



Communication Modeling – High Fidelity, Faster-Than-Real-Time

Linking Transportation and Technology

Keysight provides unique network modeling and simulation software to commercial enterprises, government and defense agencies, research organizations, and educational institutions around the world. Keysight's software enables customers to analyze and predict network performance of communication technologies prior to deployment. It lowers development costs by drastically reducing time to test wireless network performance, reliability, and security under varying environmental conditions, including urban environments with thousands of moving vehicles.

One way that customers utilize Keysight's network modeling and simulation tools is to make vehicles safer. Intelligent transportation systems, which include vehicle-to-vehicle and vehicle-to-infrastructure communications, is a new technology to improve safety on the road by relaying information between vehicles to help reduce collisions and loss of life. These systems can make drivers (human or autonomous) aware of dangers that exist outside their visual or sensory field-of-view, i.e., a vehicle speeding toward a red light in an intersection a vehicle is about to cross.

In V2X communications, interoperability is crucial. The technology must also operate with extreme reliability in a very dynamic environment with high relative speeds, very low latency for dynamic connections, and safety-critical message receipt in crowded urban environments with interfering signals.

There are competing technologies for V2X implementation. Dedicated Short Range Communications (DSRC) radios overcome frequency selective fading, shadowing, and high-speed hand-over difficulties and use 802.11p to accelerate data exchange by reducing initial handshake and association. Keysight customers have been using EXata's 802.11p wireless emulation with real DSRC radios in-the-loop to greatly

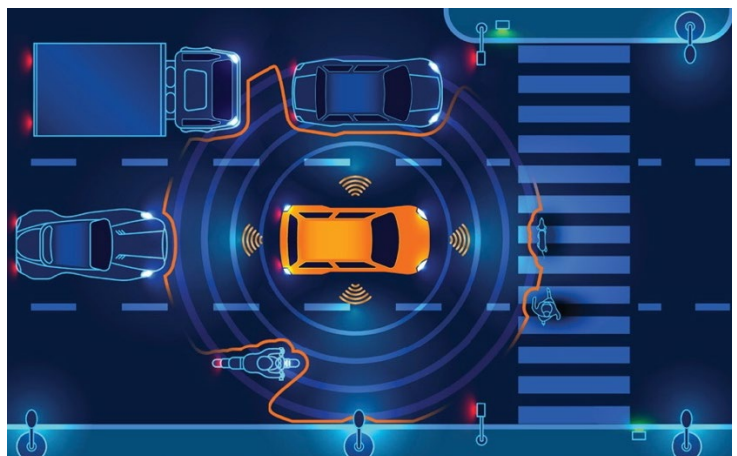
reduce testing space requirements, time, and cost. A challenge to DSRC comes from the cellular industry in the form of C-V2X, which uses LTE and will upgrade to 5G. C-V2X promises performance advantages over DSRC but has not been as extensively tested; this implies further delays that would be unacceptable to the automotive industry with its priorities to improve driver assistance systems and develop autonomous vehicles. How can C-V2X testing be shortened? DSRC and C-V2X may need to coexist, but how will interoperability and interference be tested?

Keysight's wireless simulation, which includes urban environments, vehicle mobility, fading, shadowing, path loss, and interference as well as Keysight models of 802.11p, LTE, Thread, Bluetooth and 5G, provide the answer. Keysight's tools reveal details about network performance at every layer of the stack to locate problems in various environments and scenarios and improve safety on the road.

Network Modeling

The Keysight network modeling applications are used to design, analyze, and test networks, networked systems, and distributed applications behavior. The software can model networks comprised of thousands of nodes at real-time speeds with real-world high fidelity. It is a powerful tool for developing networked equipment, protocols, and waveforms and experimenting with potential operating scenarios for various network architectures.

The EXata software includes a system- in-the-loop emulation interface and an optional Cyber Library of cyber attacks, defenses and vulnerabilities. This enables the seamless integration of live hardware and applications with the virtual network models for effective operational testing as well as the assessment of networks as to their resiliency to cyber threats.



Cyber Effects Models

Keysight offers advanced modeling and simulation technology for cyber attacks, defenses, and vulnerabilities, including:

- Defensive breach
- Network security, firewalls
- Host vulnerability exploitation
- Virus/worm propagation
- Denial of Service (DoS)
- Man-in-the-middle attacks
- Routing misconfiguration
- Adaptive attacks
- Sniffing/eavesdropping/passive traffic analysis
- Message modification
- Jamming

Learn more at: www.keysight.com

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