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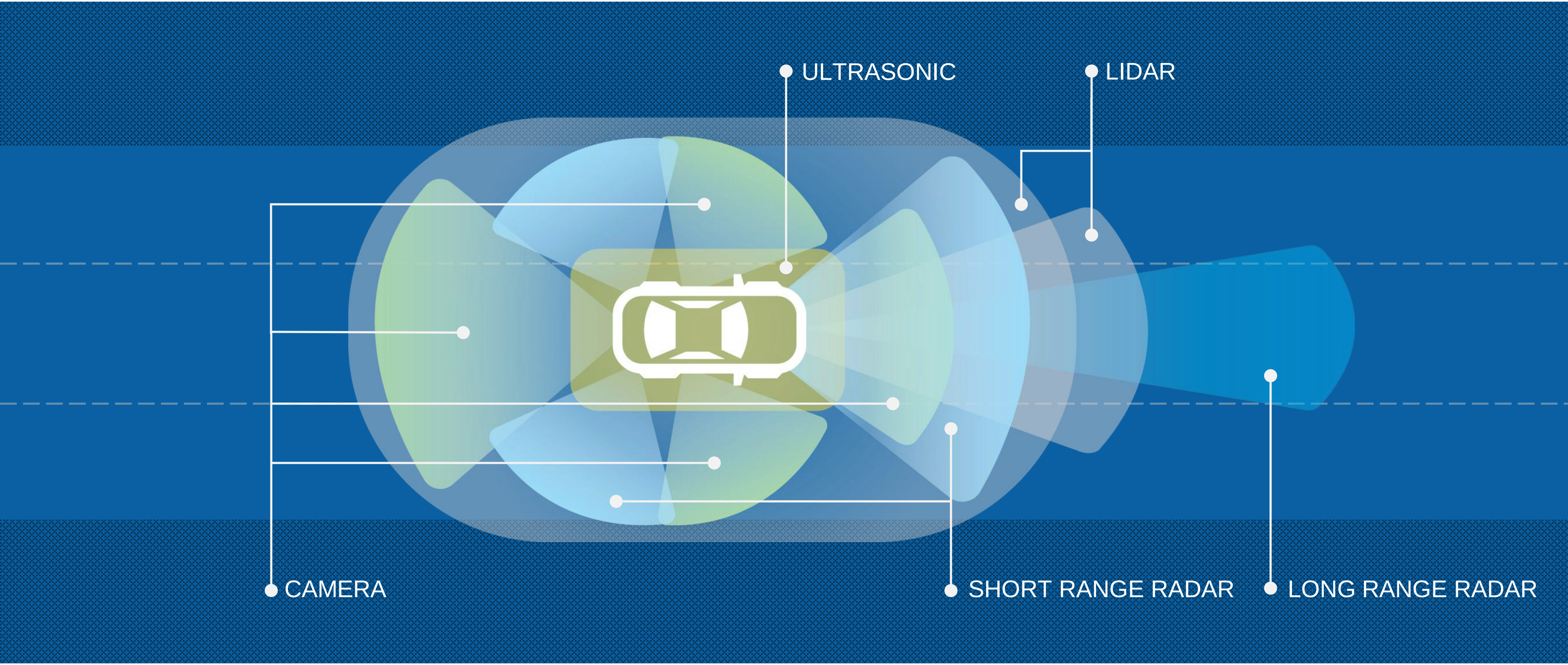
The Evolution of ADAS – Testing Systems that Include Cameras, Radar, and Sensor Fusion

Smarter Test for Smart Vehicles

Archan Mudwel

Technical Marketing Engineer

Major ADAS Sensor Types and Applications



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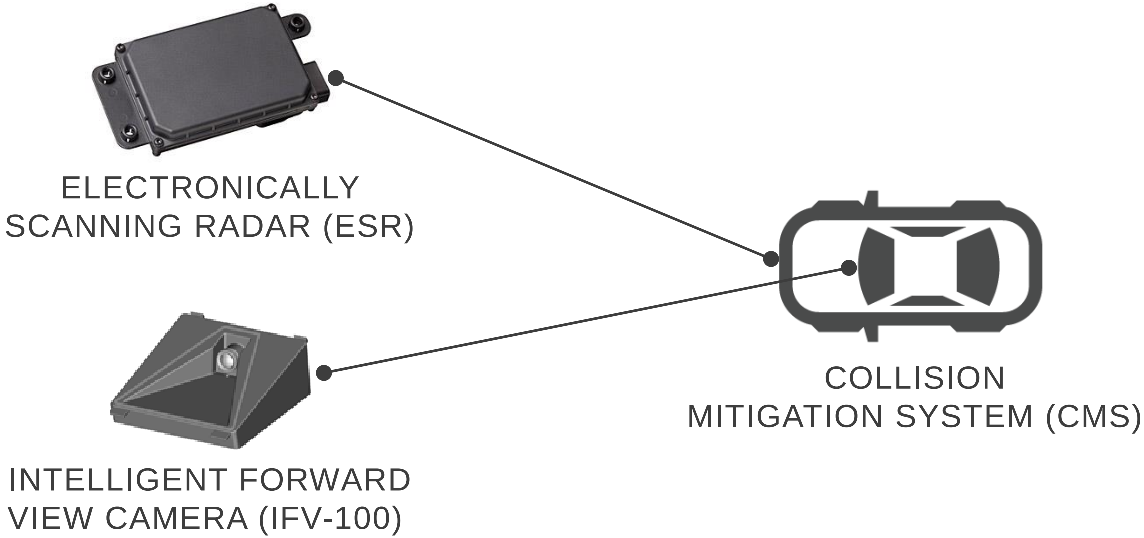
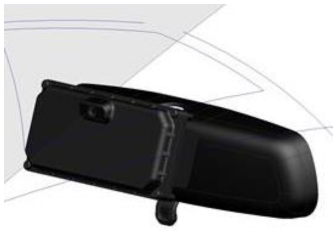
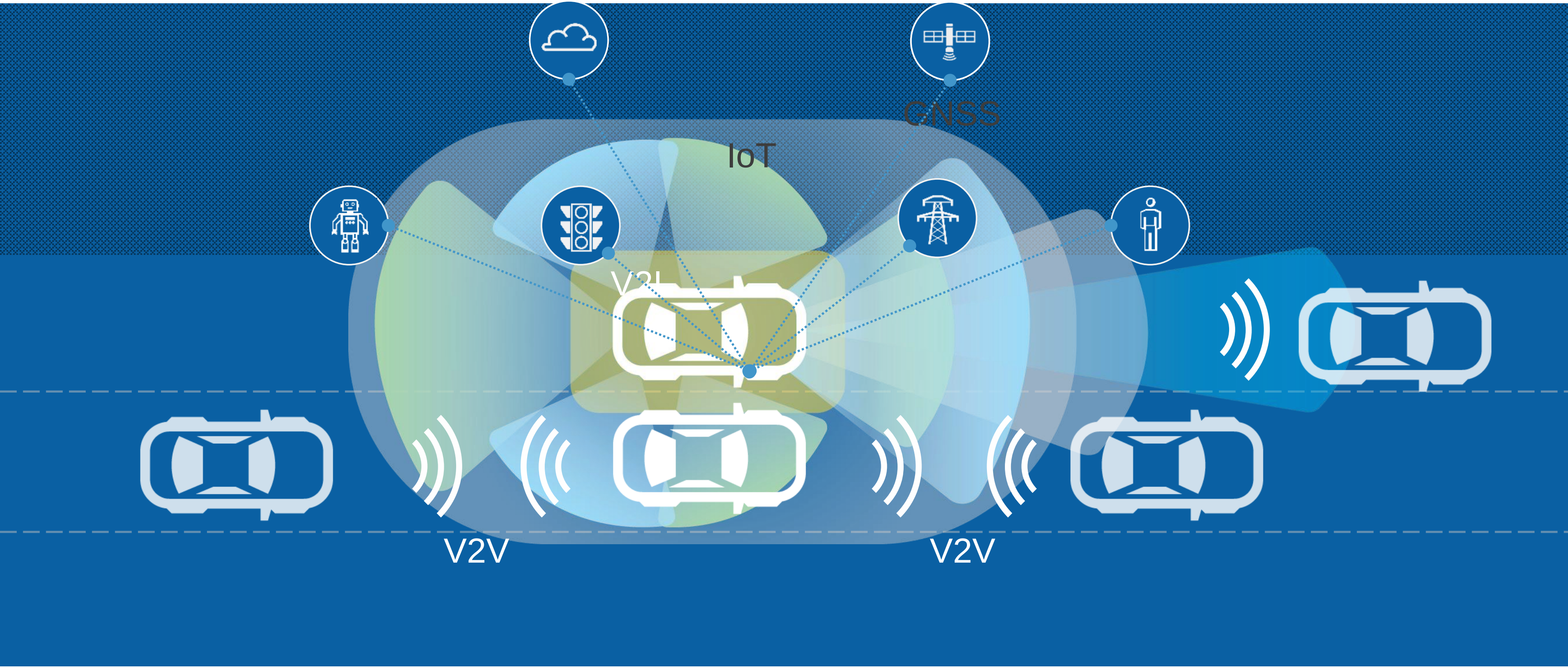




ADAS Sensor Fusion Evolution – Delphi Example

The Connected Car



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Inside the Self-Driving Tesla Fatal Accident

By ANJALI SINGHVI and KARL RUSSELL UPDATED July 12, 2016

Tesla driver dies in first fatal crash while using autopilot mode

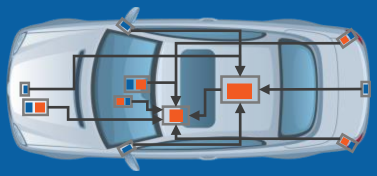
The autopilot sensors on the Model S failed to distinguish a white tractor-trailer crossing the highway against a bright sky

Tesla car mangled in fatal crash was on Autopilot and speeding, NTSB says

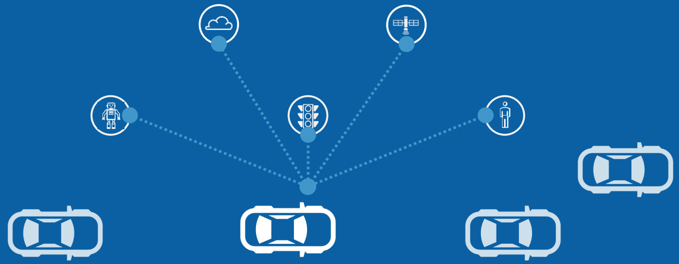
Who Has Ownership?

Testing ADAS and the Autonomous Vehicle

SENSOR



CAR



CONNECTED CAR WORLD

Characterization

Validation

Software (HIL)

Track and Road

Production

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Challenges of ADAS Testing

Regulatory
Uncertainty

Volume
of Testing

Testing Systems Instead
of Discreet Components

Integrating New Technology
Into Existing Systems

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Approaches to Test and Measurement

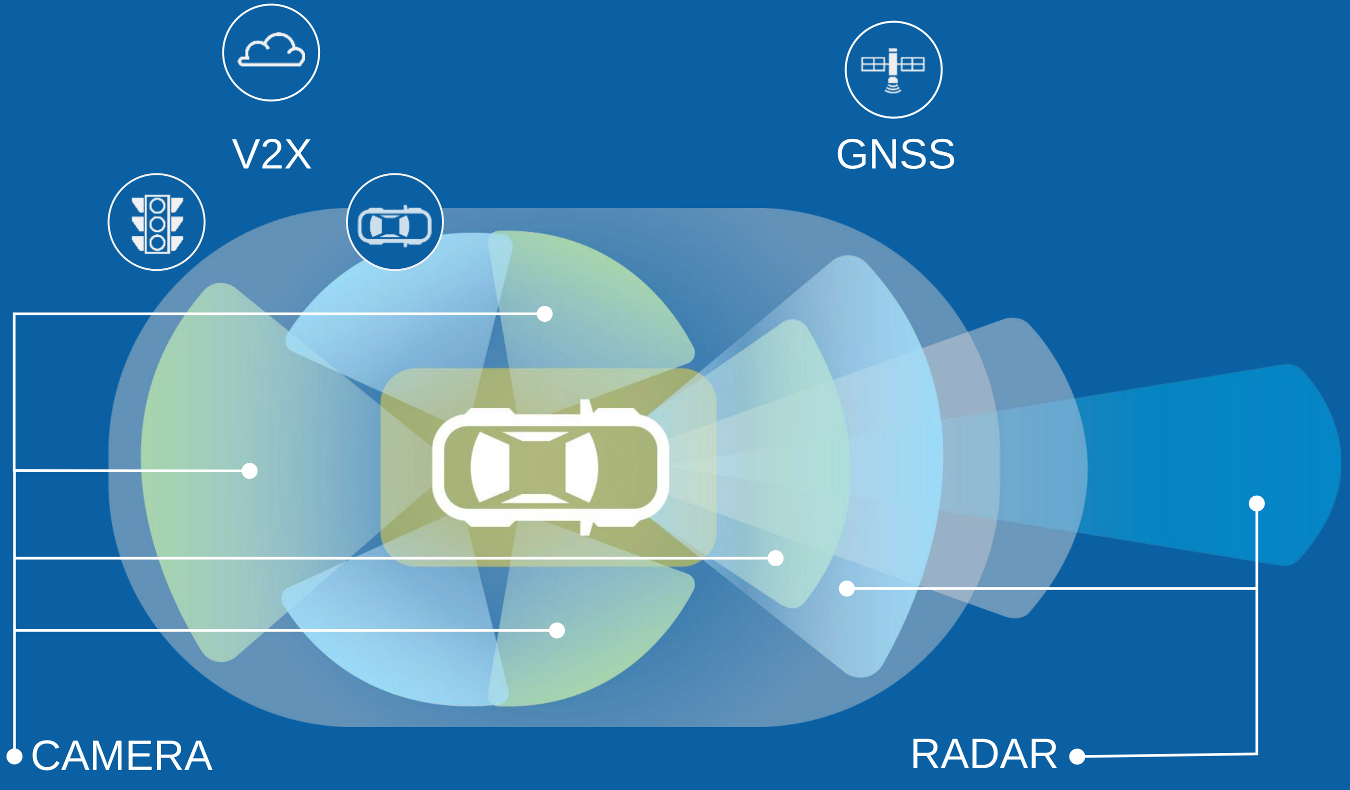
CLOSED

- “Vendor knows best”
- Fixed-functionality
- Closed ecosystem
- Customer pays

PLATFORM

- “Customer knows best”
- Customizable solution
- Open, vibrant ecosystem
- Customer designs

Major ADAS Technologies



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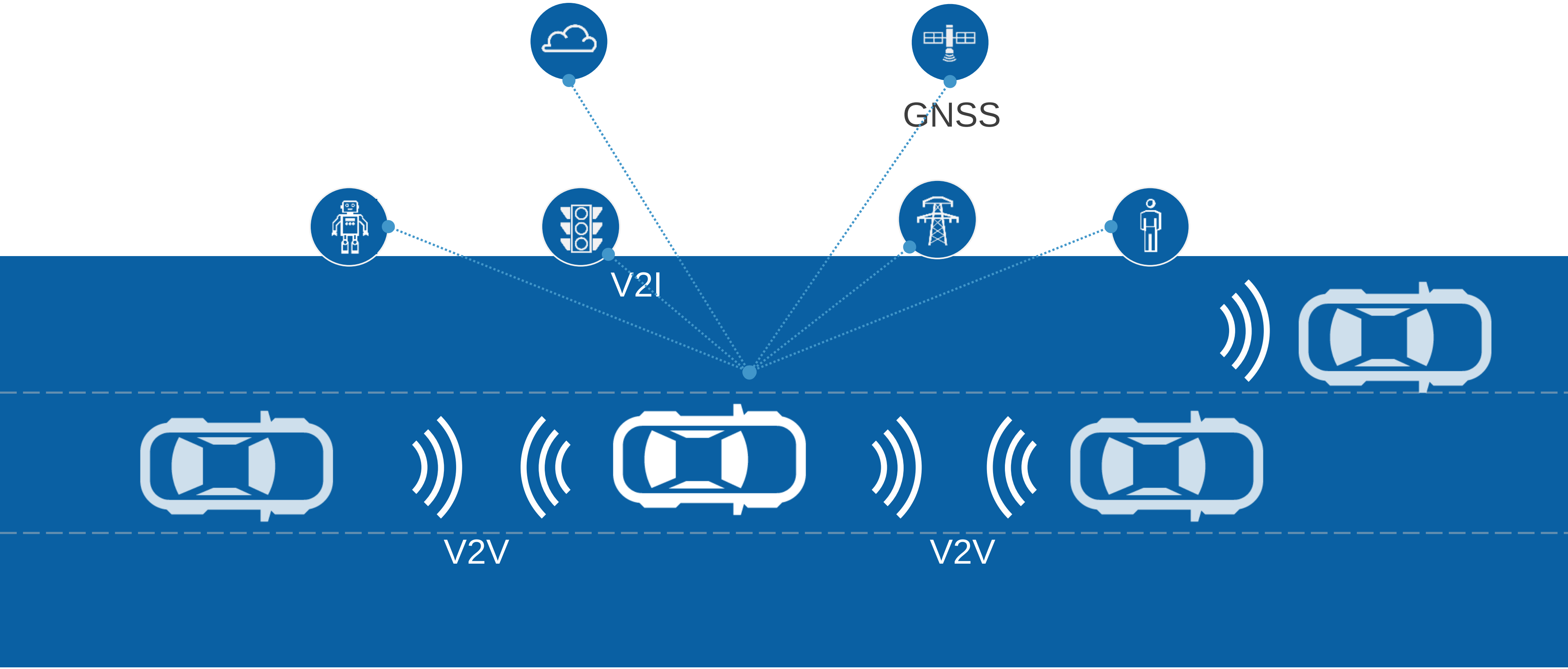
Communications

V2X and GNSS

The Connected Car



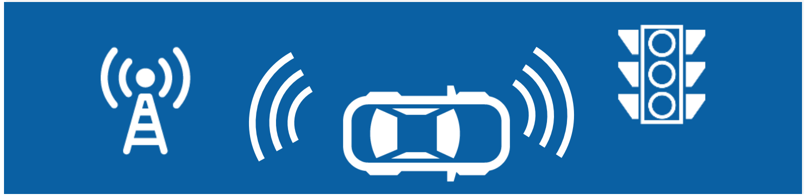
V2V & V2I Communications with 802.11p and LTE

IEEE 802.11p (DSRC)

- Referred to as Direct Short Range Communication (DSRC)
- Uses unlicensed spectrum in 5.9 GHz band
- Based on half-clocked IEEE 802.11a/g with 10 MHz channel bandwidth
- Effective Tx-Rx velocity differences of up to 200 km/hr
- Only supports V2V communication

LTE V2X (Cellular V2X)

- Part of 3GPP Release 14 – targeted for 2017
- Uses existing licensed LTE spectrum and infrastructure
- Bandwidth configurations up to 10 MHz
- GNSS-based symbol synchronization
- Supports both V2V (PC5) and V2I (Uu) modes



NI's Approach for Integrating Other Standards

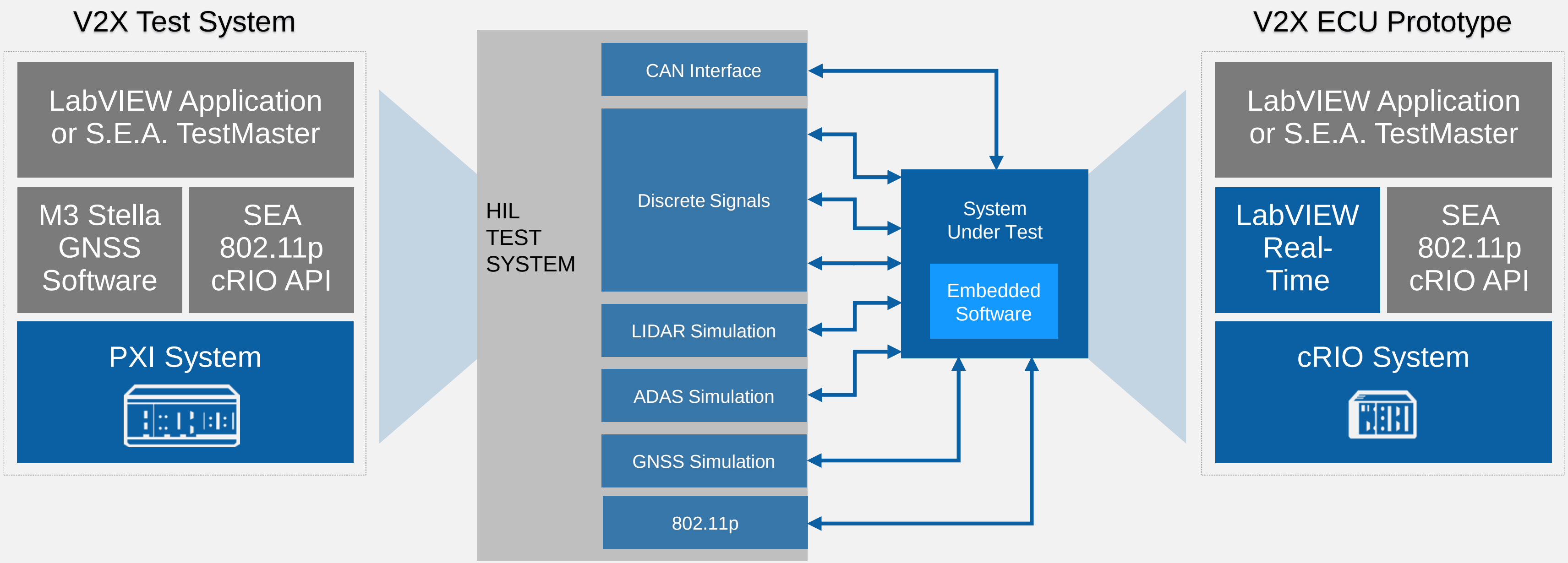
Flexible measurement IP from GSM to WiFi

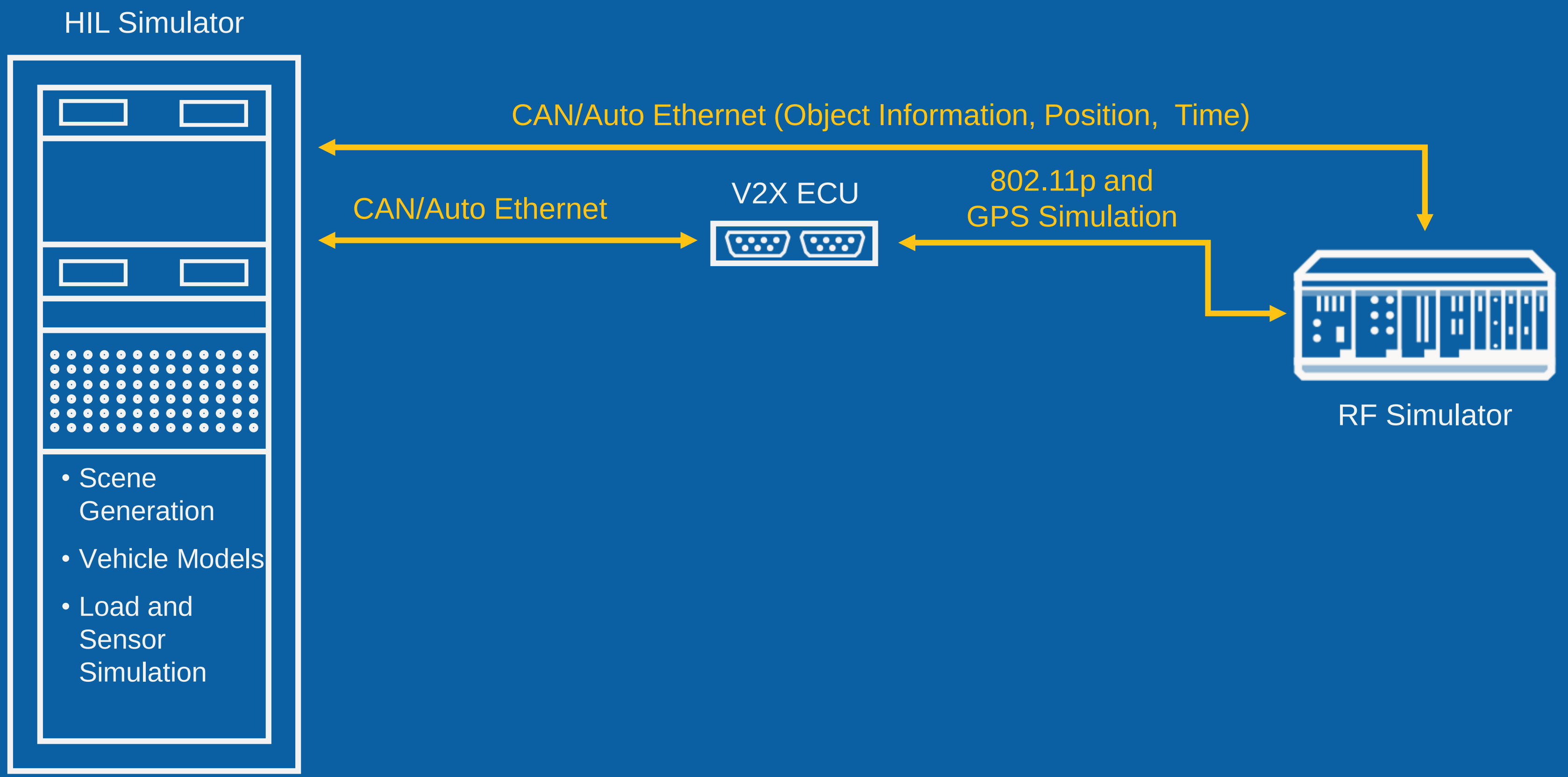
Partner IP

WLAN (802.11a/b/g/n/ac)	GSM/EDGE
Bluetooth	WCDMA/HSPA+
GPS Generation	CDMA2k
FM/RDS Generation	LTE/LTE-A (TDD & FDD)

Wireless Measurement algorithms execute on PXI controller and reconfigurable FPGAs

SEA Solution for ECU HIL Test





HIL Simulator
CAN/Auto Ethernet (Object Information, Position, Time)
V2X ECU
802.11p and
GPS Simulation
CAN/Auto Ethernet
• Scene Generation
• Vehicle Models
• Load and Sensor Simulation
RF Simulator

Radar

Trends in Automotive RADAR

Focus on Safety

- Object identification/distinction
- Rear-end Crash Avoidance
- CAR2X (Car 2 Car and Car 2 Infrastructure Communication)
- 360 degrees vehicle surveillance

Adoption of 77- 81GHz

- More reliable and more accurate
- Greater capability to distinguish objects with high bandwidth
- Smaller footprint (multi mode, multi range)

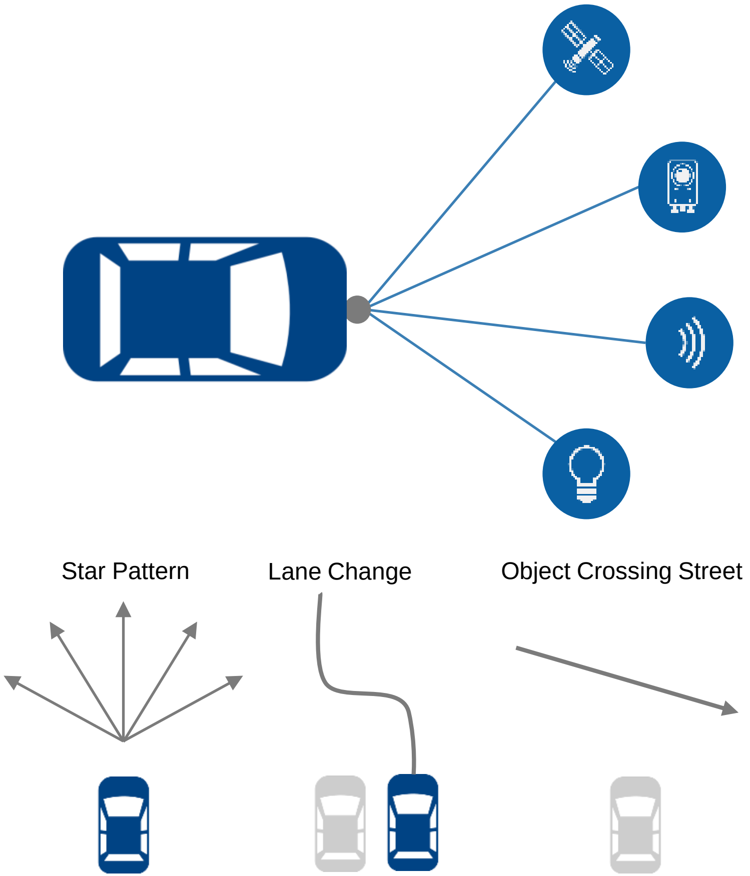
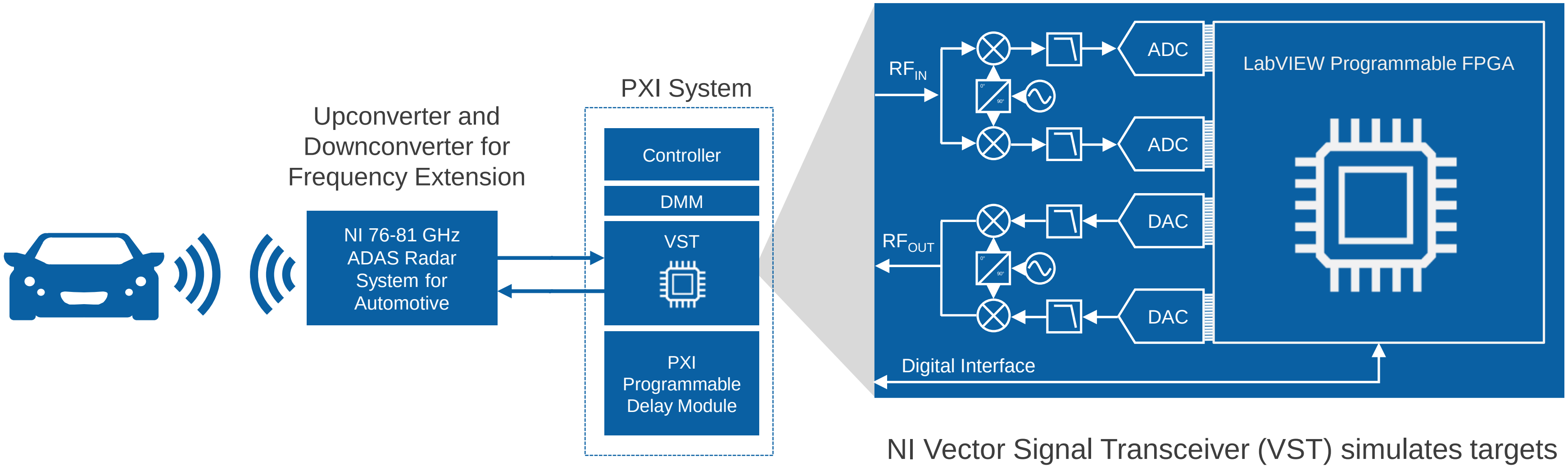


Image from http://www.wykop.pl/link/2349196//

Block Diagram of Active Radar Target Simulator



NI Vector Signal Transceiver (VST) simulates targets using LabVIEW FPGA-based signal processing

- Doppler shift via Tx-to-Rx frequency offset
- Distance to target via delay
- Multiple targets

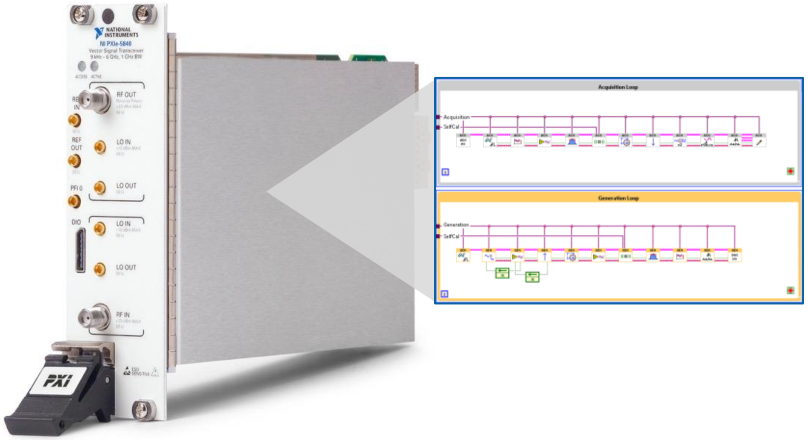
NI ADAS Test Solution

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

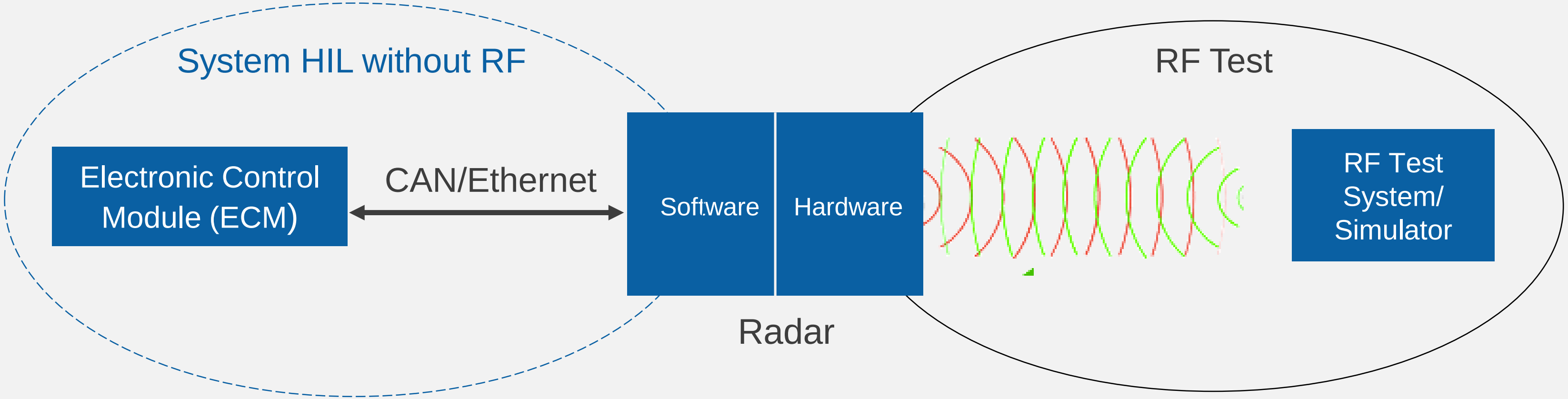
Key Specifications

- Frequency Range: 76 – 81 GHz
- Target range: 1 to 250 meters
- Range resolution: 0.1m
- Velocity: 0 to 200 km/hr



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

Automotive Sub-system Test Cases



Hardware-in-the-Loop Testing

```
--  D:\BASYS_PROJECTS\SPEED_CONTROL\TOGGLE_STM1.vhd
--  VHDL code created by Xilinx's StateCAD 9.2i
--  Wed Oct 10 13:13:12 2007

--  This VHDL code (for use with Xilinx XST) was generated using:
--  binary encoded state assignment with structured code format.
--  Minimization is enabled,  implied else is enabled,
--  and outputs are speed optimized.

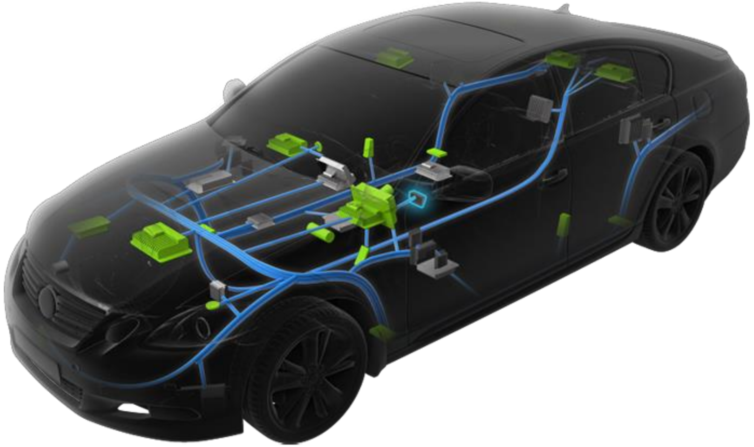
LIBRARY ieee;
USE ieee.std_logic_1164.all;

ENTITY SHELL_TOGGLE_STM1 IS
   PORT (CLK,Button,RESET: IN std_logic;
      Q0,Q1,Q2 : OUT std_logic);
END;

ARCHITECTURE BEHAVIOR OF SHELL_TOGGLE_STM1 IS
   SIGNAL sreg : std_logic_vector (2 DOWNTO 0);
   SIGNAL next_sreg : std_logic_vector (2 DOWNTO 0);
   CONSTANT STATE0 : std_logic_vector (2 DOWNTO 0) :="000";
   CONSTANT STATE1 : std_logic_vector (2 DOWNTO 0) :="001";
   CONSTANT STATE2 : std_logic_vector (2 DOWNTO 0) :="010";
   CONSTANT STATE3 : std_logic_vector (2 DOWNTO 0) :="011";
   CONSTANT STATE4 : std_logic_vector (2 DOWNTO 0) :="100";
   CONSTANT STATE5 : std_logic_vector (2 DOWNTO 0) :="101";

   SIGNAL next_Shreg0,next_Shreg1,next_Shreg2,next_Shreg3 : std_logic;
   SIGNAL Q : std_logic_vector (2 DOWNTO 0);
   SIGNAL Shreg : std_logic_vector (3 DOWNTO 0);

   SIGNAL Res,Set,Shreg0,Shreg1,Shreg2,Shreg3: std_logic;
BEGIN
   PROCESS (CLK, next_Shreg0, next_Shreg1, next_Shreg2, next_Shreg3)
   BEGIN
      IF CLK='1' AND CLK'event THEN
         Shreg0 <= next_Shreg0;
```



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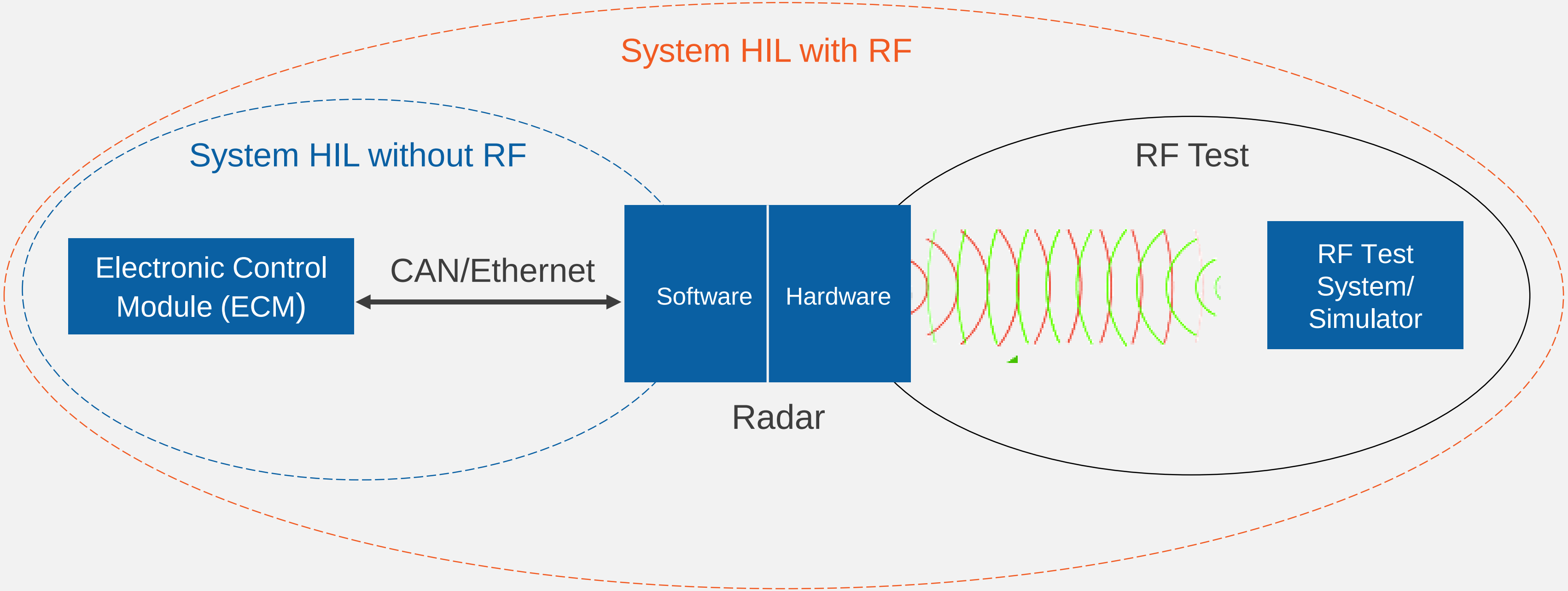
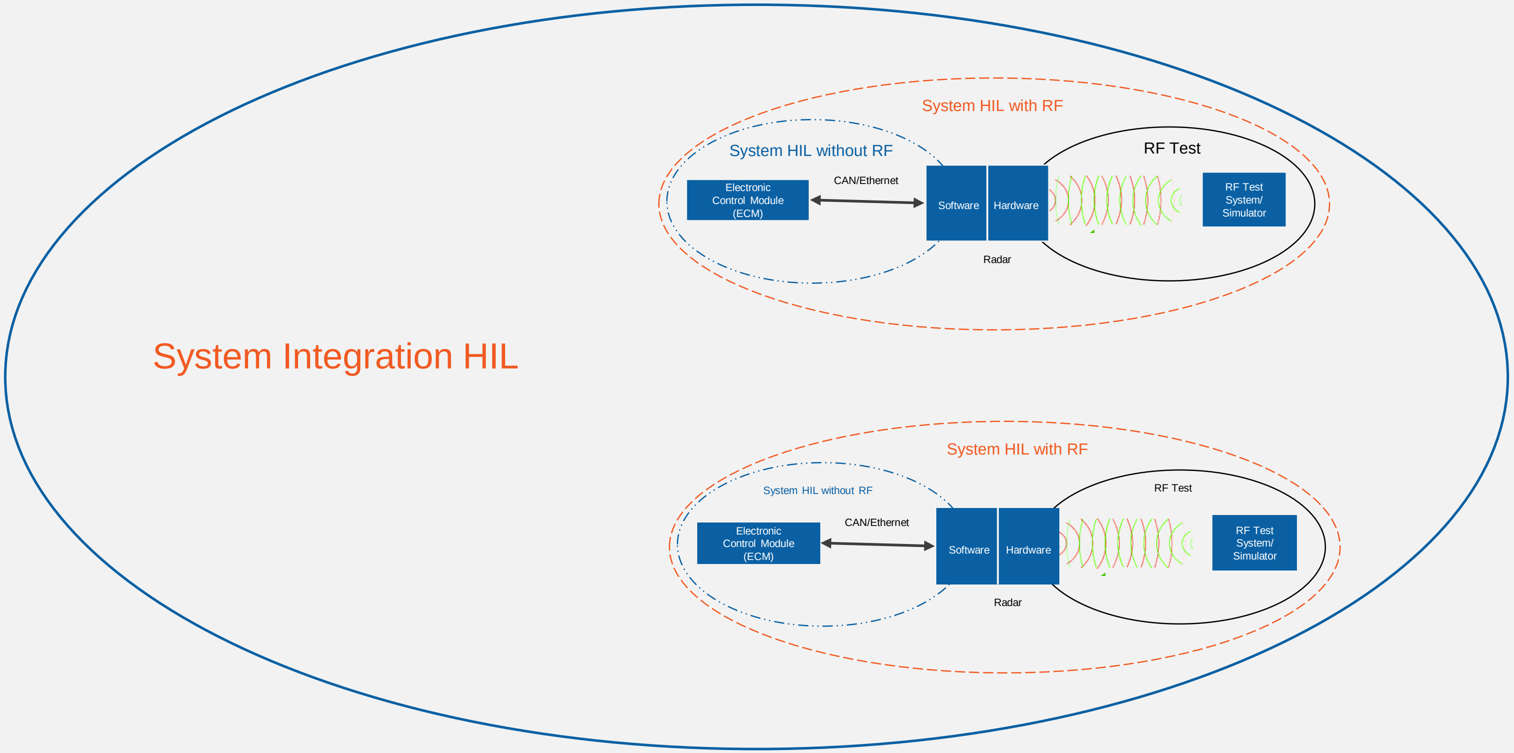
```

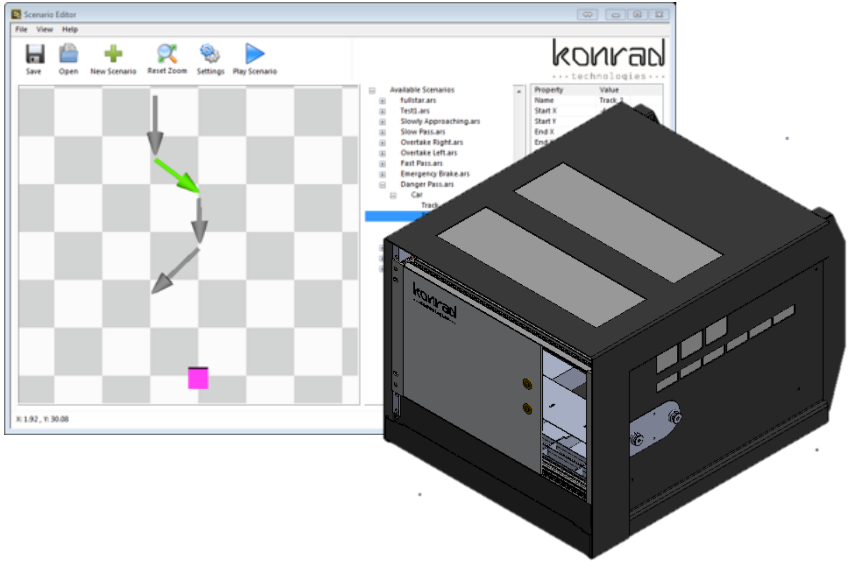
Automotive Sub-system Test Cases



Systems Integration Testing



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

konrad
...technologies...

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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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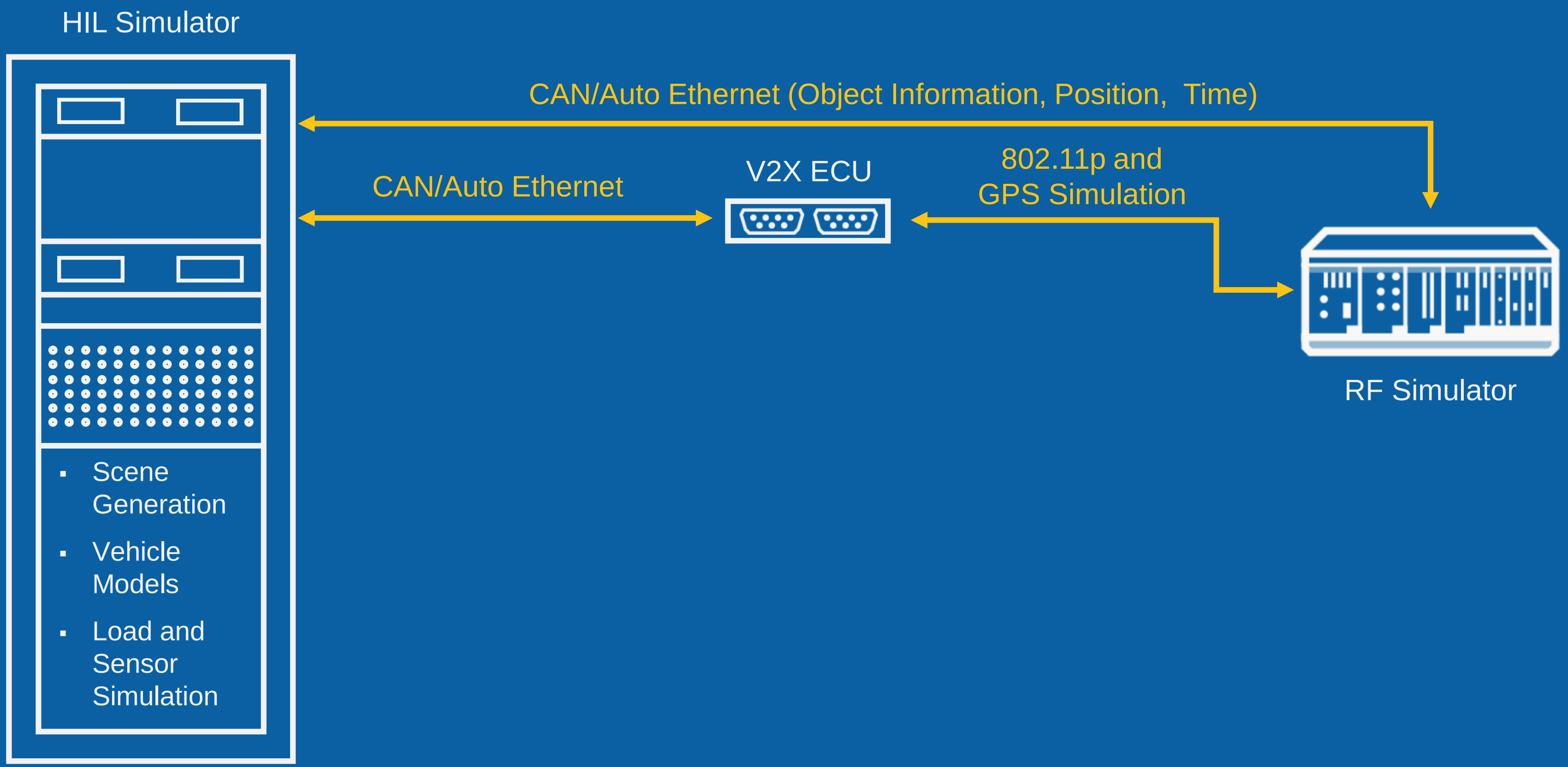
ni.com/smater-test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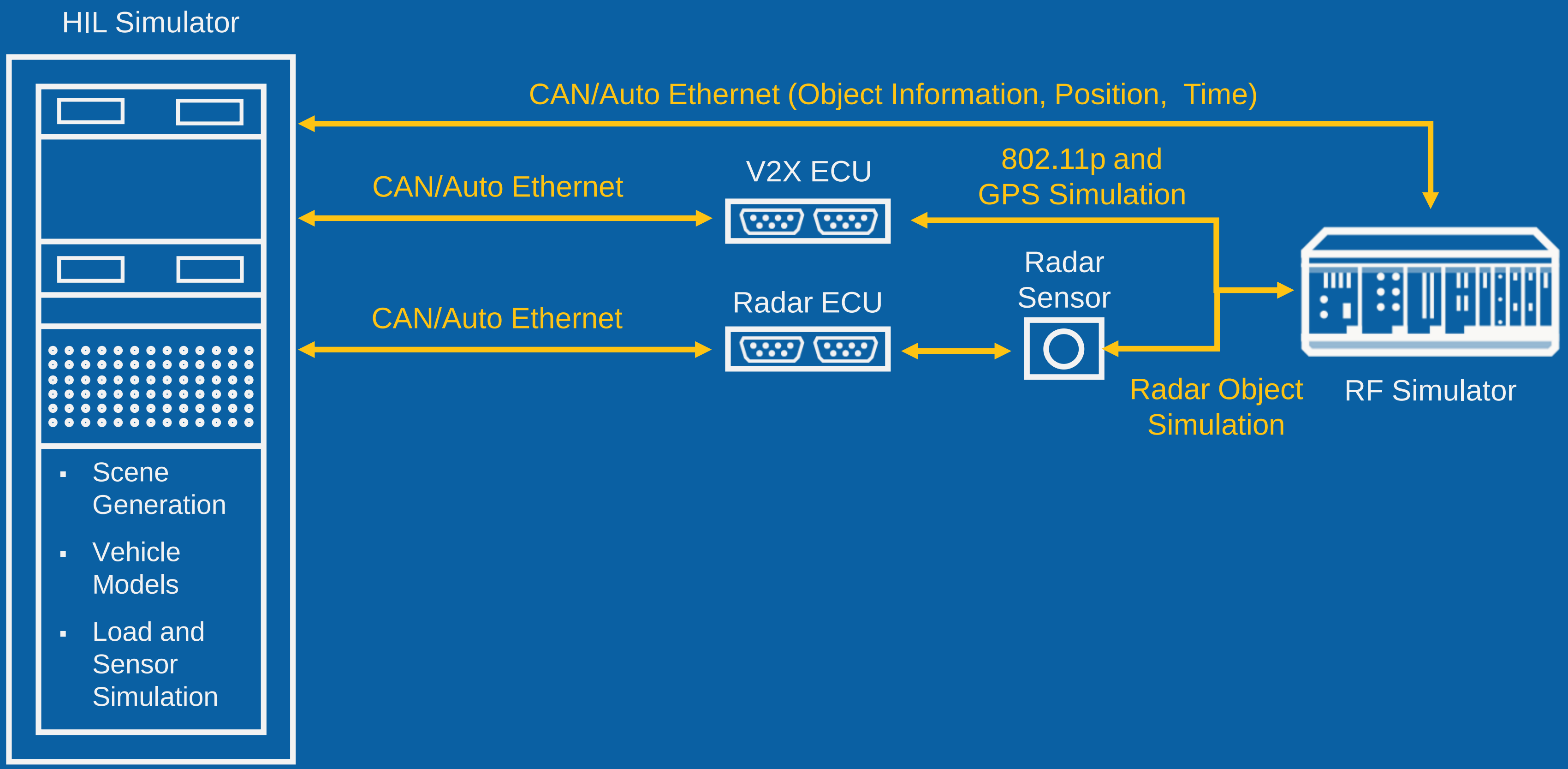
Vehicle Models
Load and Sensor Simulation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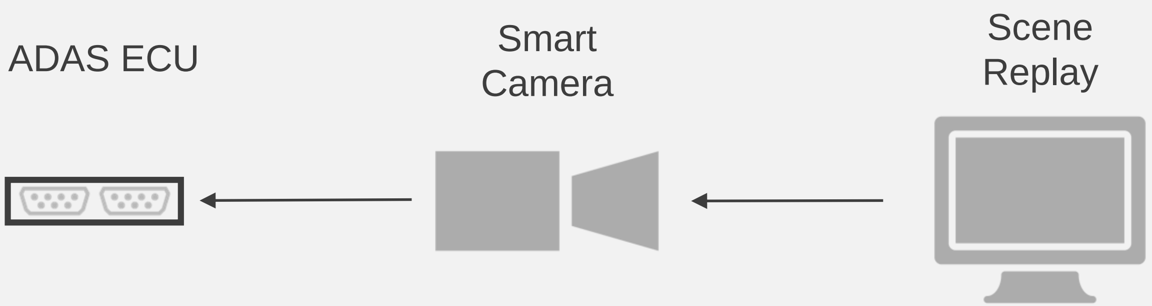
Camera

Challenges of Camera Testing

Increasing Number of Cameras

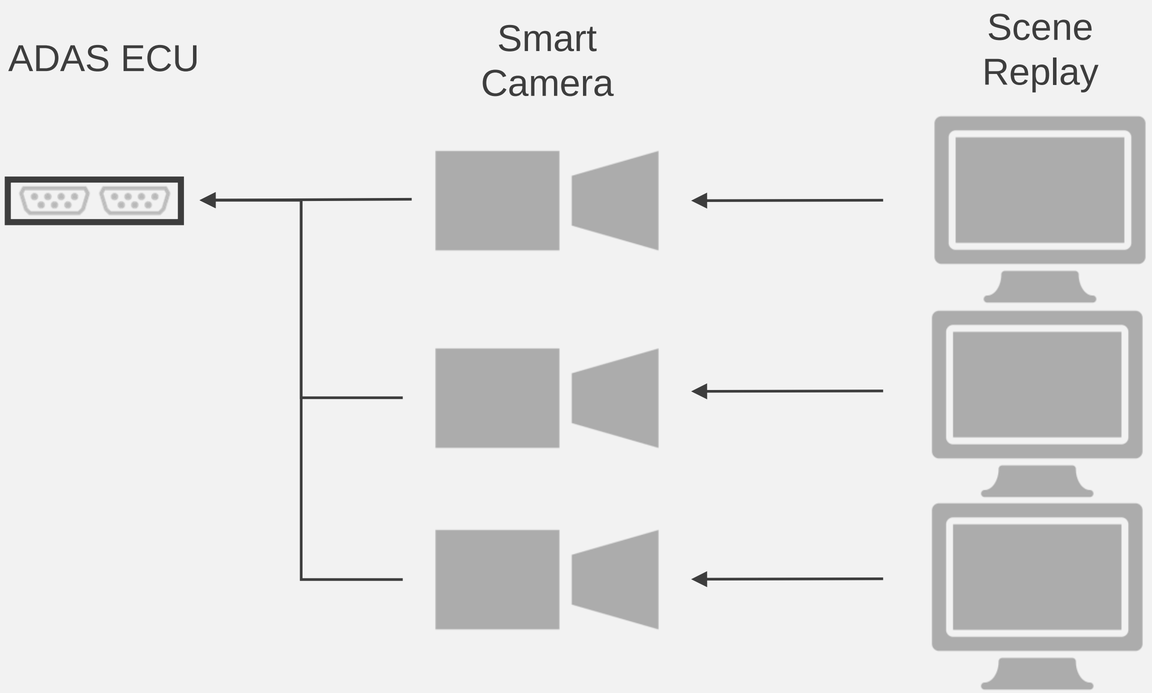
Properly Simulating Conditions

Approaches to Camera Testing

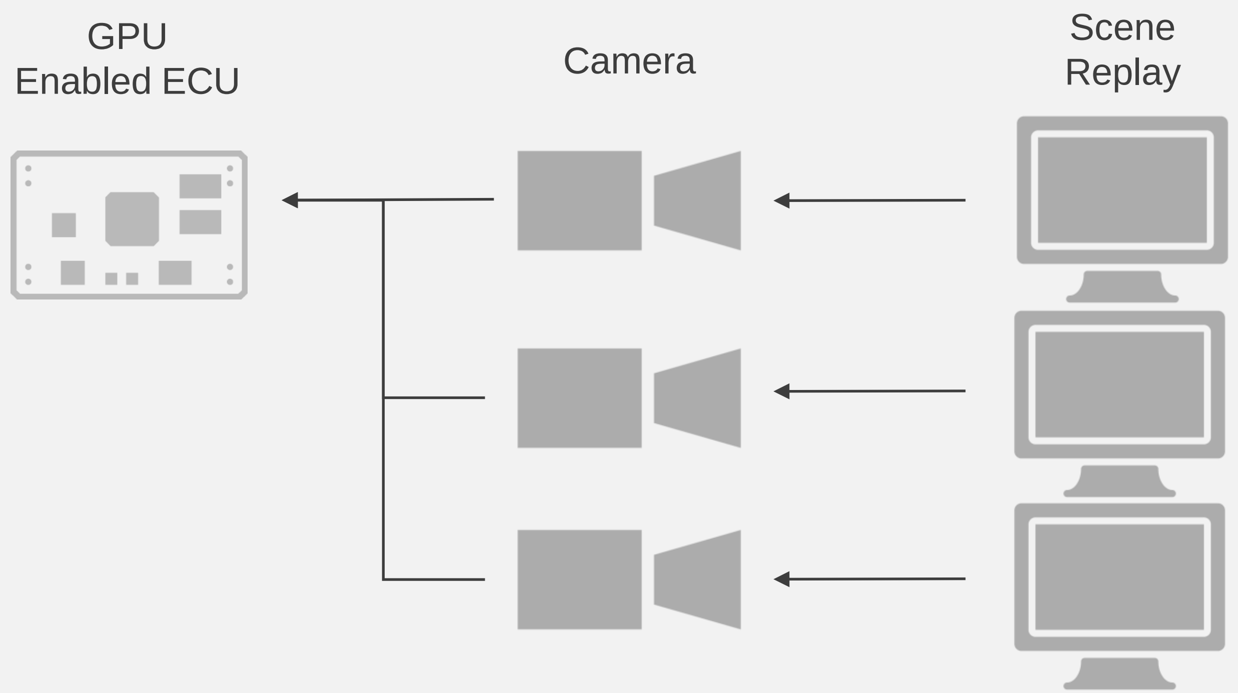


Demo

Approaches to Camera Testing



Approaches to Camera Testing



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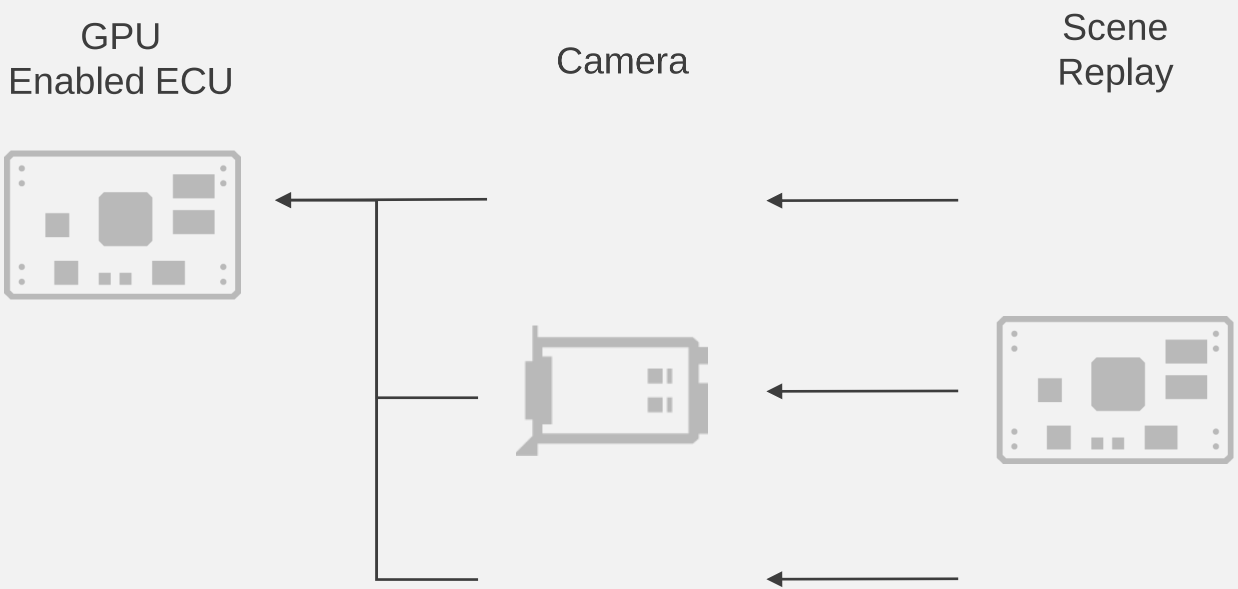

Image Manipulation with FPGA

Dropped Frames or Frame Delay

Noise and Error Injection

Bitstream Manipulation

Custom Protocols

HIL System Integration with IPG CarMaker

Carmaker Provides

- Vehicle dynamics
- Scene generation
- Sensor simulation
- Vehicle response

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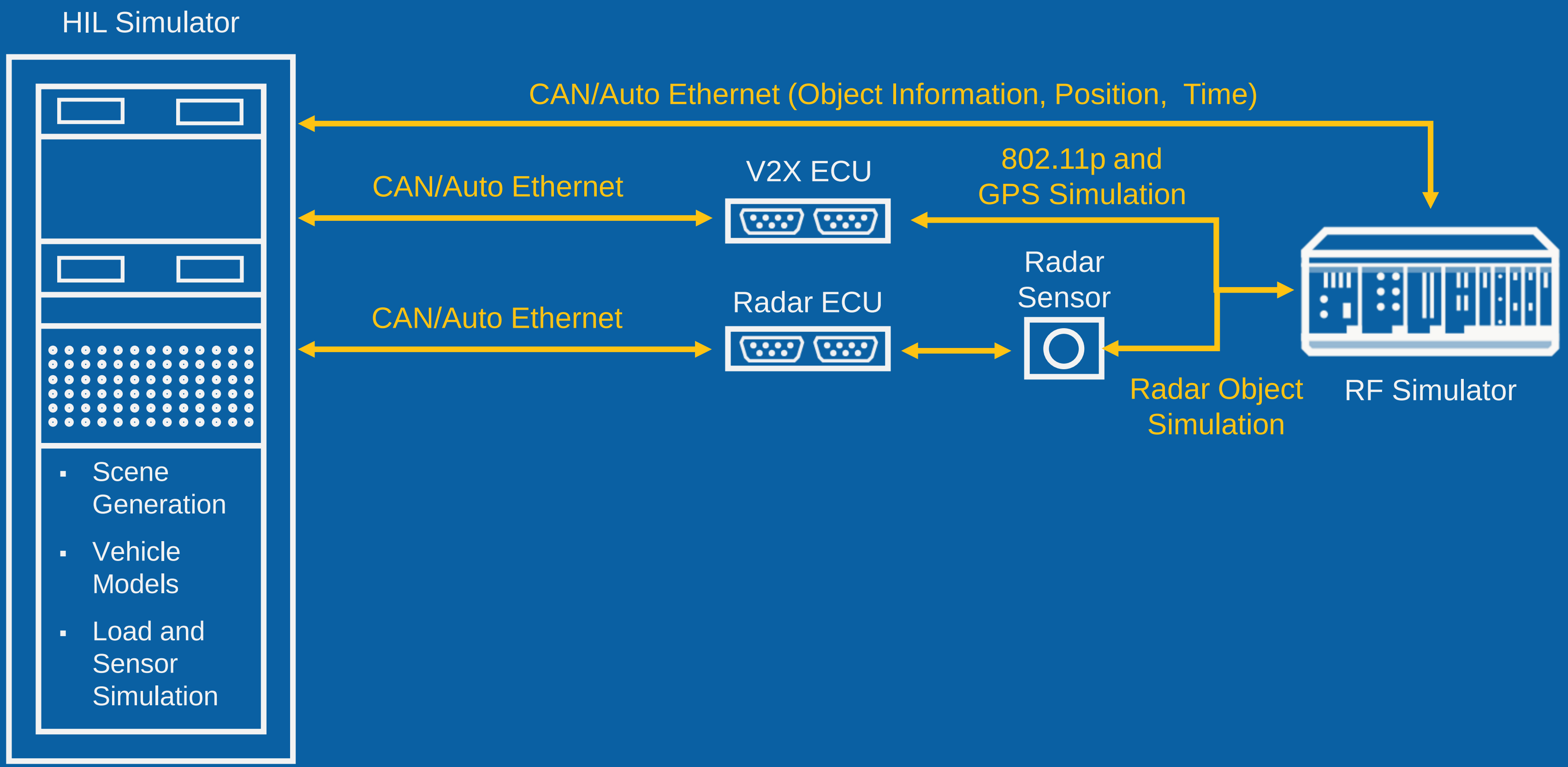
testit 全面
汽车电子
AOS Technologies AG
貝斯特科技(香港
Bisstest Technology (Hong
Vehicle ADAS HIL Test
KYOW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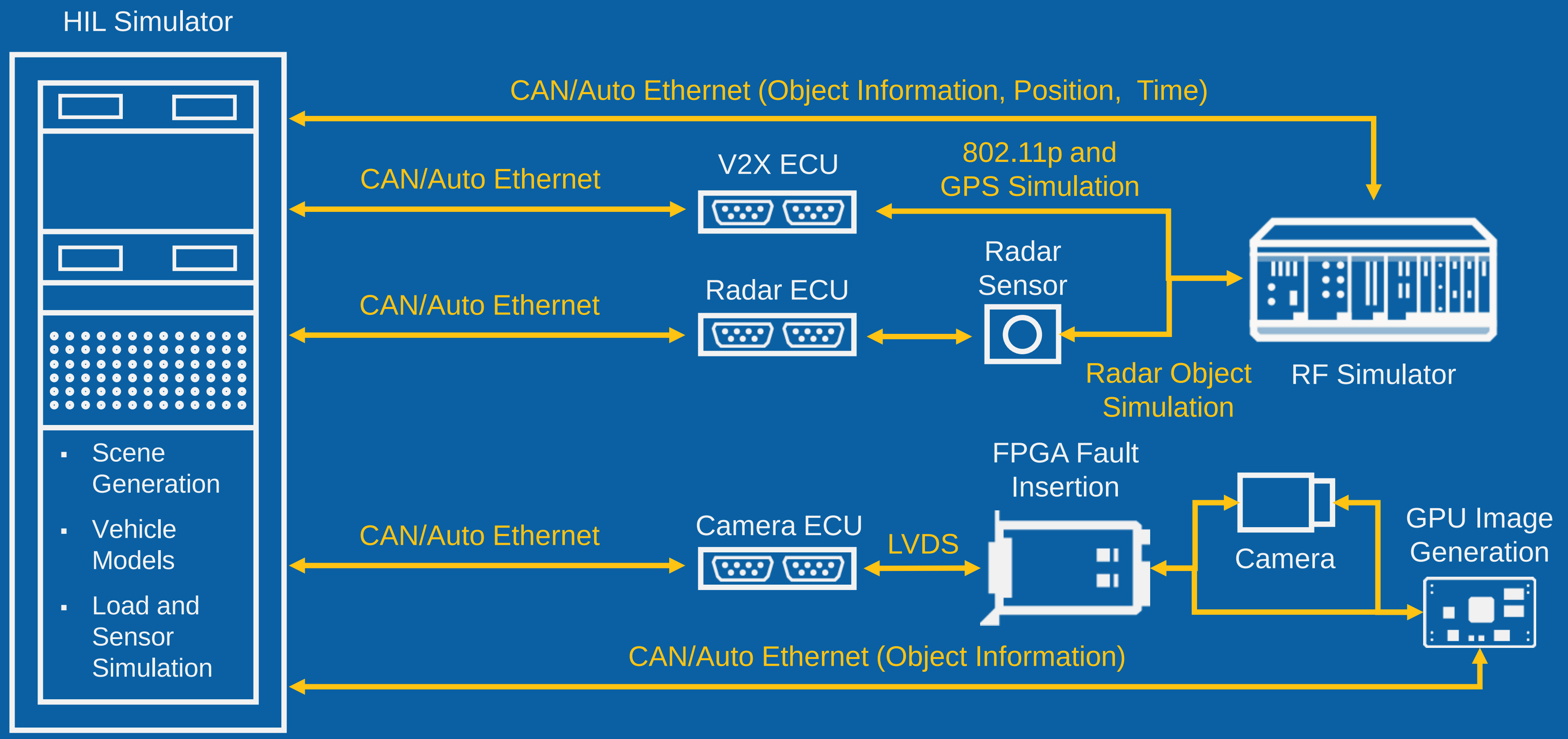
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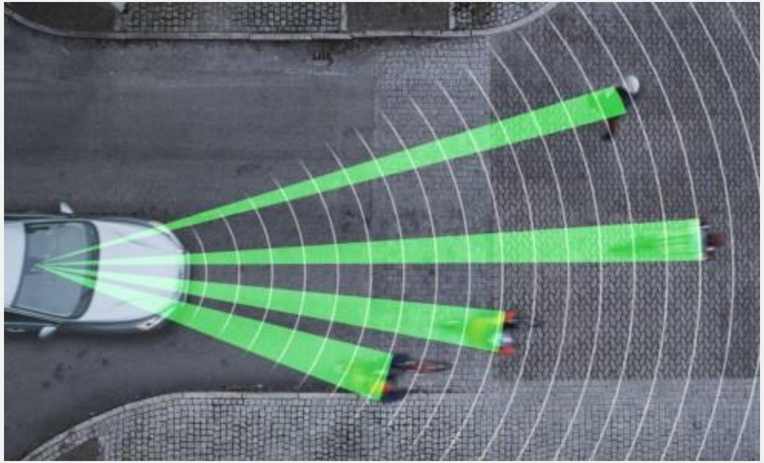
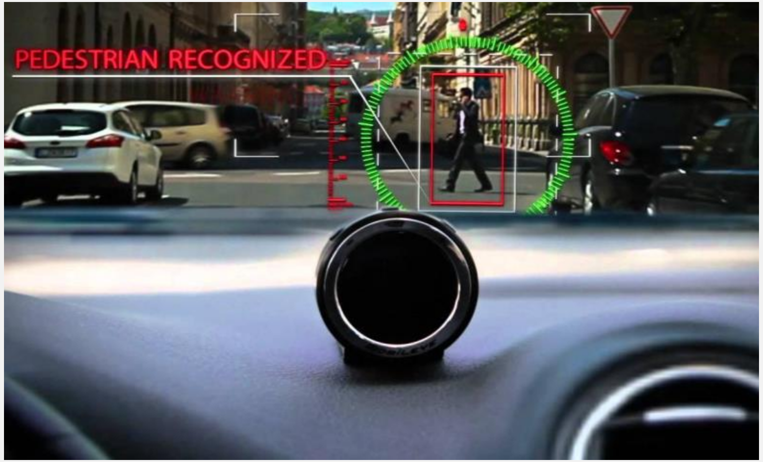
CAN/Auto Ethernet
Radar ECU
Radar Object Simulation
RF Simulator
FPGA Fault Insertion
Camera
GPU Image Generation
CAN/Auto Ethernet
Camera ECU
LVDS
CAN/Auto Ethernet (Object Information)

Sensor Fusion

Cameras and Radar Working Together



Object Detection Using Radar



Object Classification Using Cameras

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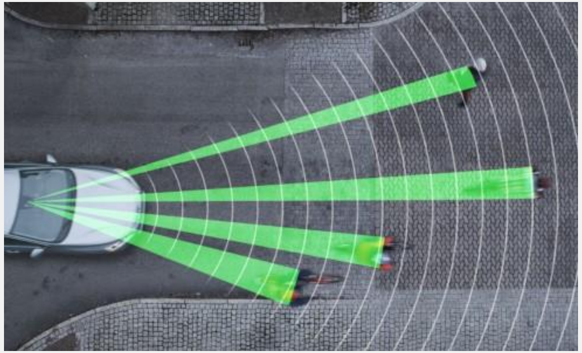
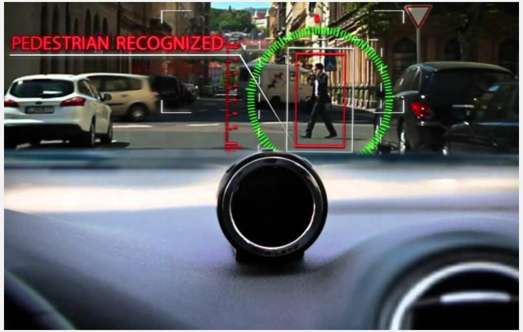
Cameras and Radar Working Together



Object Detection Using Radar

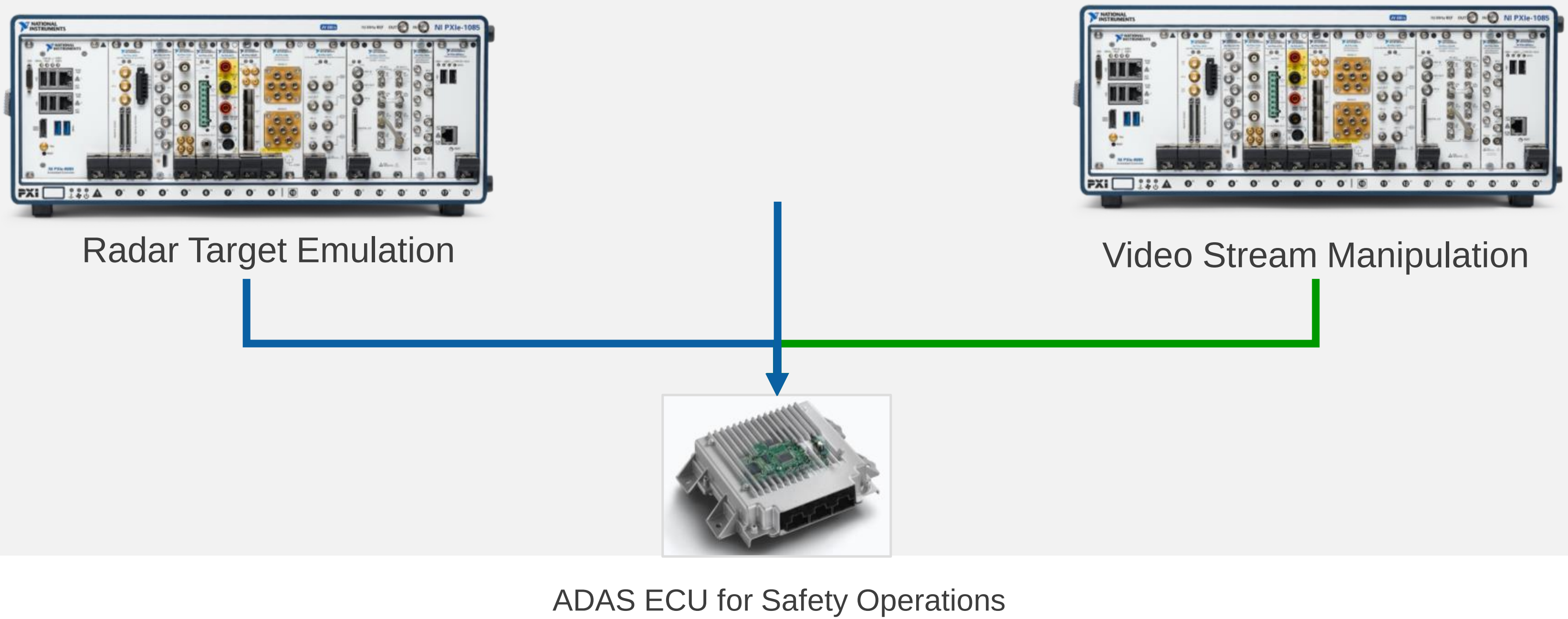
Synchronization



Object Classification Using Cameras

ADAS ECU for Safety Operations

Testing Sensor Fusion Embedded Software



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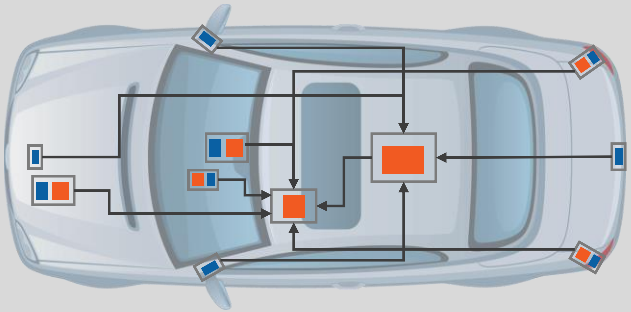
Hardware-in-the-Loop

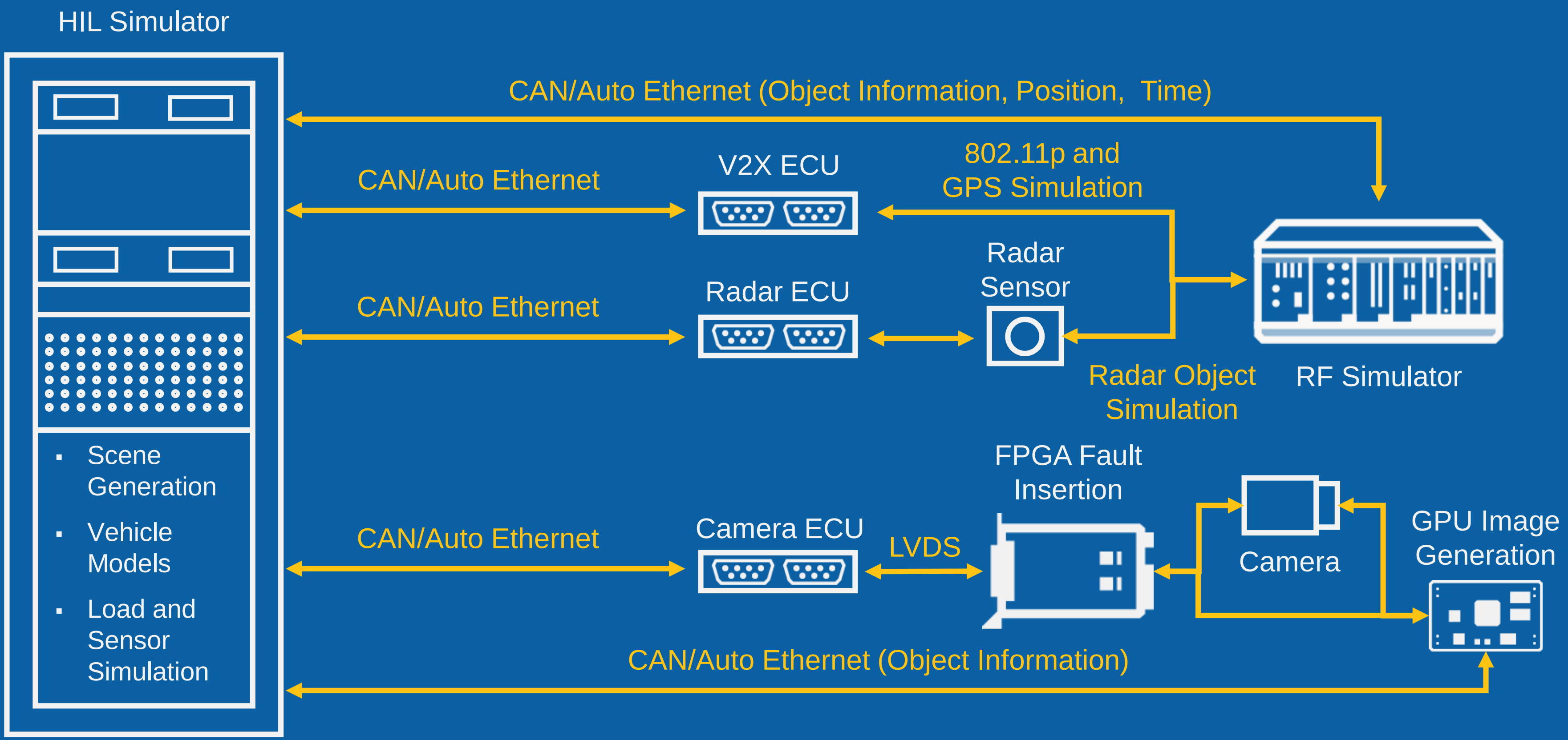
CAN Interface

GNSS Simulation

Radar Target Simulation

Image Simulation

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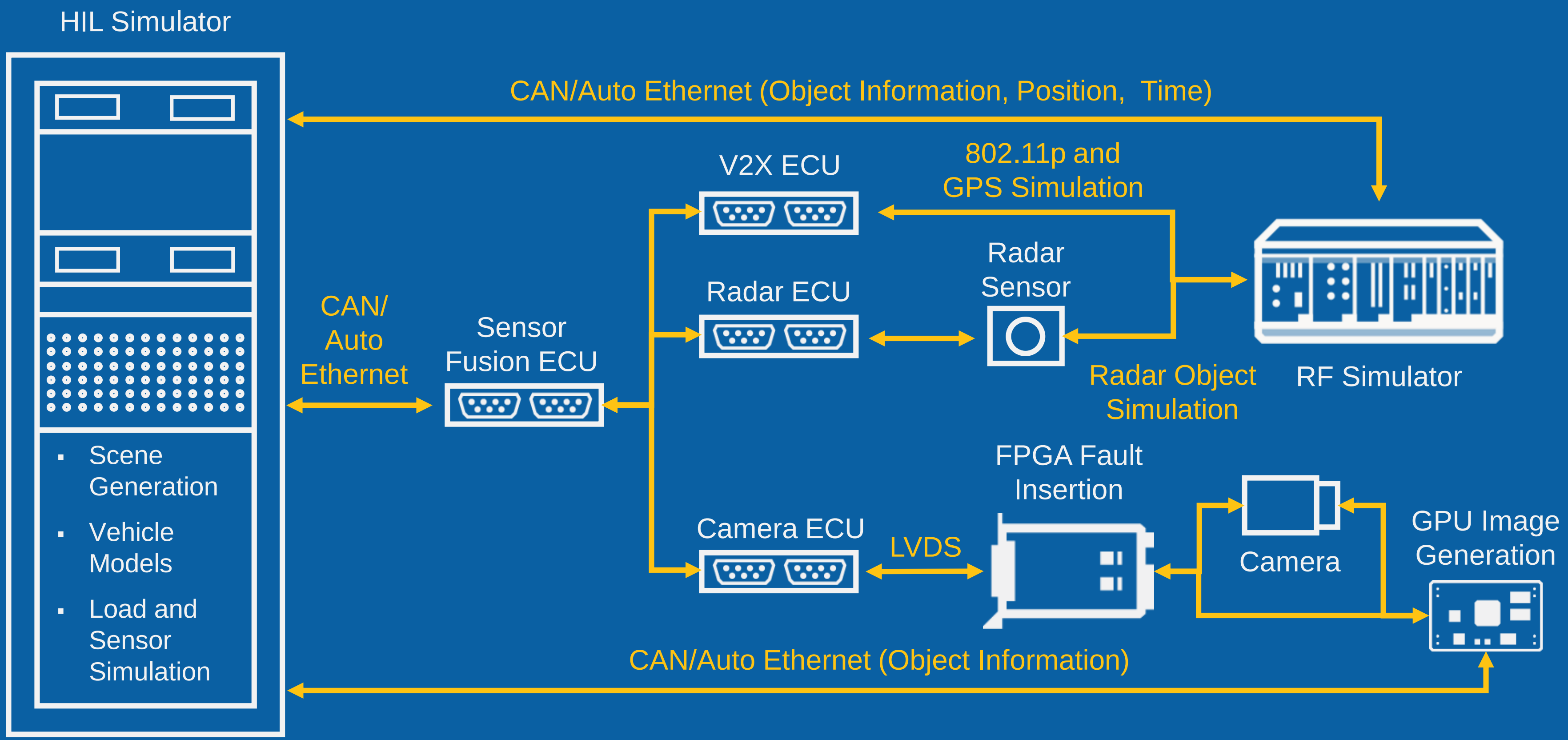
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