatched RF Performance and Fidelity
 - Superior Scalability and Flexibility
 - Outstanding Value

ACE MX Detailed Overview

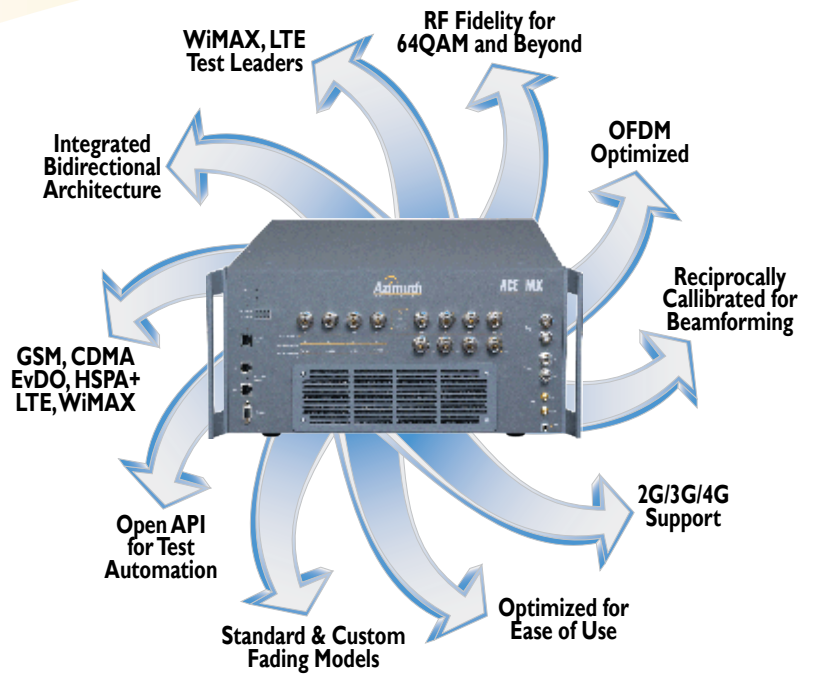
The ACE MX uses advanced signal processing technology to perform real-time lab emulation of a multipath fading environment as well as supporting real-time data streaming to playback field recorded conditions. The ACE MX scales from testing single channel SISO devices up to MIMO 4x4 devices (up to 32 channels) or even up to 8x4 MIMO. The ACE MX is also optimized to support bi-directional channel modeling that can accurately emulate real world wireless over-the-air conditions in both the downlink and uplink paths simultaneously in a single enclosure.

Built with ease-of-use in mind, the ACE MX is a complete test solution with all the required RF components included internally, thus eliminating the need for external hardware to connect and configure complex test topologies. This simple RF-in/RF-out design, combined with an intuitive graphical user interface, makes set up, configuration and test execution quick and easy.

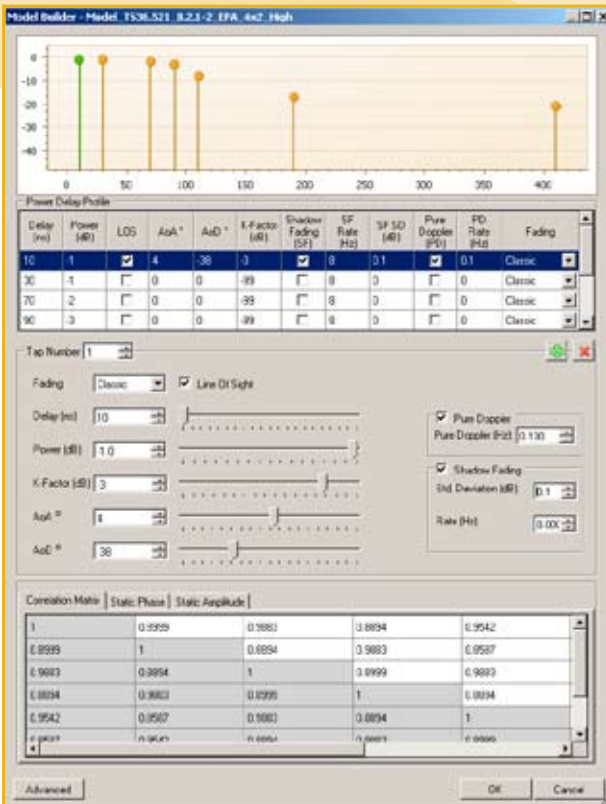
Designed to support 2G/3G, LTE, WiMAX and 802.16m next generation broadband wireless technologies, the channel modeling features of the ACE MX enable industry standard channel models or custom designed models to be loaded and run on the real-time dynamic digital signal processing engine.

The ACE MX is designed for automated test together with the Azimuth DIRECTOR II Test Executive. DIRECTOR II provides a comprehensive GUI to configure and control the channel emulator's parameters as well as offering full script control through a TCL API for automation or remote control.

The ACE MX is the most scalable solution available. Its modular hardware and flexible software design enable single and multilink MIMO configurations, support for TDD or FDD transmissions, and Uni or Bi-directional fading requirements. The ACE MX is ideally suited to support point to multipoint configurations for testing the performance of features like handoff, interference, multicast/broadcast or collaborative links.

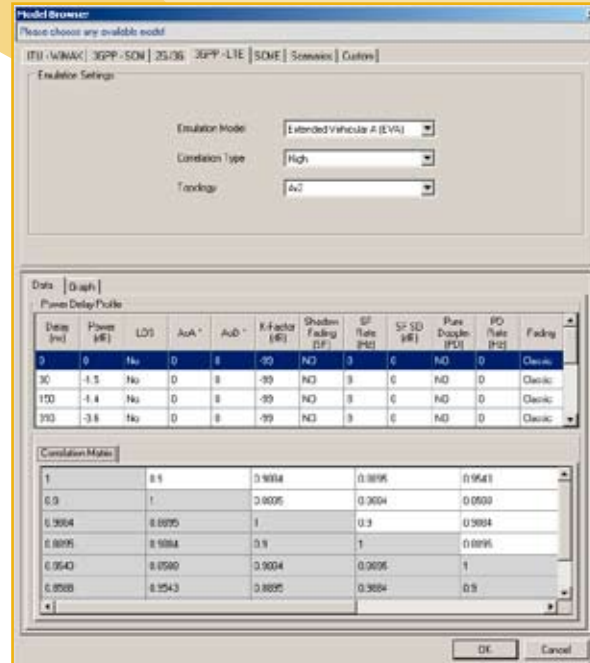


Features	Benefits
MIMO channel emulation up to 4x4 or 8x4	Scalable architecture tests multi antenna functions like spatial multiplexing, Tx and Rx diversity, collaborative uplink and multicast/broadcast under diverse RF conditions
Unrivaled RF performance	Quality test tool provides the EVM and SNR to support testing for 64QAM and beyond
Complete modular architecture	Scalable solution that can be used for unit test through to complex full system testing makes resource planning, training and test configuration simpler
Dynamic bi-directional channel modeling	Recreates real world conditions by emulating dynamic channel conditions in both the downlink and uplink paths simultaneously, enabling applications such as FDD emulation and beamforming
Patented SmartMotion™ mobility	Dynamic fading emulates real world channel conditions and programmable attenuation simplifies the measurement of performance of User Equipment in mobile scenarios without leaving the lab
GUI-based configuration with advanced user control	Fast forward, rewind, play and pause commands allow the user to evaluate specific channel conditions in an instant without waiting for lengthy emulation runs
Custom channel builder utility	Gives users the ability to program the ACE MX with user-defined MIMO channel models for increased test flexibility
Outstanding value	ROI built in - flexible scalable hardware and software ensures best short term and long term value for your investment



Flexible Modeling Capabilities

Standard industry approved models can be selected from the model manager (below) and specific custom models can be created and saved using the custom model manager (left)



Advanced Channel Modeling

The ACE MX provides advanced capabilities ensuring broad support of test conditions including:

Dynamic Channel Conditions

ACE MX dynamic modeling capabilities allow fading and multipath conditions to be varied over time. Statistical channel models are run on a powerful real time DSP engine in conjunction with dynamic Doppler velocity to recreate authentic life like motion.

3G/4G Ready MIMO Channel Modelling

Enhanced channel modeling capabilities of the ACE MX enable the configuration of diverse and complex channel conditions typical to multi-antenna transmission systems. The digital emulation engine supports a large number of taps, long path delays and very flexible complex antenna correlation capabilities.

Flexible Path Delay Configurations

Different configurations will have different test needs and the ACE MX has configurable features to adjust path delay of the signal path both on a tap-by-tap and a global basis. Transmission delay, variable delay, high speed train delay and more effects are configurable.

Shadow Fading

Shadow fading creates the effects of terrain or large objects like hills or buildings and other obstacles. The ACE MX provides a log normal slow fading process that can be applied in a highly configurable manner, over the selected fast fading channel model.

AWGN

Additive White Gaussian Noise (AWGN) introduces spectrally flat noise over the faded signal and is used in the analysis, modeling and performance prediction of communication systems. The ACE MX generates AWGN at each RF output to allow the user to accurately set a signal-to-noise ratio of the output signal transmitted to the device under test.

Standard Channel Models

Different 3GPP, 3GPP2, ITU, IEEE and independent groups like COST and WINNER define standard SISO and MIMO propagation conditions for typical testing. The ACE MX offers a wide range of all the popular models including special scenarios like high speed train, moving propagation and birth-death.

Custom Model Builder

Custom Model Builder enables users to program their own models or modify existing models. Users can create or import environment-specific channel models using power delay profiles and correlation parameters developed in simulations. The graphic editor or XML file formats allow the user to program the individual taps (power delay profile), Doppler spectrum (fading profile) and antenna characteristics (complex correlation matrices).

Designed for Usability

The need for channel emulation in many standardized tests for compliance, performance, interoperability and functionality puts the ACE MX in the hands of novice as well as expert users. So while still providing advanced capabilities to the user, the ACE MX user interface is keenly focused on providing a user experience which will make test setup and operation extremely easy.

All RF Included - the ACE MX includes both uplink and downlink paths inside the unit including all RF connections. This simplifies the setup and calibration process and ensures that RF specifications are maintained for the end-to-end test configuration.

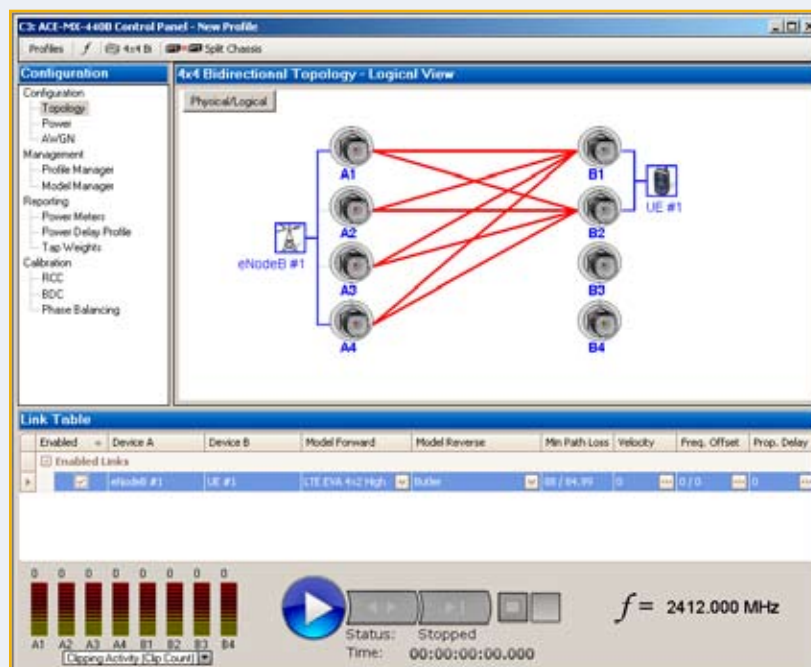
Easy-to-Use GUI - user friendly and intuitive setup tool provides full access and configuration of the links between devices. The GUI requires only 4 steps from power on to full operation and allows more complex configurations to be stored in configuration profiles.

Simple Automation - the real value of test equipment is achieved when the system functions with minimal interaction and implements hundreds of test cases using script automation. The ACE MX and Director II API support scripting. The entire unit can be easily configured using test profiles, standard or custom models and intuitive libraries.

Self Calibration - this end-to-end system requires no field calibration for standard operation. Advanced testing with multiple units or phase/amplitude balance for beamforming can be simply and quickly calibrated using wizard-guided calibration procedures.

DIRECTOR II Test Executive

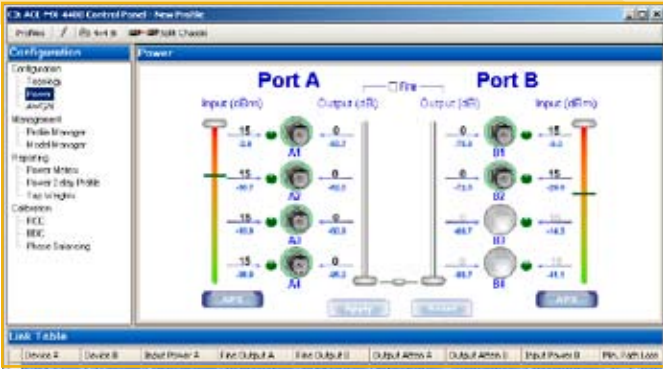
DIRECTOR II Test Executive is a flexible software management tool that provides centralized control over Azimuth test platforms including the ACE MX. An intuitive user interface allows users to configure and manage the ACE MX as well as nodes in the network. DIRECTOR II supports advanced scripting automation of the ACE MX allowing the user to run manual tests or completely automated test scripts.



Testbed Manager

Provides the user with a common, centralized interface to control and manage all the test bed devices within this test environment. Testbed Manager includes the ability to configure and operate the ACE MX as well as advanced tools for saving test profiles, custom models, and importing and exporting all parameters for use on similar systems.

The ACE MX and DIRECTOR II provide an open API providing full control of every function of the ACE MX to be configured and used from a TCL script or from a remote 3rd party test automation application. The automation API enables simple integration of channel emulation into test beds and test suites.



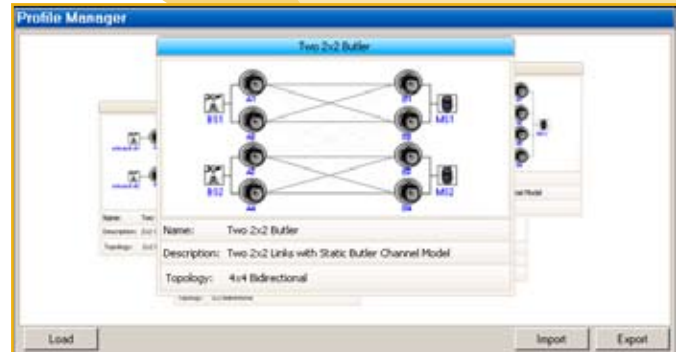
Single Screen Power Management

Control input power and output power on all ports in both upstream and downstream with a simultaneous view of power meter readings



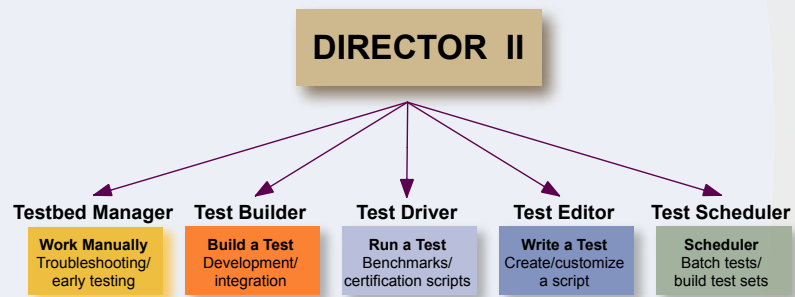
Intuitive Model Control

Easily start, stop, pause, fast forward, rewind or loop channel emulation playback



Profile Manager

Common configurations or specific test profiles can be saved, loaded and exported from the GUI or script interface



Azimuth DIRECTOR™ II Test Executive Software enables users to:

- Improve operator efficiency through a simple, centrally managed console to control, configure and operate the ACE MX channel emulator
- Automate the ACE MX and test process with the advanced TCL automation interface or through an open API to a remote 3rd party automation tool
- Increase test flexibility by leveraging automation and control libraries of the channel emulator and other devices
- Provide tests to speed time-to-market by finding issues earlier in the development cycle
- Create automation to shrink test cycles and execution time and make better use of data by sharing it across development organizations and partners

Use Case Examples

Receiver Sensitivity Test (BLER vs. CINR)

Objective:

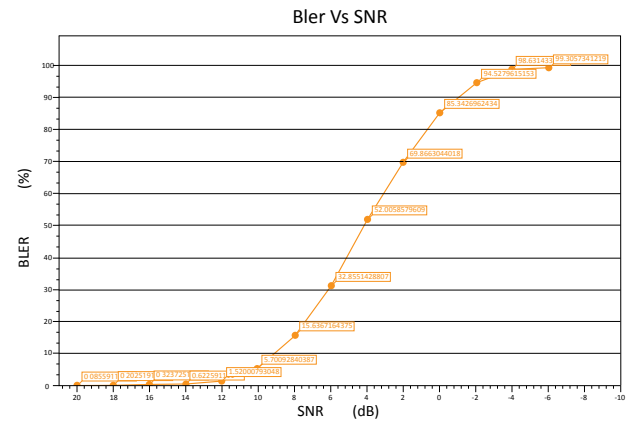
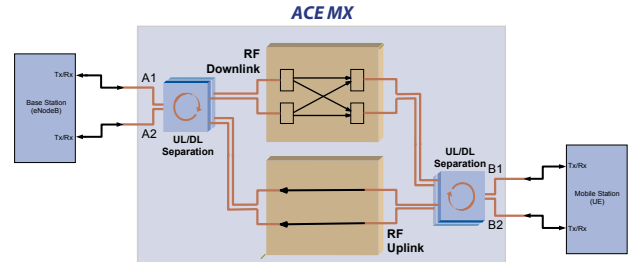
Test measures error rate (BLER) of the UE DUT as the noise level (CINR) is varied over time. This is a performance test to evaluate the transmission quality as this procedure is run under different conditions. like channel model and velocity.

Configuration:

Point to Point 2x2 MIMO with uni-directional propagation conditions

Azimuth Advantages:

- Uni+ mode provides simplest setup with internal non-fading return path (no external components)
- Script automation configures initial setup profiles, channel model, UE velocity, start/stop/reporting of traffic, and varies the CINR value in defined steps and time.
- Additional libraries can be developed to control and collect reporting data from the UE



UE Throughput Test (Mbps vs. SNR)

Objective:

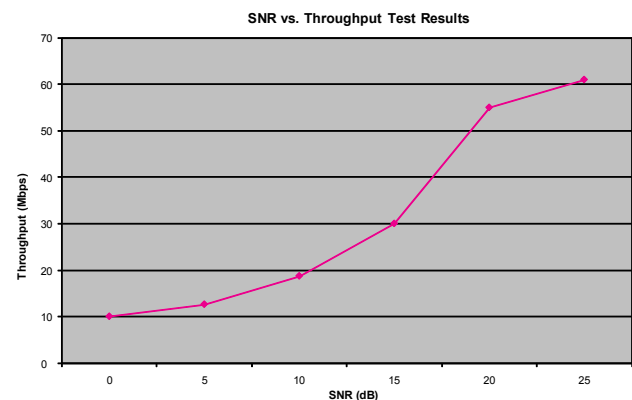
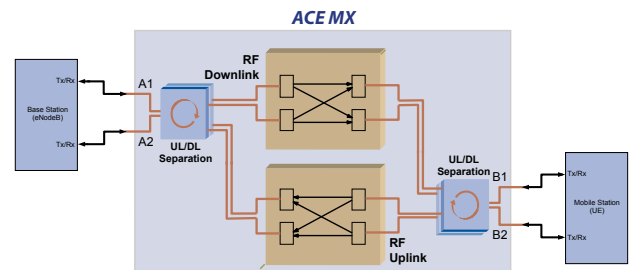
The test is a performance test to measure the throughput of a link under different interference conditions (SNR). The test is run under different propagation conditions (channel model and velocity).

Configuration:

Point to Point 2x2 MIMO with bi-directional propagation conditions

Azimuth Advantages:

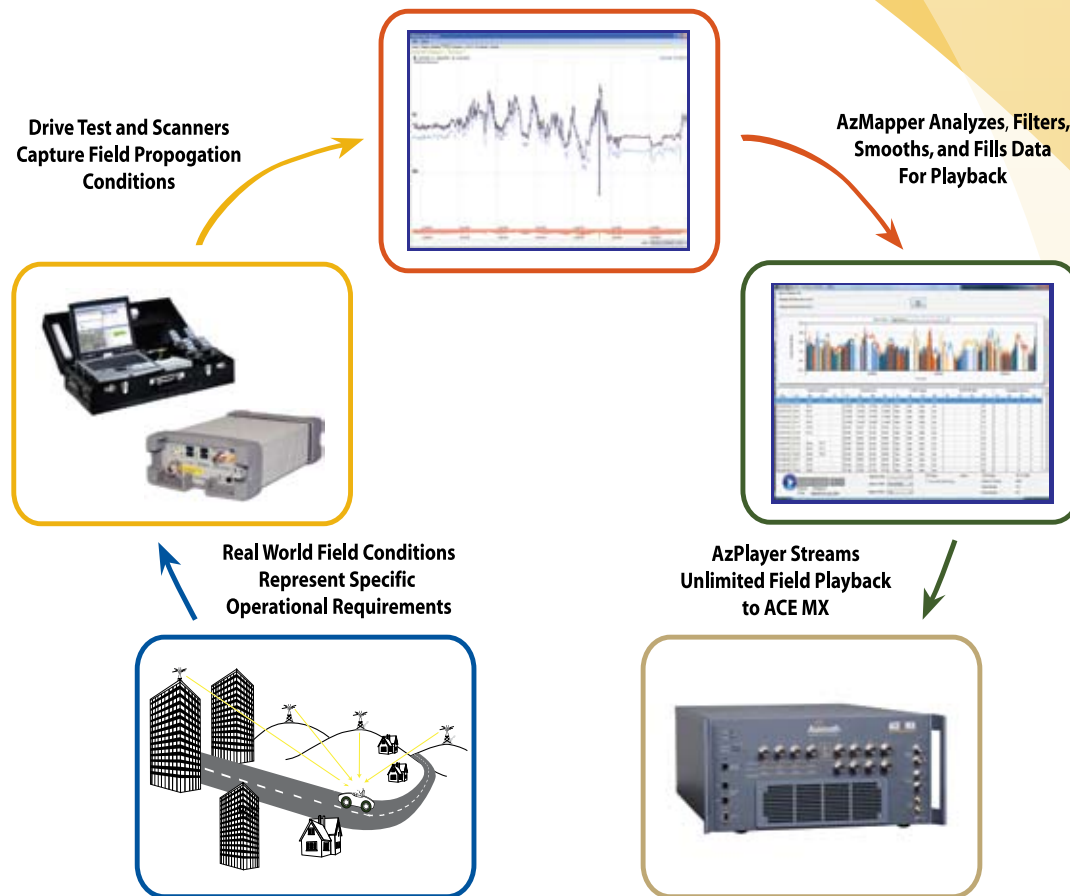
- Fully bi-directional configuration offers simple and easy set up with no calibration required
 - RF in/RF out with no external RF components required
- Test can be run with fading on uplink and downlink, only on the uplink or only on the downlink without reconfiguration
- Script automation configures setup profiles, channel model, UE velocity, start/stop/reporting of traffic, and varies the SNR from 0 dB to 25 dB in 5 dB steps
- SNR values can be changed without stopping test or traffic
- Additional libraries can be developed to control and collect reporting data from the iperf traffic generator and the UE



Field-To-Lab Solution

Testing mobile devices involves many phases, the final test being the validation of the devices in field conditions where the subscribers actually use them. Field testing in diverse conditions of terrain, population density, physical location and motion of devices is extremely time-consuming and costly and is only possible late in the development cycle when the device is close to complete.

The ACE MX Field-to-Lab solution is an effective solution that allows users to take real world channel conditions representing many ecosystems of different sites around the globe and re-use this data in any lab at any phase of the design and development cycle. This solution allows arduous but very crucial testing to be simplified and run in repeatable conditions again and again. Many different mobile recordings of field condition playback can be used from very early in the development cycle and on many devices in the lab rather than having to travel to multiple sites worldwide.



Azimuth Field-to-Lab takes drive test data and overlays it on the channel between base stations and mobile devices.

Drive Test Scanner Log Parsing and Conversion - takes vendor-specific binary drive test logs and parses or converts it them into a format where the drive data mapping can be performed.

AzMapper Drive Data Mapping and Playback File Generation - converts the drive test data into a playback file for a given number of Base Stations into ACE-MX channels, and generates an Azimuth playback file with the generated data. The data needs to be filtered, smoothed and filled to ensure realistic playback conditions.

AzPlayer Playback on Channel Emulator - playback control tool configures the ACE MX and streams the playback conditions to the signal path of the channel emulator between the UE and eNodeB.

Channel Emulation Specifications

Max Number of Channels	Scalable from 4 to 64 channels
Taps per Channel	20 > 24*
Channel Models	Industry standard models such as:
- Model Packs:	<ul style="list-style-type: none"> - WiMAX Forum Channel Models based on ITU M.1225 - 3GPP SCM Channel Models (Spatial channel model for Multiple Input Multiple Output (MIMO) simulations) - 3GPP/3GPP2 GSM/CDMA/3G Channel Models (SISO Models from the 3GPP and 3GPP2 for GSM, CDMA, EDGE, HSPA etc.) - 3GPP LTE Channel Models - SCME Channel Models for link level Extended SCM Models - High speed train model scenarios - Birth/death and moving propagation scenarios
- Custom Model mode	User friendly interface to program new or edit existing channel models
- Bypass mode (identity matrix)	no correlation, no fading, no multipath
- Butler mode (Butler matrix)	no correlation, no fading, no multipath
Maximum Doppler Shift	2 kHz (>500 km/hr @ 3.6 GHz)
Programmable Propagation Delay	0 to 1.0 msec

Note: Specifications are preliminary and subject to change
 * - with corresponding s/w release

RF Specifications

RF Input Frequency	450 - 2700 MHz 3300 - 3800 MHz 4900 - 5900 MHz
Center Frequency	Tunable in 10 KHz steps*
Bandwidth	40 MHz
Input Signal Level	+15 to -40 dBm
Crest Factor	15 dB
RF Attenuator Range	75 dB
RF Output Power Peak	-18 dBm
Residual EVM (Error Vector Magnitude)	< -40 dB typical With 10 MHz OFDM Signal Input power = -10dBm Output power = -43dBm
Output Noise Floor	< -166 dBm/Hz
Additive White Gaussian Noise (AWGN)	
SNR setting	-20 to +35 dB
- Resolution	0.1 dB
- Crest factor	10 dB

Physical Specifications

Dimensions	9.25" H x 17.45" W x 28.5" D (0.24m H x 0.45m W x 0.73m D)
Weight	~58 lbs. (~24 kgs)
Power	100 - 240 VAC, 50-60 Hz, 4.0/2.0 Amps

ACE MX Configurations

Test Configurations	<ul style="list-style-type: none"> - 1x1, 2x2, 2x1/1x2, 4x4, 4x1/1x4, 4x2/2x4, 8x1/1x8, 8x2/2x8, 8x4/4x8 - Uni-directional and bi-directional - SISO, SIMO, MISO, MIMO - Beamforming - Point-to-point and point-to-multipoint (Handoff)
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