
NATIONAL
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Tackling the Test Challenges of Next Generation ADAS Vehicle Architectures

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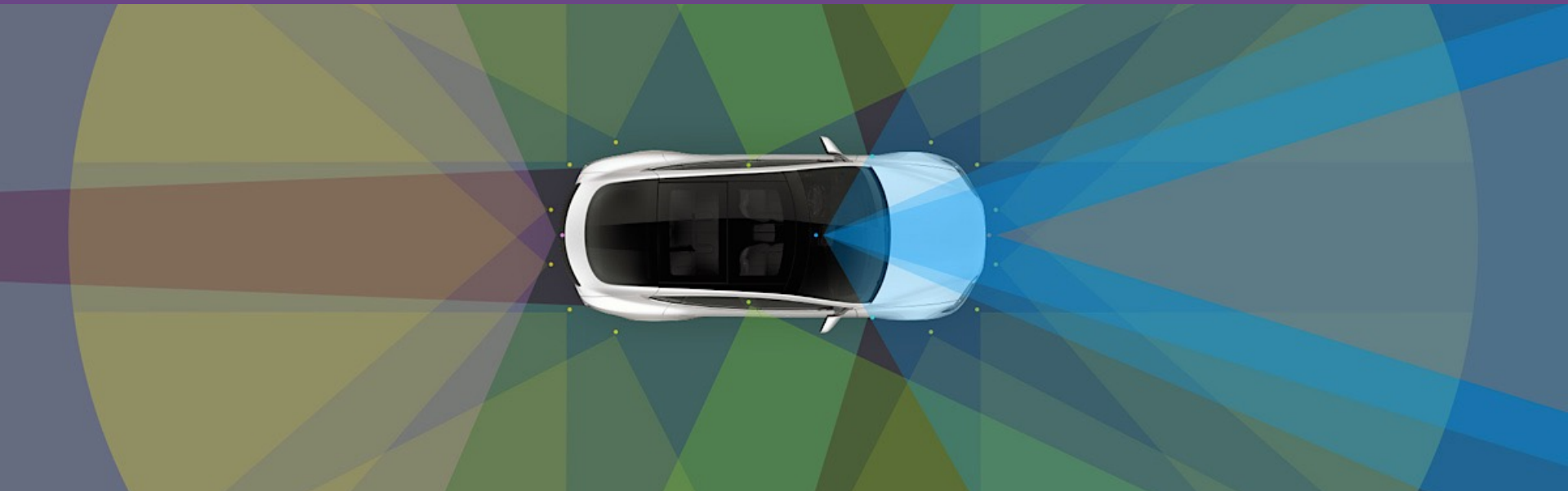
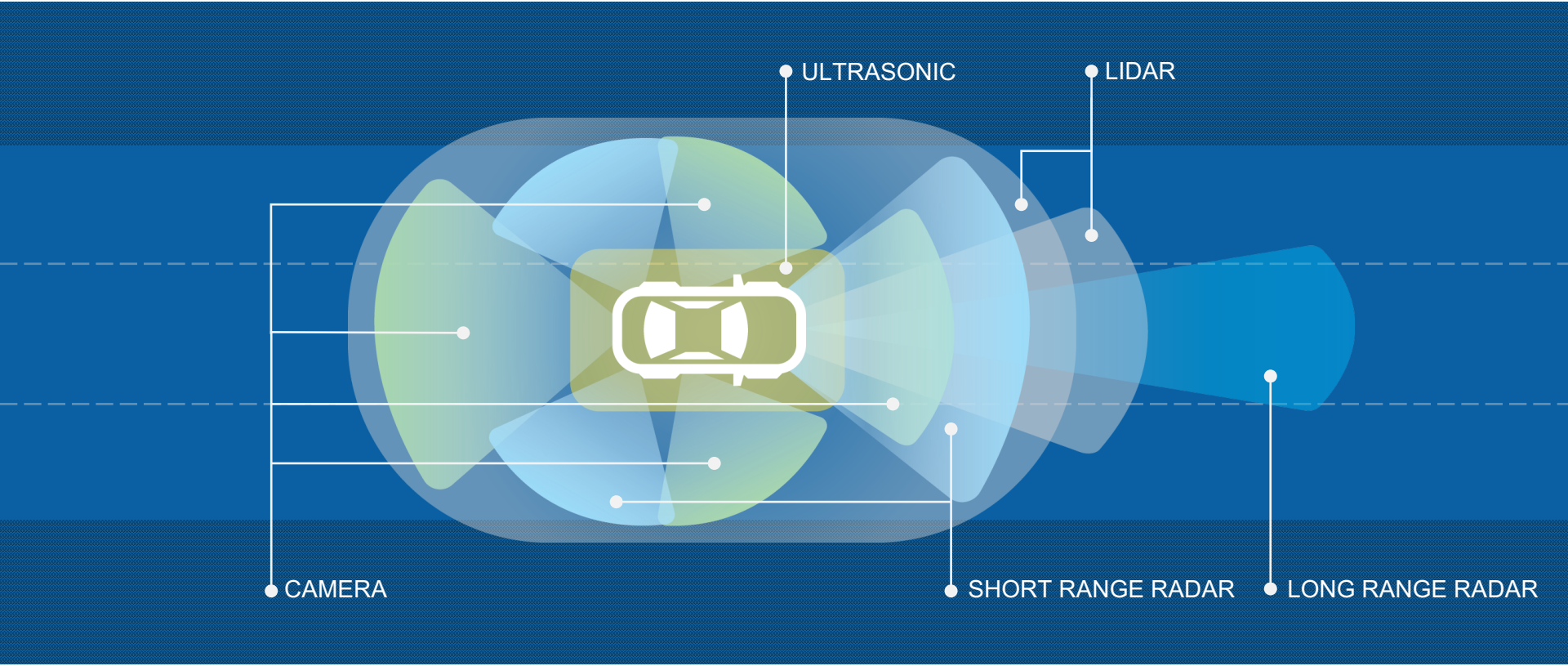
The Tesla Team

All Tesla Cars Being Produced Now Have Full Self-Driving Hardware

October 19, 2016



Major ADAS Sensor Types and Applications



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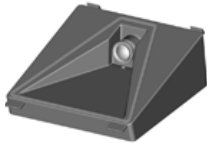
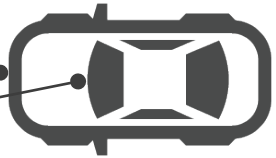
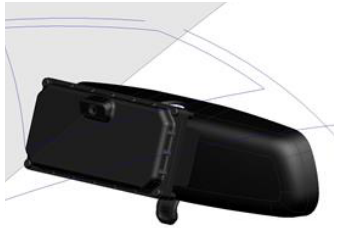
ELECTRONICALLY
SCANNING RADAR (ESR)



INTELLIGENT FORWARD
VIEW CAMERA (IFV-100)



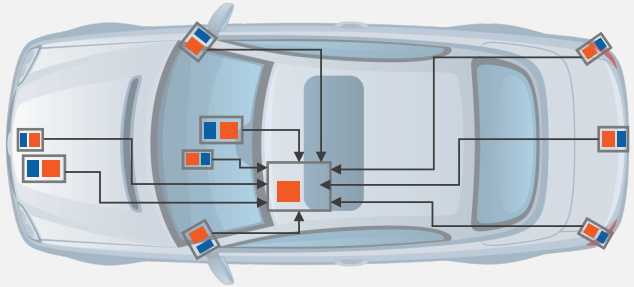
COLLISION
MITIGATION SYSTEM (CMS)



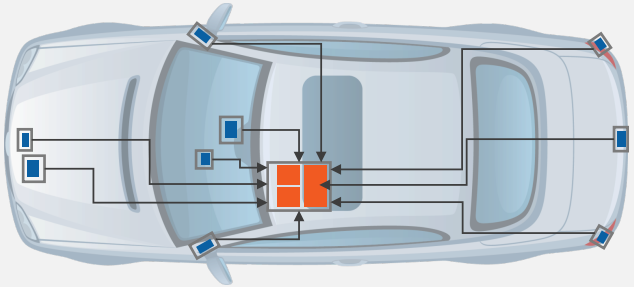
RACAM
(RADAR + CAMERA)

ADAS Sensor Fusion Evolution – Delphi Example

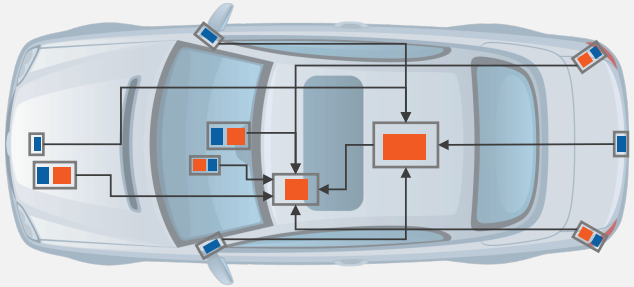
ADAS Architectures Continue to Evolve



SMART SENSORS/DECENTRALIZED PROCESSING



RAW SENSOR DATA/CENTRALIZED PROCESSING



HYBRID SENSOR/PROCESSING

Sensor

Electronic Control Module (ECM)

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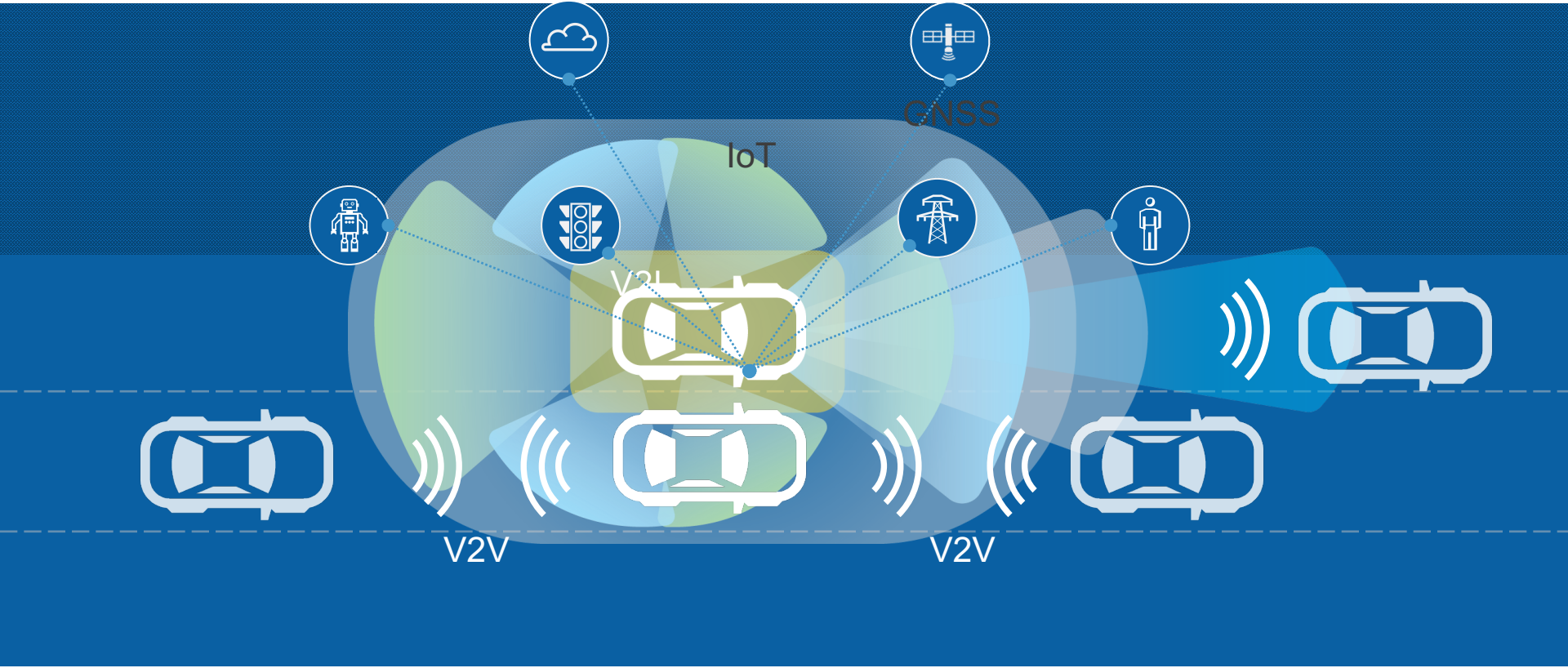
Source: electronics-eetimes

DEEP NEURAL NETWORK

Deep Learning For Self-Driving Cars

- Environmental perception is key to autonomous driving, e.g. lane position
- Traditional feature recognition and image processing techniques don’t scale to needed complexity
- Deep neural networks learn efficient feature representation
- Inductive learning leads to evolving software operation that is challenging to test

The Connected Car



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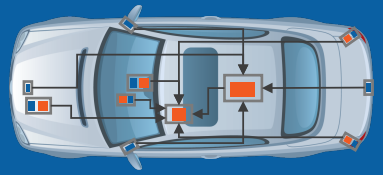
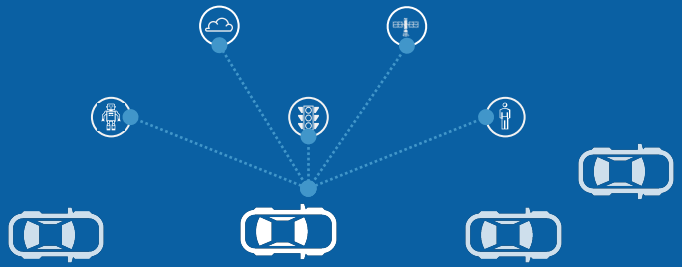
Testing ADAS and the Autonomous Vehicle

SENSOR



CAR



CONNECTED CAR WORLD

Characterization

Validation

Software (HIL)

Track and Road

Production

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Requirements For An Autonomous Vehicle Testing Platform

- Wide range of I/O – DC to RF, Vehicle Networks, Wireless Communications
- Highly adaptable software to meet changing requirements and architectures
- Real time performance to enable emulation of real-world conditions and HIL testing
- System-wide timing and synchronization to correlate across full range of I/O and communications
- Connectivity to standard design, simulation and scenario generation tools

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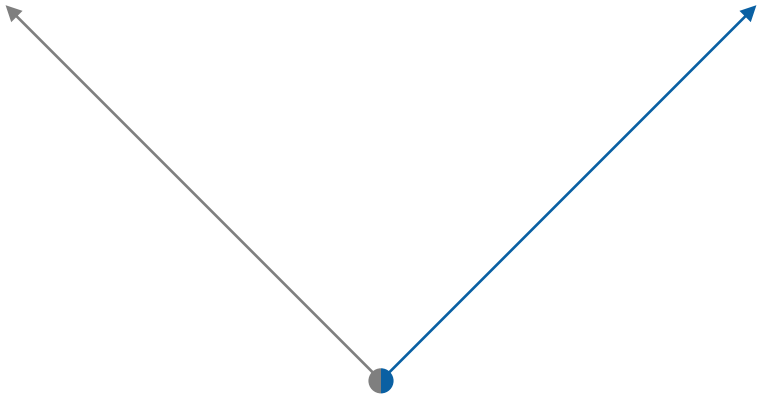
Approaches for Test and Measurement

CLOSED APPROACH

"Vendor knows best"

- Fixed-functionality box instruments
- Extend with **vendor accessible** customization
- Fixed software applications
- Monolithic instrument design
- Resulting closed vendor ecosystem



PLATFORM APPROACH

"Customer knows best"

- Out of box measurement ready
- Extend with **user accessible** customization
- Productive, approachable software tools
- Modular instrument design with consistent APIs
- Resulting open partner, user, and IP ecosystem

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Flexibility of PXI for Automotive Design and Test

GNSS Simulation

Infotainment Test

V2X Testing

Hardware-in-the-Loop

Radar Target Simulation

Bus Interfacing

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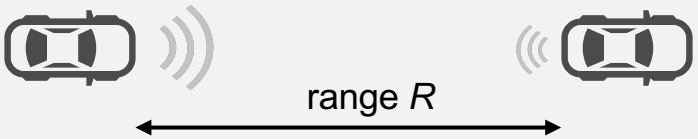
Introduction to Radar Target Emulation

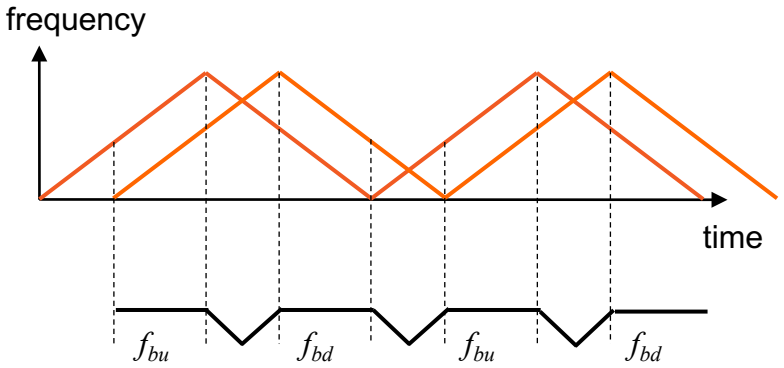
Principles of FMCW Radar

Stationary Single Target



range and radial velocity can be obtained as:

$$R = \frac{cT_{sweep}}{2B_{sweep}} \frac{f_{bd} + f_{bu}}{2}$$



Beat frequency components due to range and Doppler frequency shift:

$$f_r = \frac{2R}{c} \frac{B_{sweep}}{T_{sweep}} \qquad f_r = f_{bu} = f_{bd}$$

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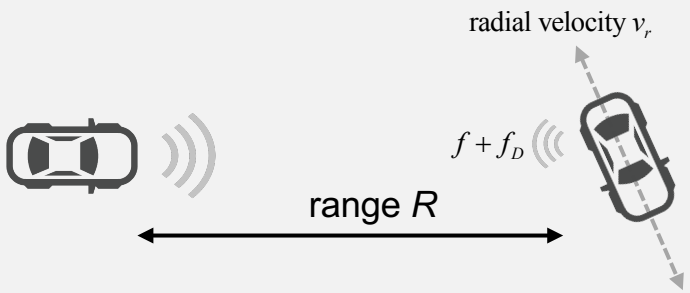
Principles of FMCW Radar

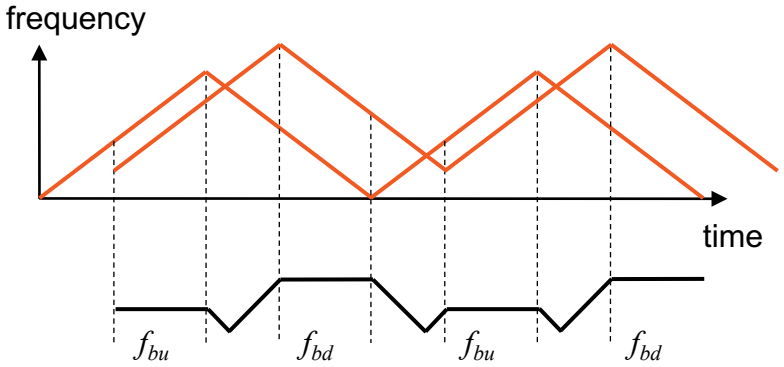
Moving Single Target



range and radial velocity can be obtained as:

$$R = \frac{cT_{sweep}}{2B_{sweep}} \frac{f_{bd} + f_{bu}}{2}$$

$$v_r = \frac{\lambda}{2} \frac{f_{bd} - f_{bu}}{2}$$



Beat frequency components due to range and Doppler frequency shift:

$$f_r = \frac{2R}{c} \frac{B_{sweep}}{T_{sweep}} \qquad f_d = \frac{2v_r}{\lambda}$$

that are superimposed as:

$$f_{bu} = f_r - f_d \qquad f_{bd} = f_r + f_d$$

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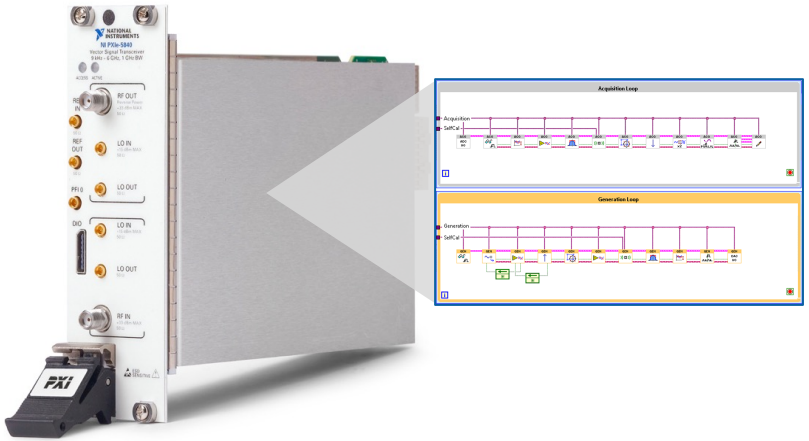
NI ADAS Test Solution

FEATURES AT A GLANCE

- Simulates 2 targets per VST and settings include velocity, RCS, and angle of arrival
- Measurements include: radiation pattern, EIRP, phase noise, spectrum occupancy, beam width, & chirp analysis
- Flexible software-based approach allows users to create custom target scenarios

KEY SPECIFICATIONS

- Frequency Range: 76 – 81 GHz
- Target range: 1 to 250 meters
- Range resolution: 0.1m
- Velocity: 0 to 200 km/hr
- Bandwidth: 2 GHz for short-range, 1 GHz for long-range



The NI ADAS Test Solution is based on NI's 2nd generation Vector Signal Transceiver and uses a LabVIEW-programmable FPGA for target emulation.

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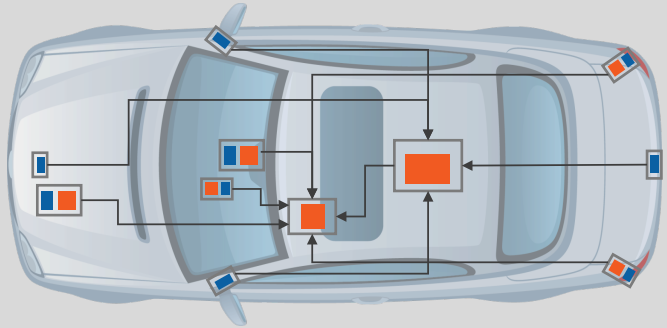
Hardware-in-the-Loop

CAN Interface

GNSS Simulation

Radar Target Simulation

Image Simulation



Camera

Radar

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“With the PXI Vector Signal Transceiver, the combination of the industry’s widest bandwidth and low latency software has allowed us to discover our automotive radar sensors as never before.”

—Niels Koch, Audi

Audi

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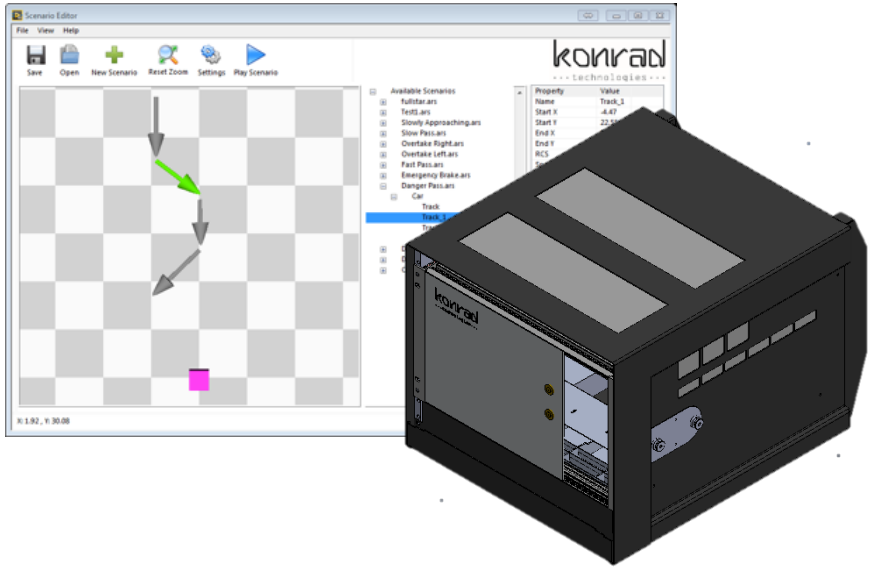
ni.com/smater-test

Konrad
77 GHz Radar Target Simulator



System Features

- Konrad ABex Production System uses National Instruments ADAS Test System
- 19” 6HE Rack, all electronics and RF components integrated in one box.
- Antenna blind mate connectors for remote antenna connection.

Scenario Editor Software

- Supports creation of custom scenario generation and tracks
- Sequence Tracks to simulate various radar environments

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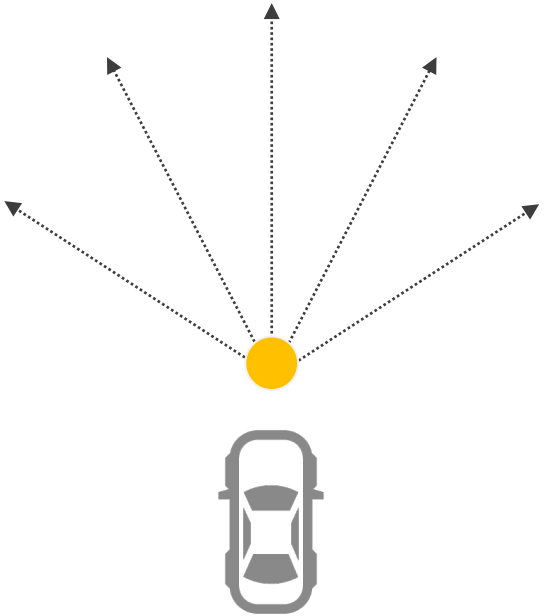
konrad technologies

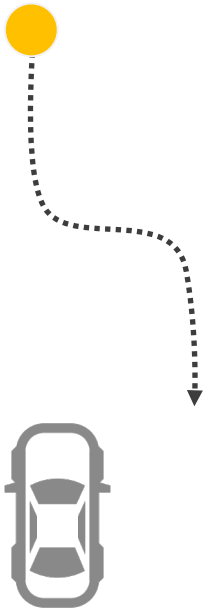
ni.com

Typical Target Simulation Scenarios

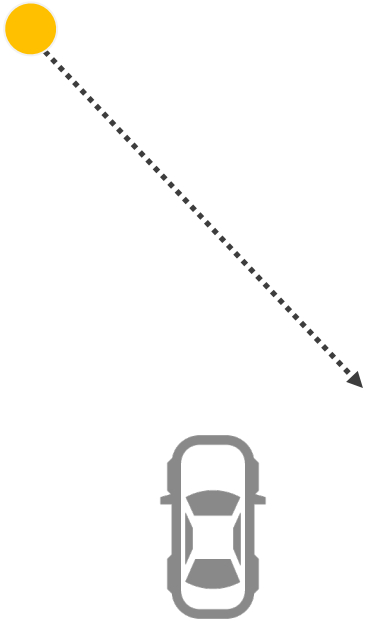
STAR PATTERN



LANE CHANGE



OBJECT CROSSING STREET



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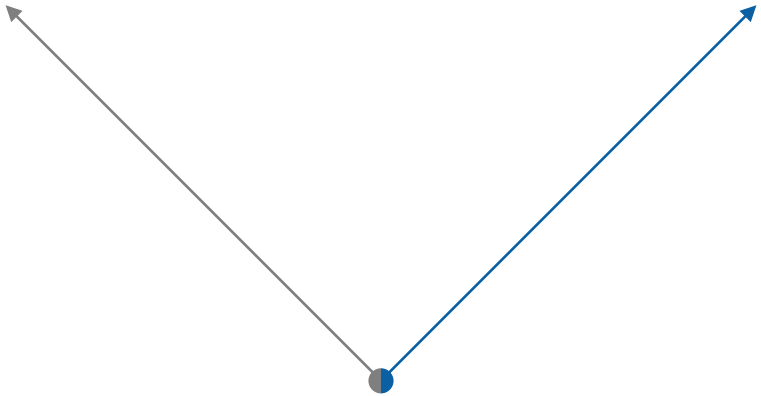

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Summary

- Autonomous driving is quickly becoming a reality
- Technologies, architectures and requirements are evolving rapidly
- RF and communications technologies and standards are playing a central role
- Complexity of systems and applications requires a platform-based approach to test