NIDays

ENGINEER NEXT

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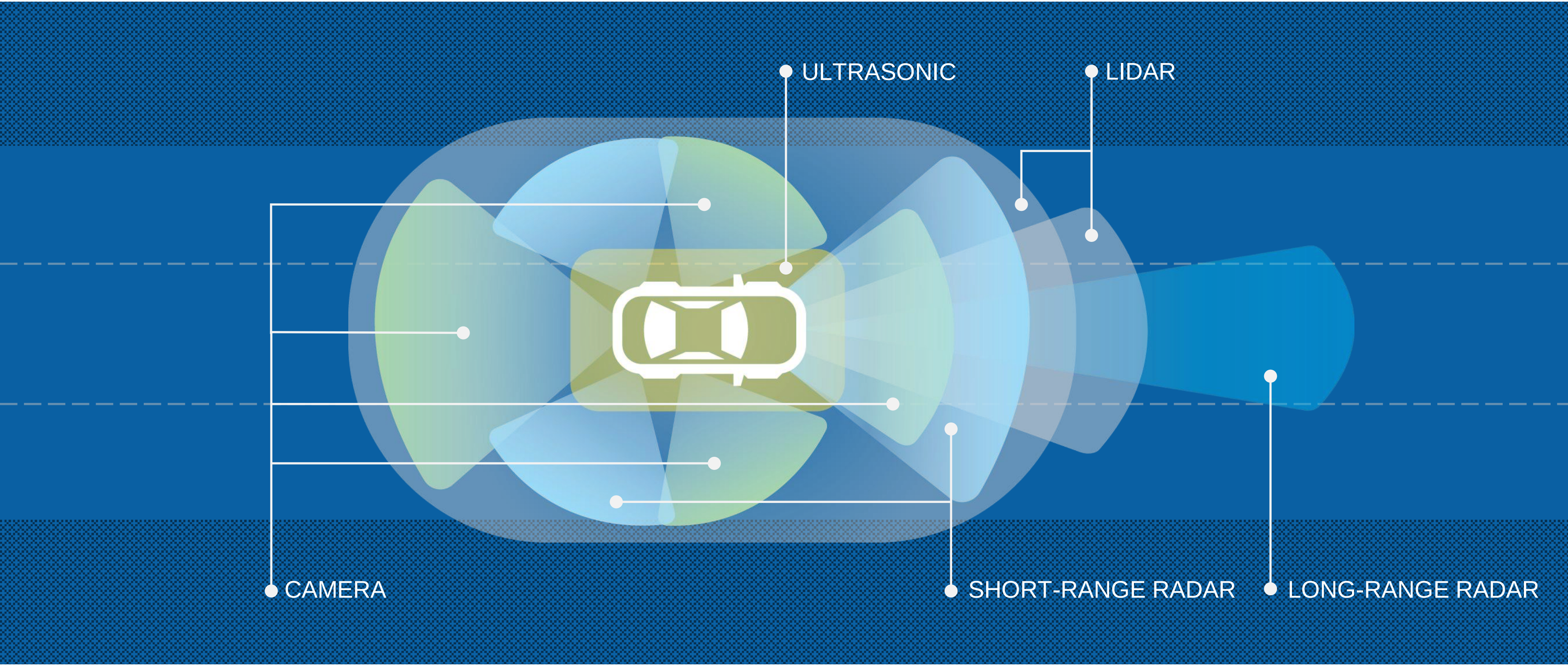
The Evolution of ADAS: Testing Systems That Include Cameras, Radar, and Sensor Fusion

Smarter Test for Smart Vehicles

Name

Title

Major ADAS Sensor Types and Applications



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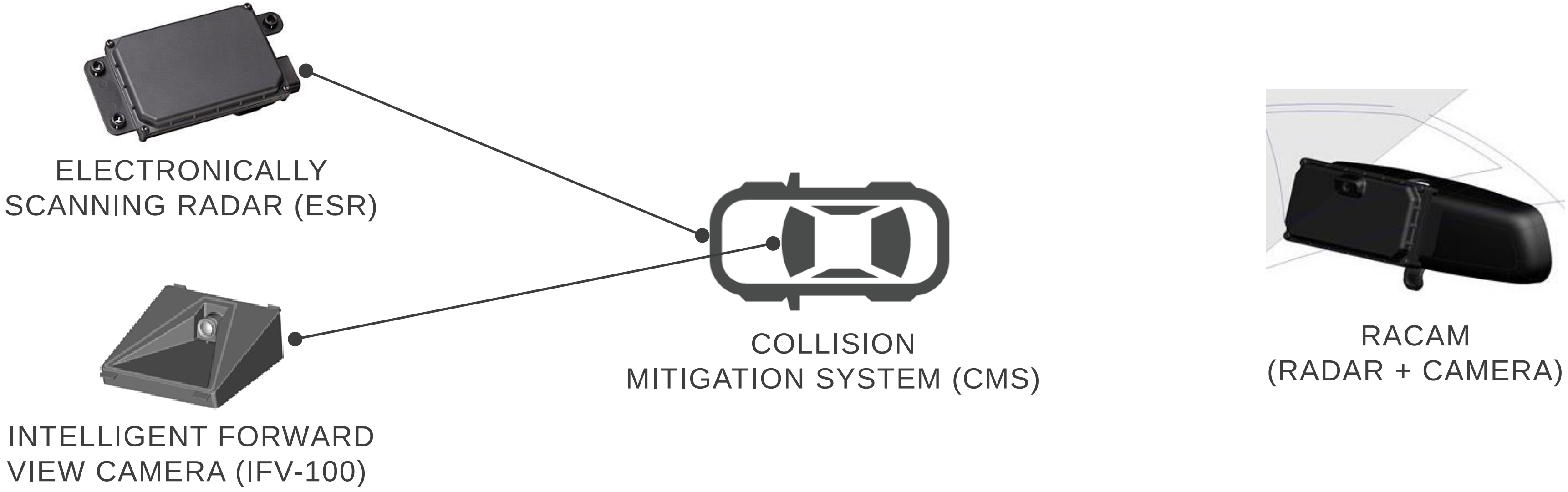
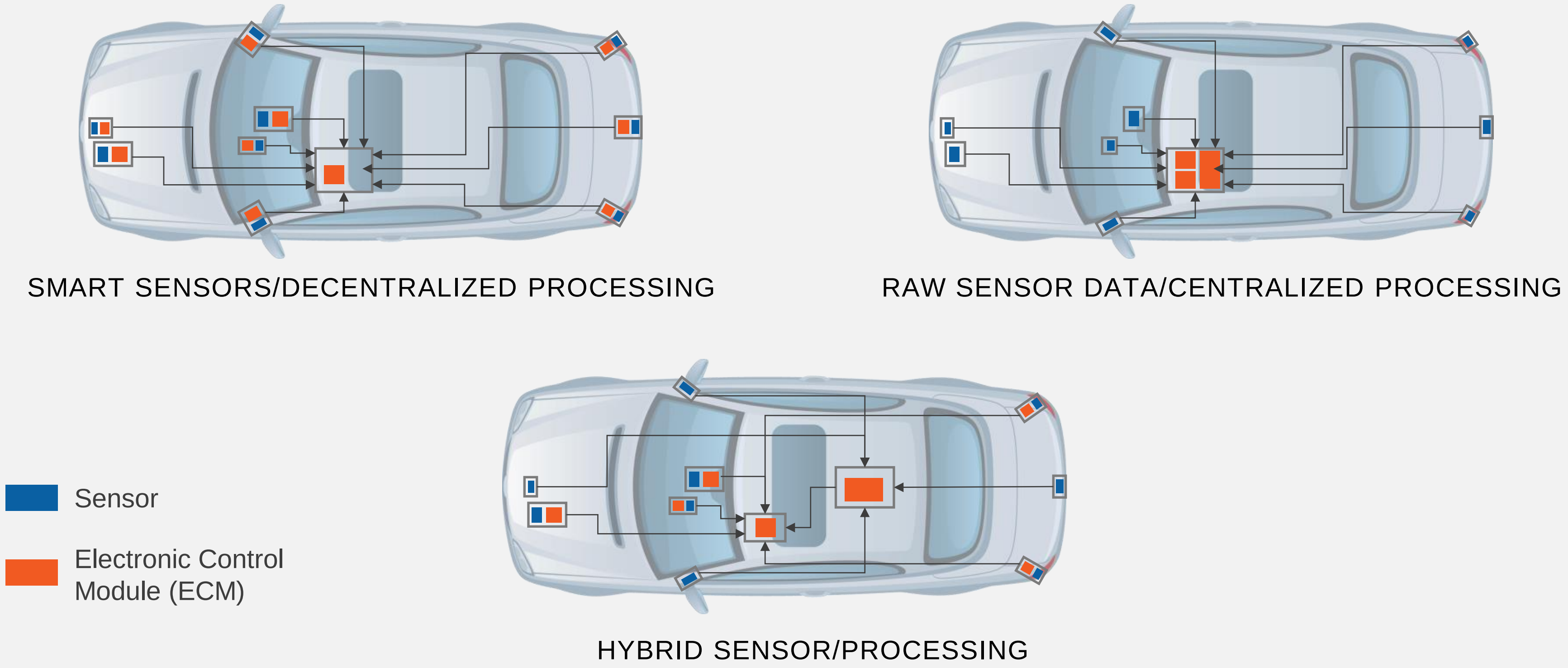
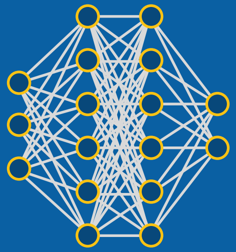


ADAS Sensor Fusion Evolution: Delphi Example

ADAS Architectures Continue to Evolve



Source: electronics-eetimes

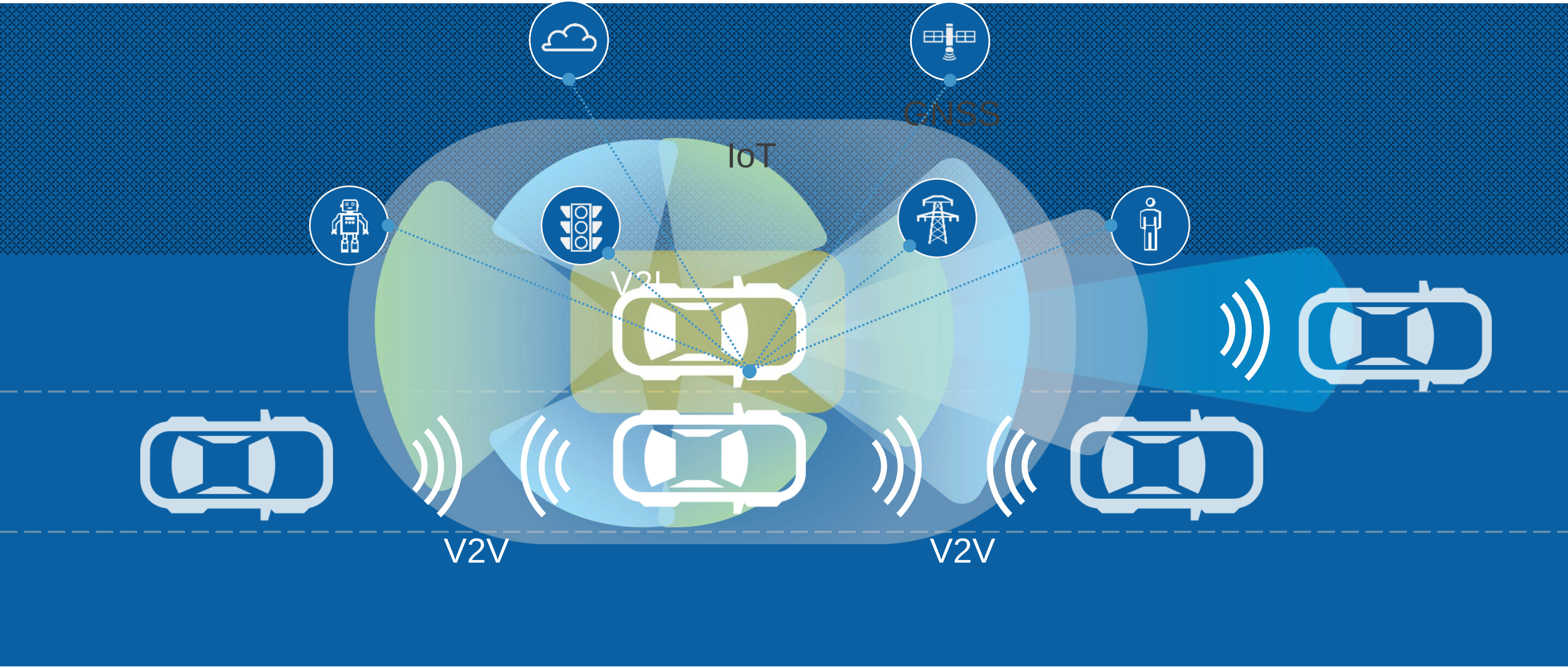


DEEP NEURAL NETWORK

Deep Learning for Self-Driving Cars

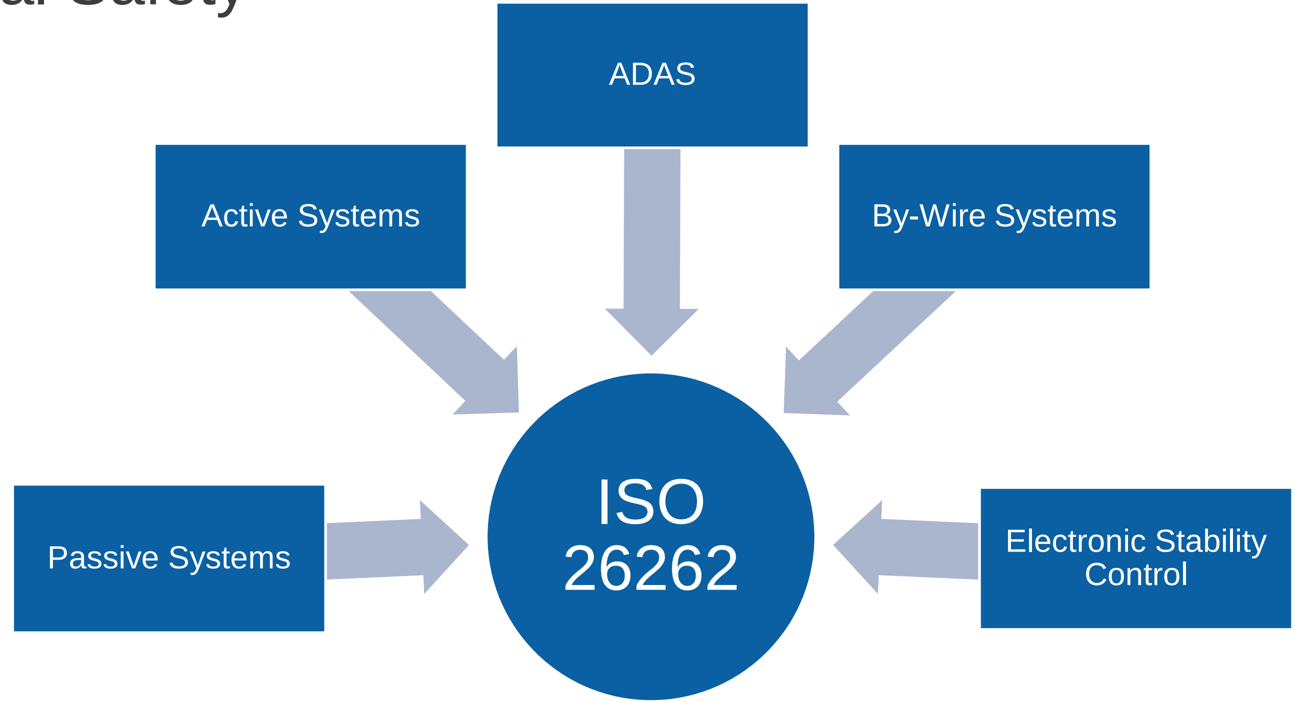
- Environmental perception is key to autonomous driving, e.g., lane position
- Traditional feature recognition and image processing techniques don't scale to needed complexity
- Deep neural networks learn efficient feature representation
- Inductive learning leads to evolving software operation that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

The Connected Car



Functional Safety

ISO 26262



All interactions between systems of systems must be known and tested to determine how errors propagate across system and subsystem boundaries.

Challenges of ADAS Testing

Regulatory
Uncertainty

Volume
of Tests

Testing Systems Instead
of Discrete Components

Integrating New Technology
Into Existing Systems

Approaches to Test and Measurement

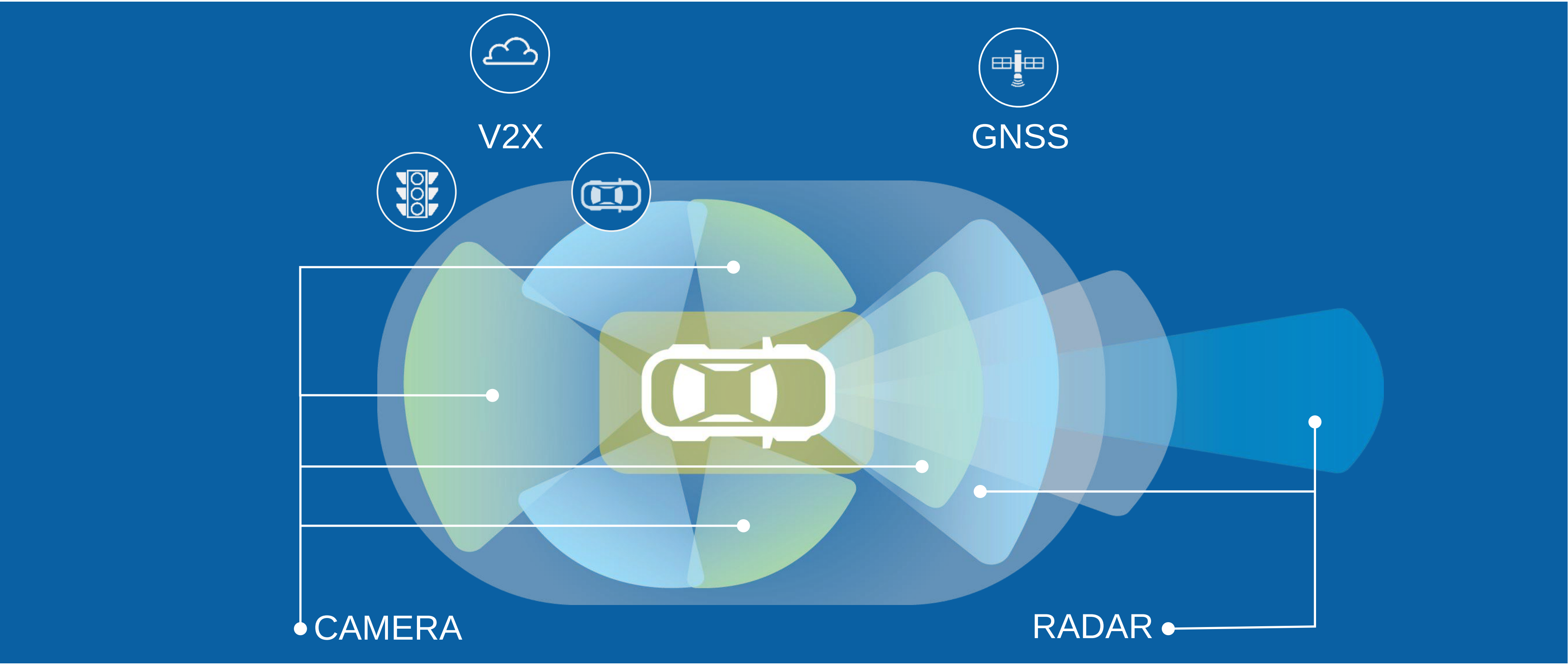
CLOSED

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

PLATFORM

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

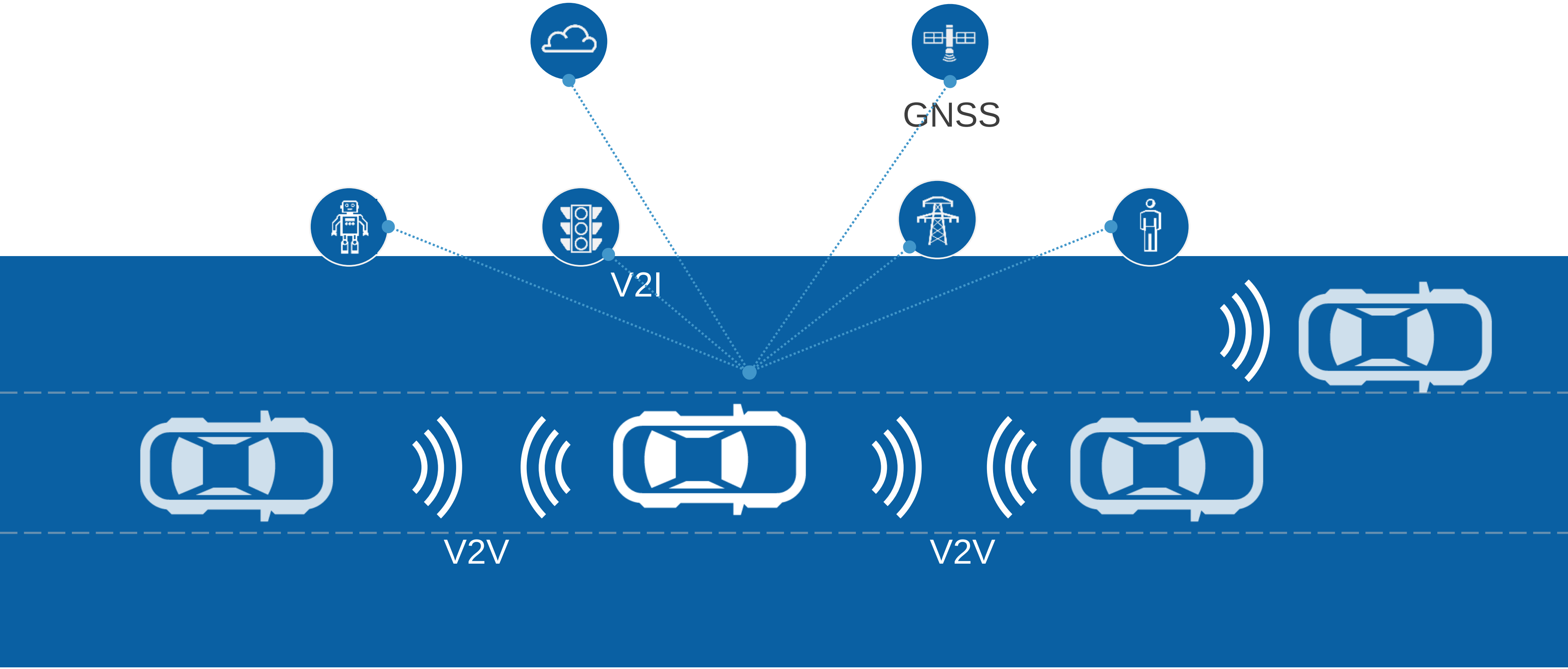
Major ADAS Technologies



Communications

V2X and GNSS

The Connected Car



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V2V and V2I Communications With 802.11p and LTE

IEEE 802.11p (DSRC)

- Referred to as Dedicated 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
- Supports only 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

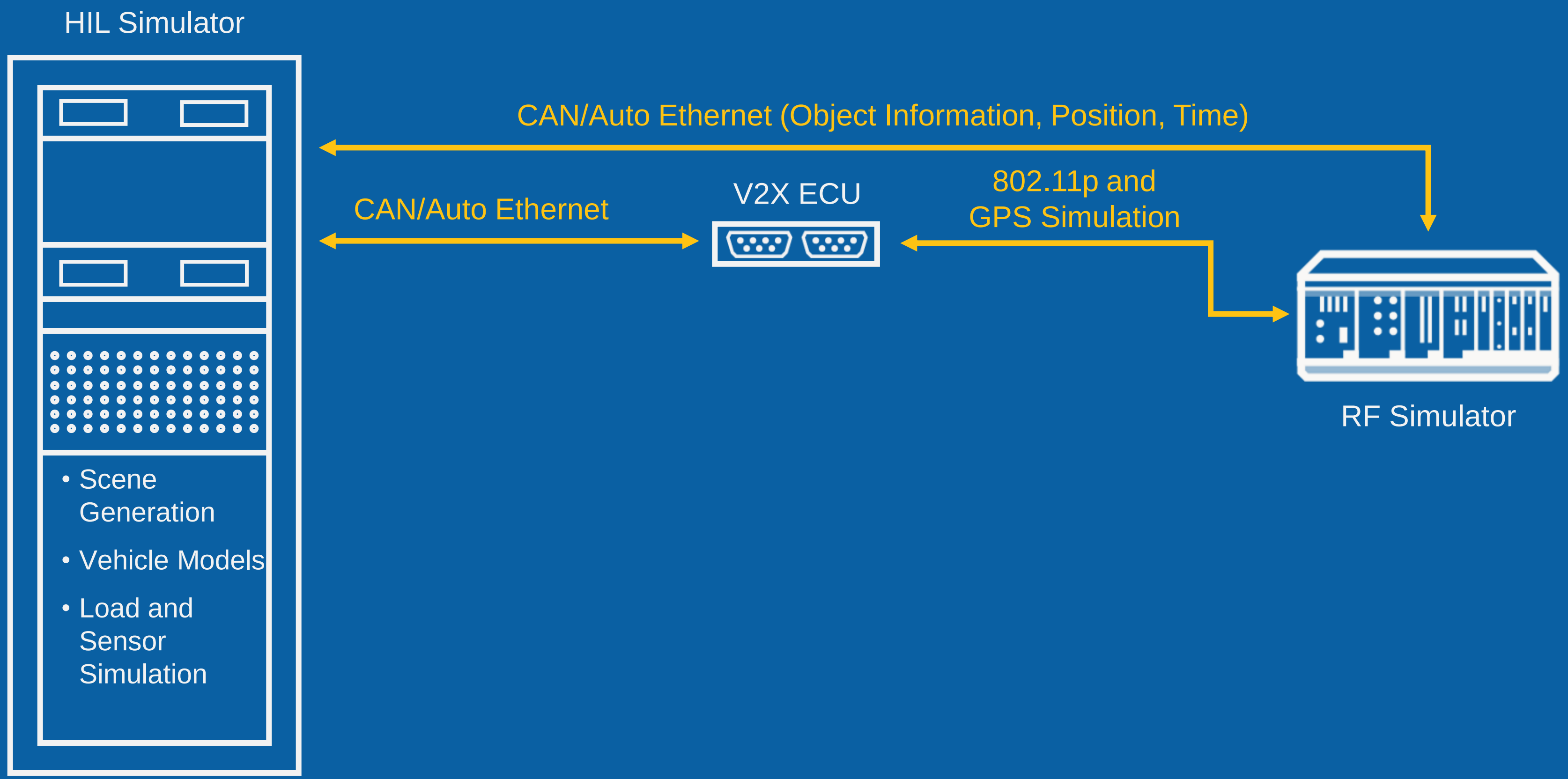
NI’s Approach for Integrating Other Standards

Flexible measurement IP from GSM to Wi-Fi

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 controllers and reconfigurable FPGAs.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V2X ECU
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802.11p and
GPS Simulation
RF Simulator
• Scene Generation
• Vehicle Models
• Load and Sensor Simulation

Radar

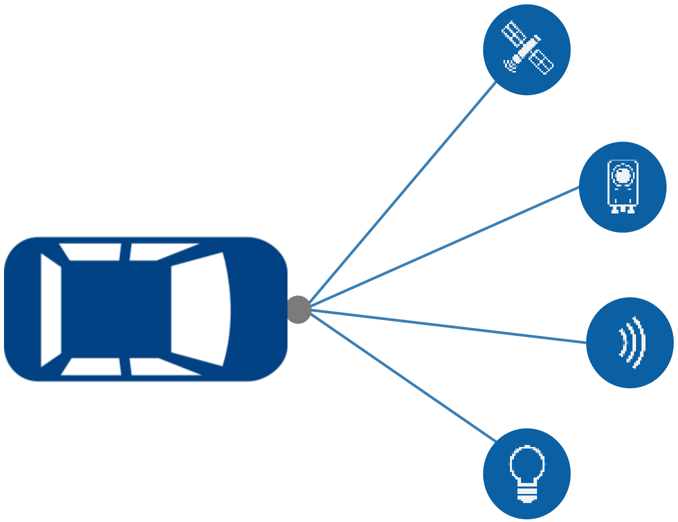
Trends in Automotive Radar

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 77–81 GHz

- More reliability and more accuracy
- Greater capability of distinguishing objects with high bandwidth
- Smaller footprint (multimode, multirange)



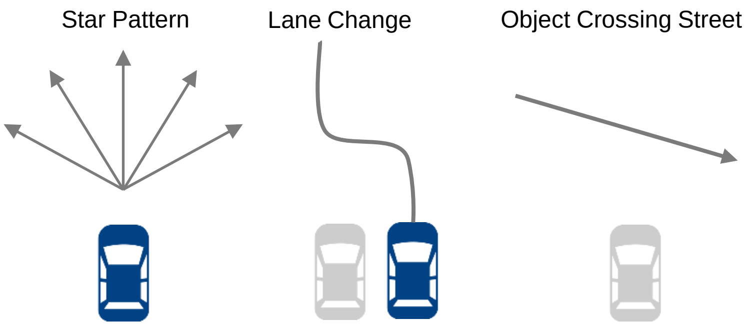
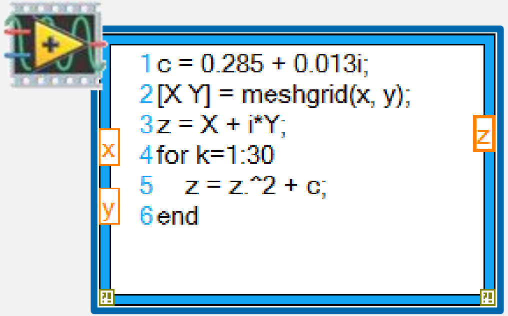


Image from http://www.wykop.pl/link/2349196//

Benefits and Trade-Offs of Testing Approaches

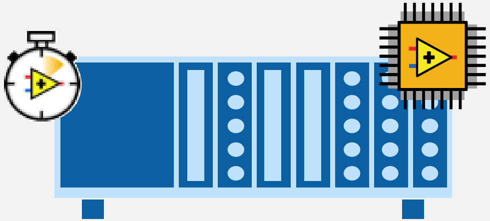
Simulation

- Uses software-only techniques
- Lowers setup complexity
- Does not truly emulate real-world behavior



Emulation

- Uses hardware-in-the-loop (HIL) techniques
- Allows the emulation of real-world scenarios
- Scales for future applications
- Requires knowledge of both hardware and software



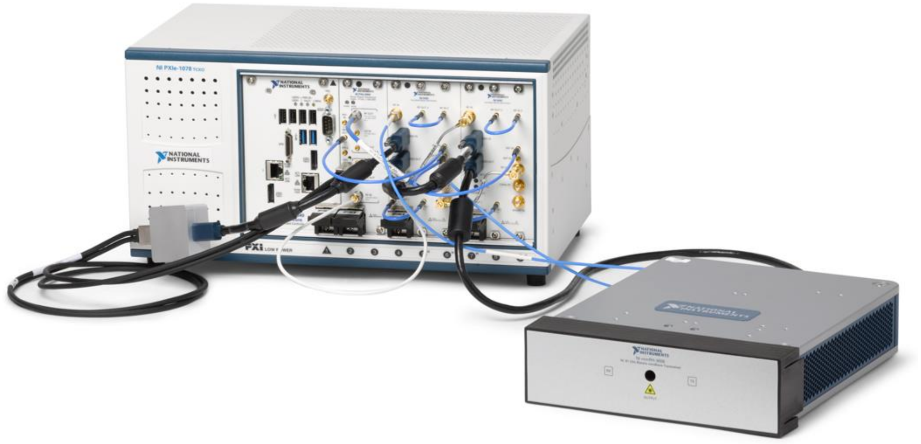
Field Test

- Offers true real-world test
- Is difficult to set up and scale
- Limits test case coverage due to time and space complexity

Vehicle Radar Test System (VRTS)

FEATURES AT A GLANCE

- Single system performs both obstacle simulation and radar measurements
- Obstacle simulation settings include velocity, range, RCS, and angle of arrival (Ao))
- Measurements include: radiation pattern, EIRP, phase noise, spectrum occupancy, beam width, and chirp analysis
- Tight synchronization with modular PXI hardware for hardware-in-the-loop (HIL) and ADAS test applications

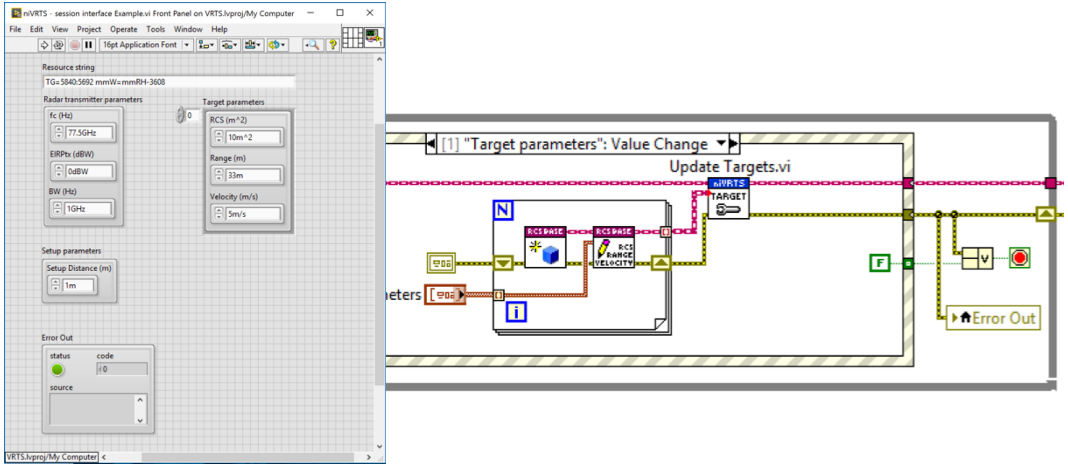


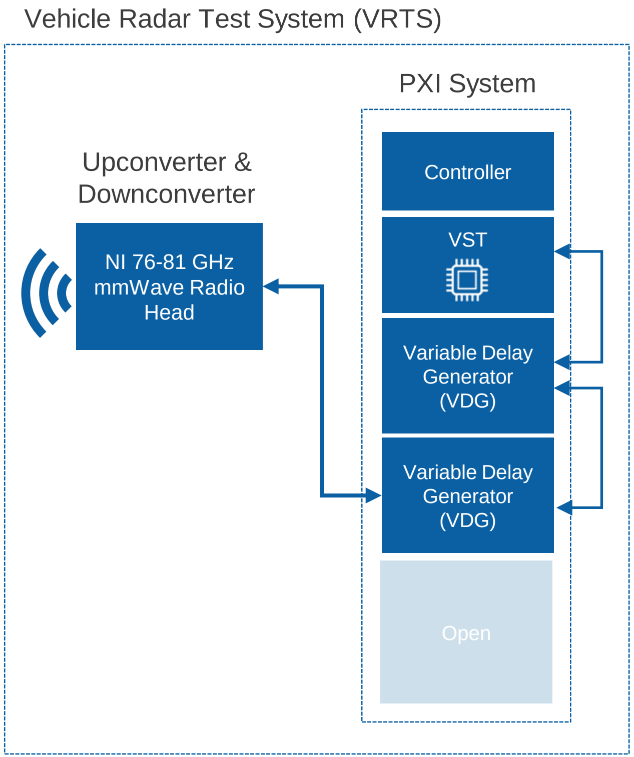
The NI VRTS is a flexible test system that combines PXI hardware with modular milimeterwave radio heads

KEY SPECIFICATIONS

- Frequency Range: 76 – 81 GHz
- Number of Obstacles: 2 to 8+
- Obstacle range: 4m to 300+ meters
- Minimum VRTS to DUT: 70 cm
- Range resolution: 10 cm
- Range Accuracy: ± 70 cm
- Velocity: 0 to 500 km/hr (75 kHz)

VRTS Software





- VRTS partners provide highly customized turn-key solution based on end user requirements
- Partners build on VRTS LabVIEW reference application – which includes:
  - Measurement examples for radar hardware characterization
  - Object simulation examples for embedded software and system test

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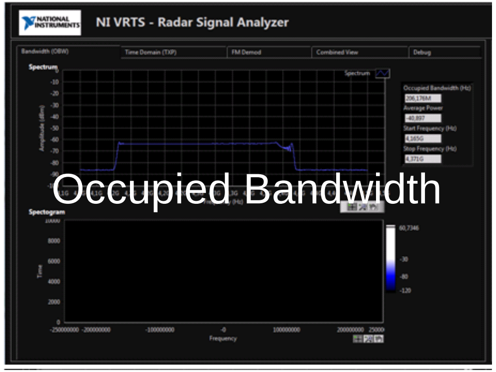
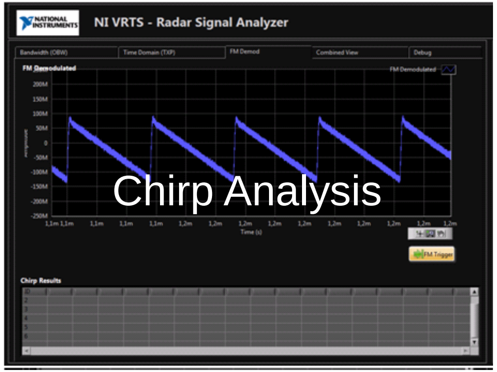
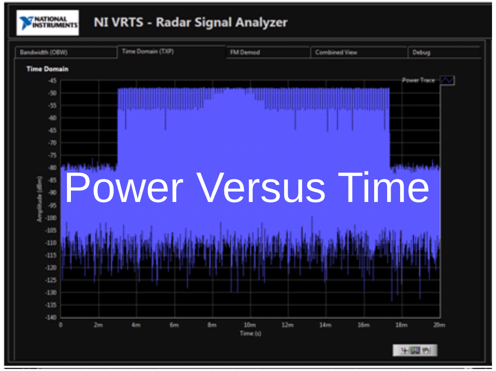
Typical Radar Measurements

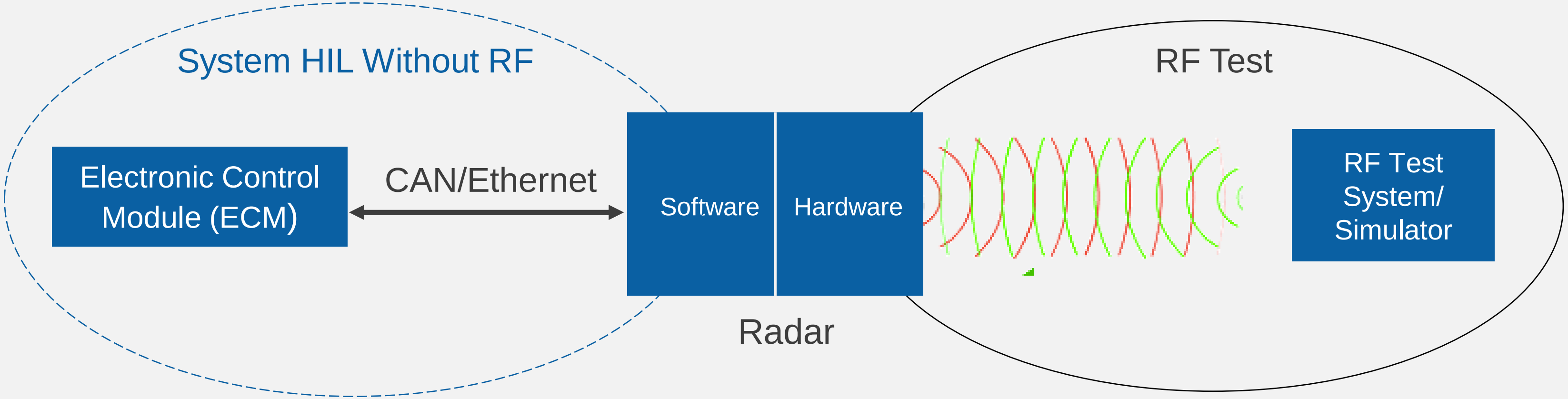




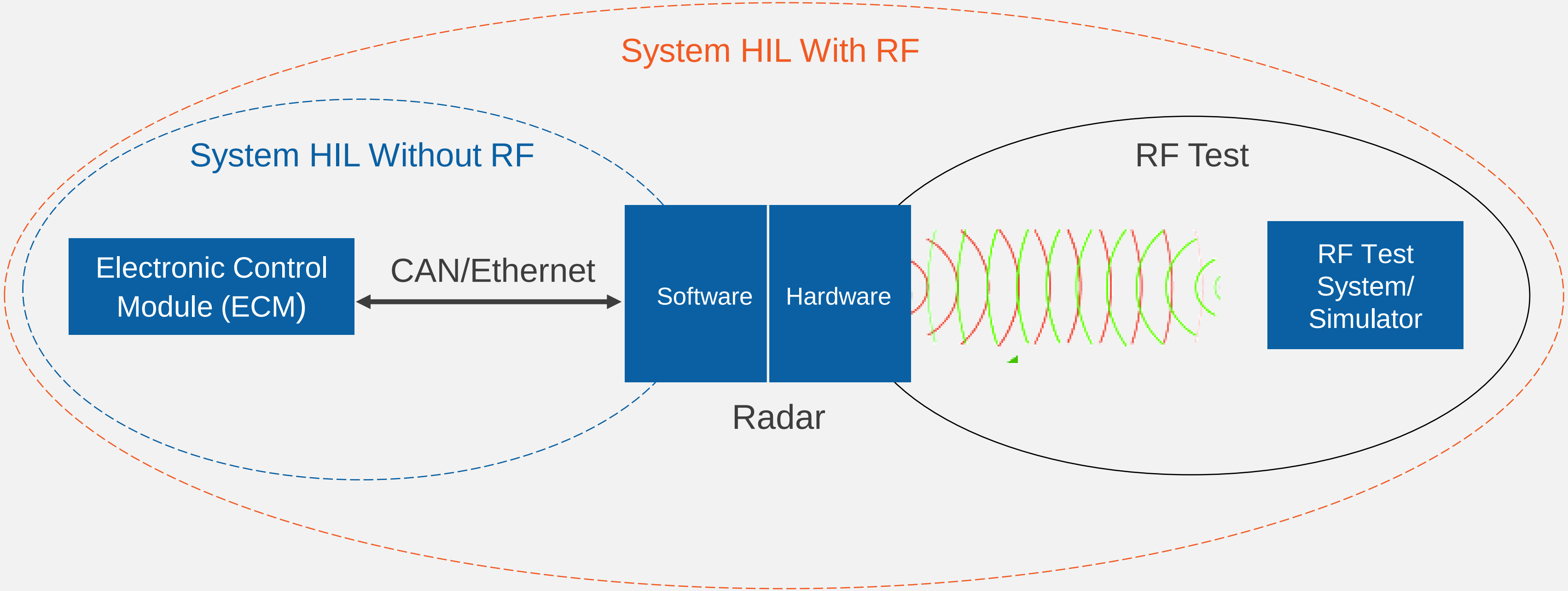


- Frequency Domain Analysis
    - Power level, Occupied Bandwidth, Center Frequency
- Time Domain Analysis
    - Update Rate, Pulse Width, Ramp Bandwidth, Rising or Falling FM Ramps
    - Detect signal anomalies

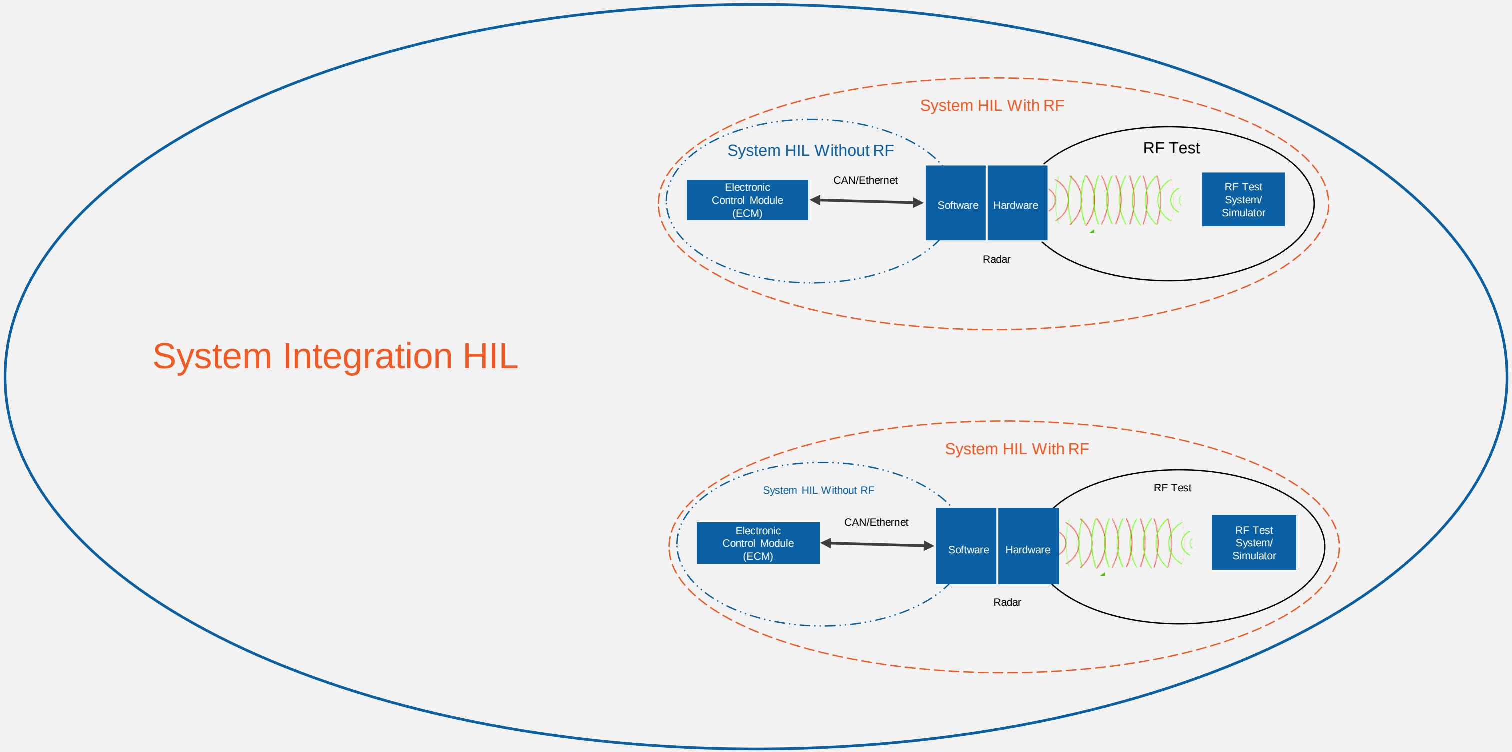
Automotive Subsystem Test Cases



Automotive Subsystem Test Cases



Systems Integration Test



VRTS Partners

Averna

- Platinum Alliance Partner
  - RF & Wireless Specialty Partner
- Locations in Canada, Netherlands , US, Japan, Poland, Mexico, and Belgium
- 17 Years of experience
- 110 Certified LabVIEW architects and developers

恒润科技 HIRAIN TECHNOLOGIES

- Silver Alliance Partner
- Location in Beijing, China
- 19 Years of experience
- 2 Certified LabVIEW developers
- Specializes in automotive, embedded systems, and HIL applications

LINKTRON

- Gold Alliance Partner
- Locations in China
- 28 Years of Experience
- 5 Certified LabVIEW architect and developers
- Specializes in data acquisition, automotive ATE applications

konrad technologies

- Platinum Alliance Partner
  - RF & Wireless Specialty Partner
- Locations in Germany, Austria, Hungary, US, and China
- 20 Years of Experience
- 13 Certified LabVIEW architects and developers

NOFFZ TECHNOLOGIES

- Platinum Alliance Partner
- Locations in Germany, Hungary, Mexico and China
- 28 Years of Experience
- 6 Certified LabVIEW architects and developers

"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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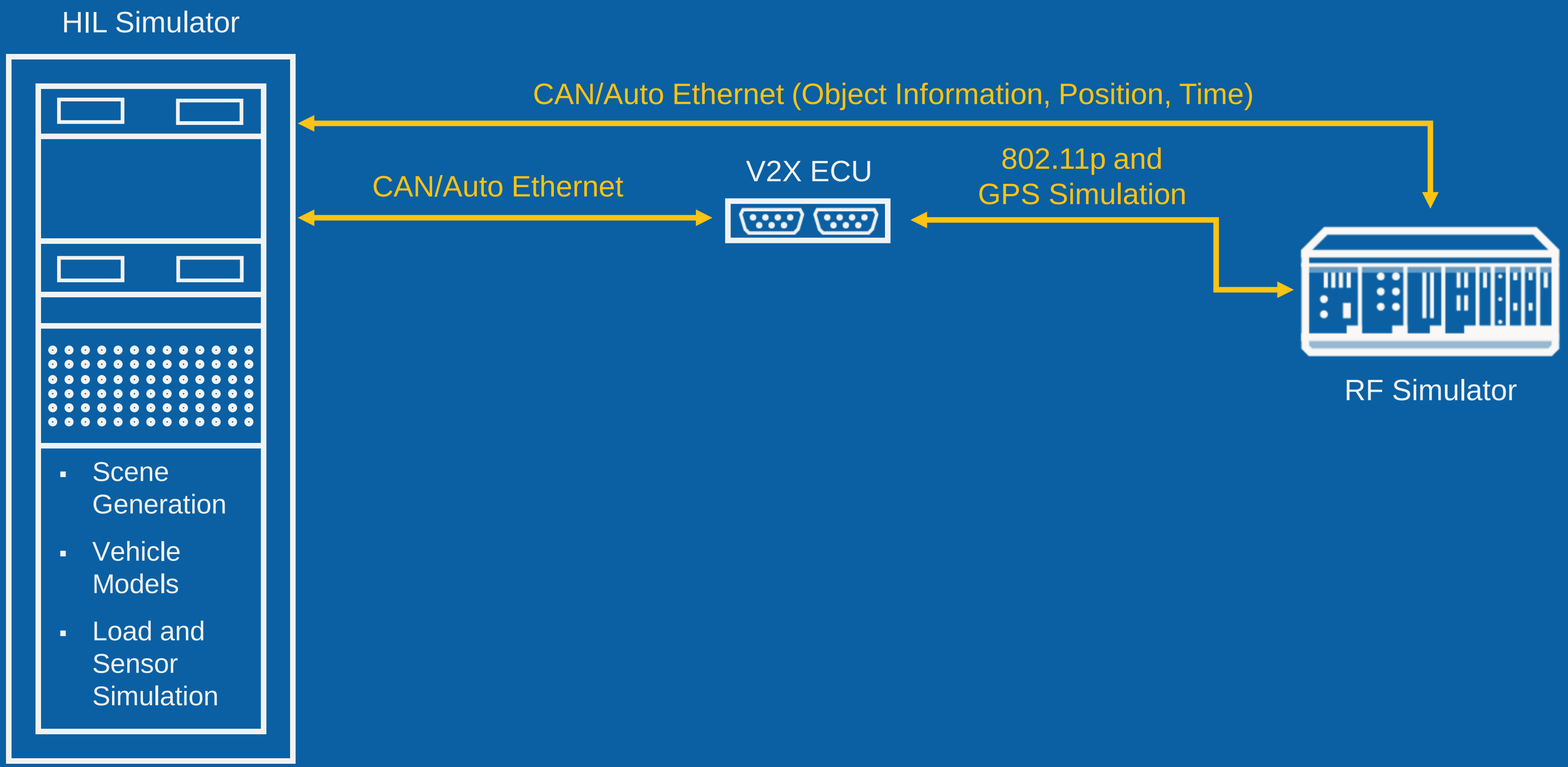
ni.com/smarter-test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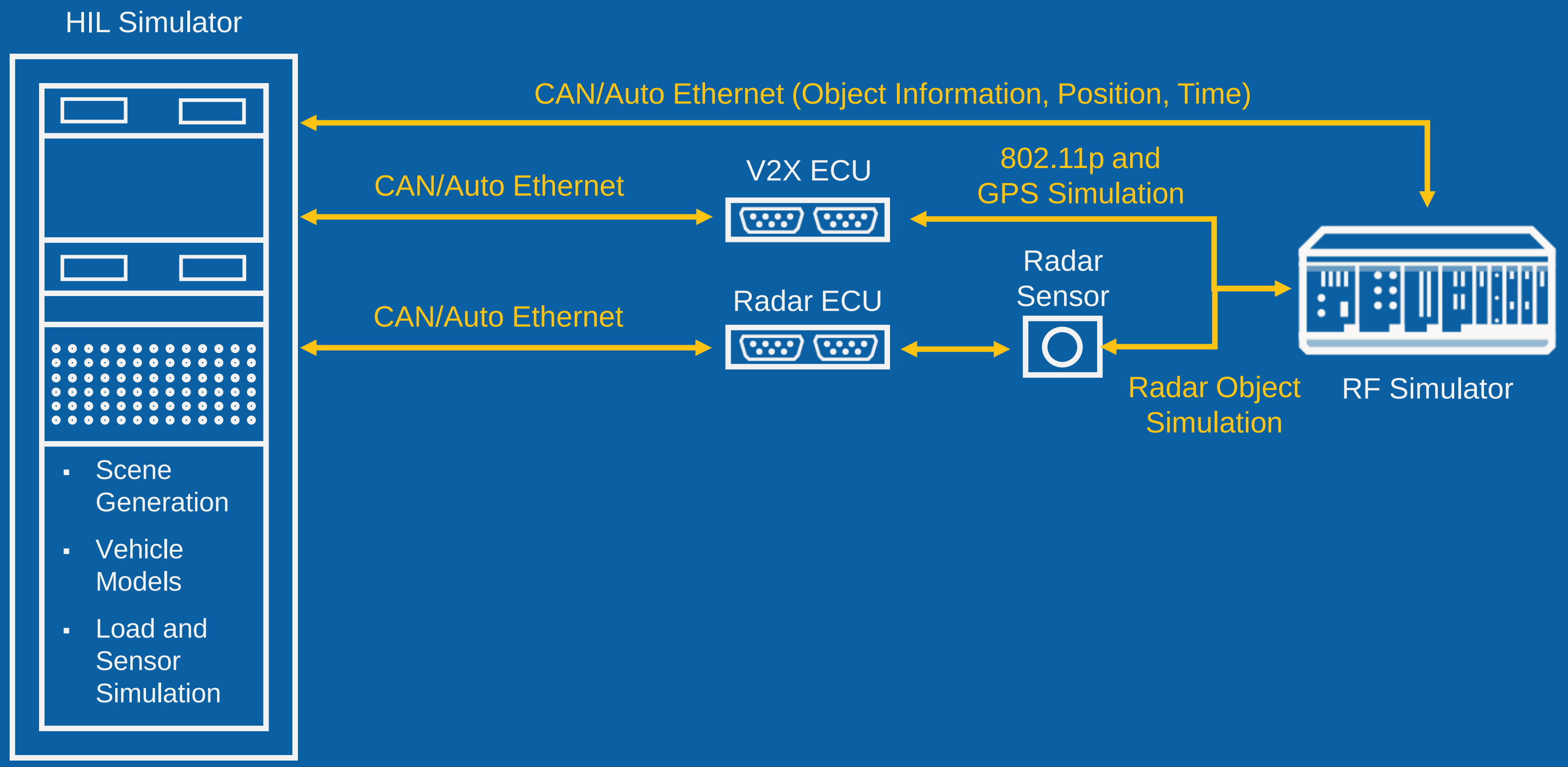

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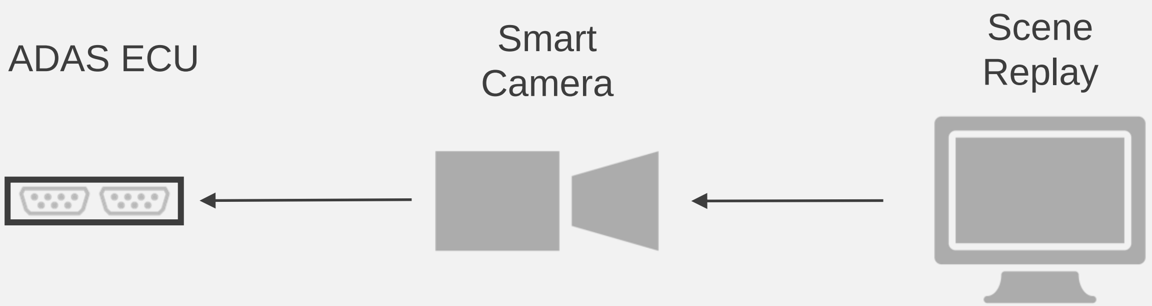
Camera

Challenges of Camera Test

Increasing Number of Cameras

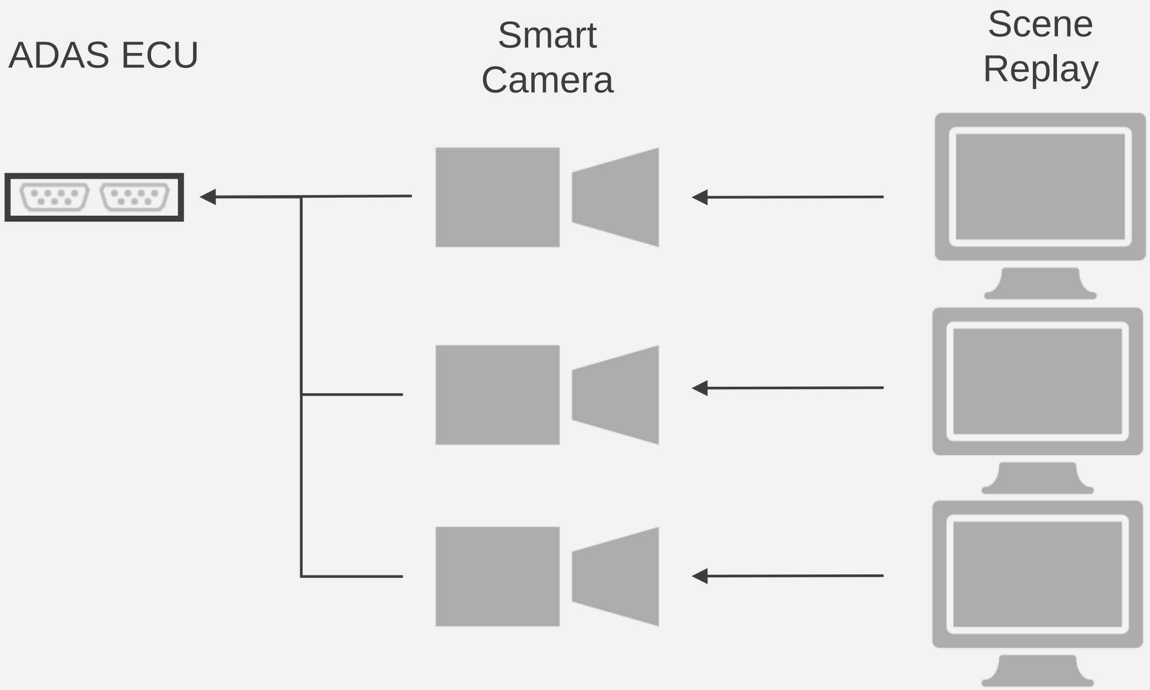
Properly Simulating Conditions

Approaches to Camera Test



Demo

Approaches to Camera Test



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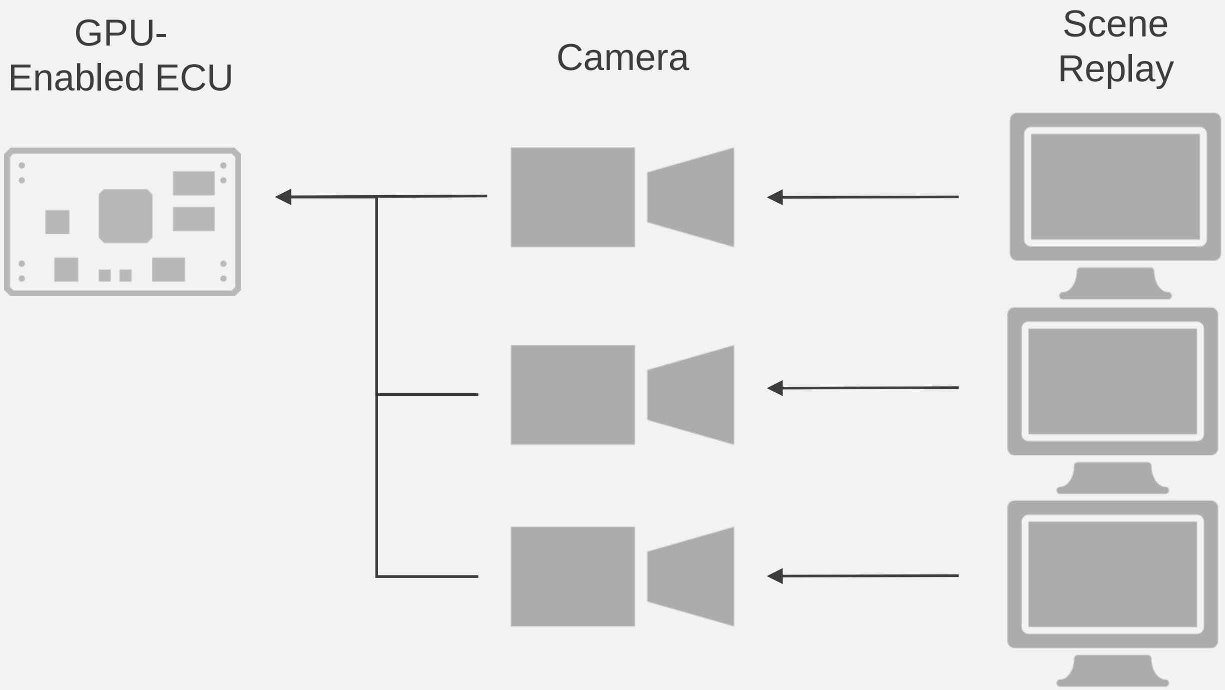

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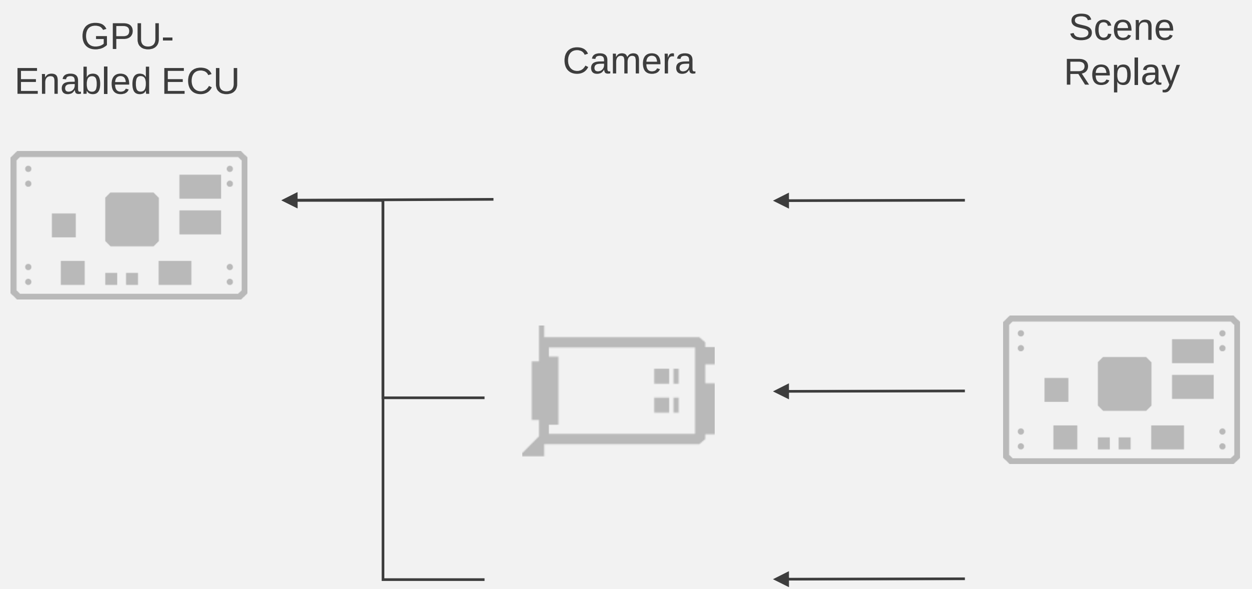


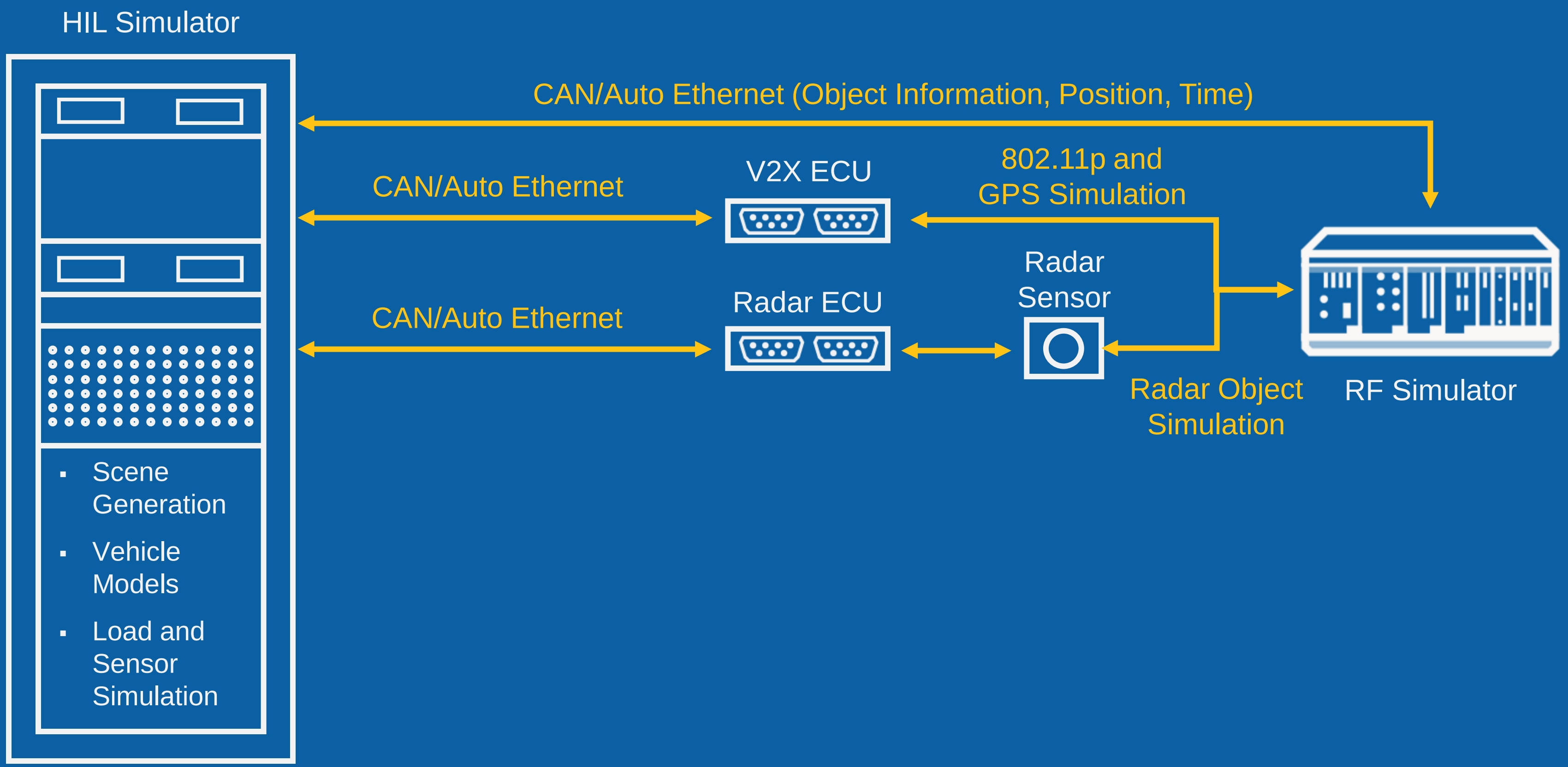
Image Manipulation With FPGA

Dropped Frames or Frame Delay

Noise and Error Injection

Bitstream Manipulation

Custom Protocols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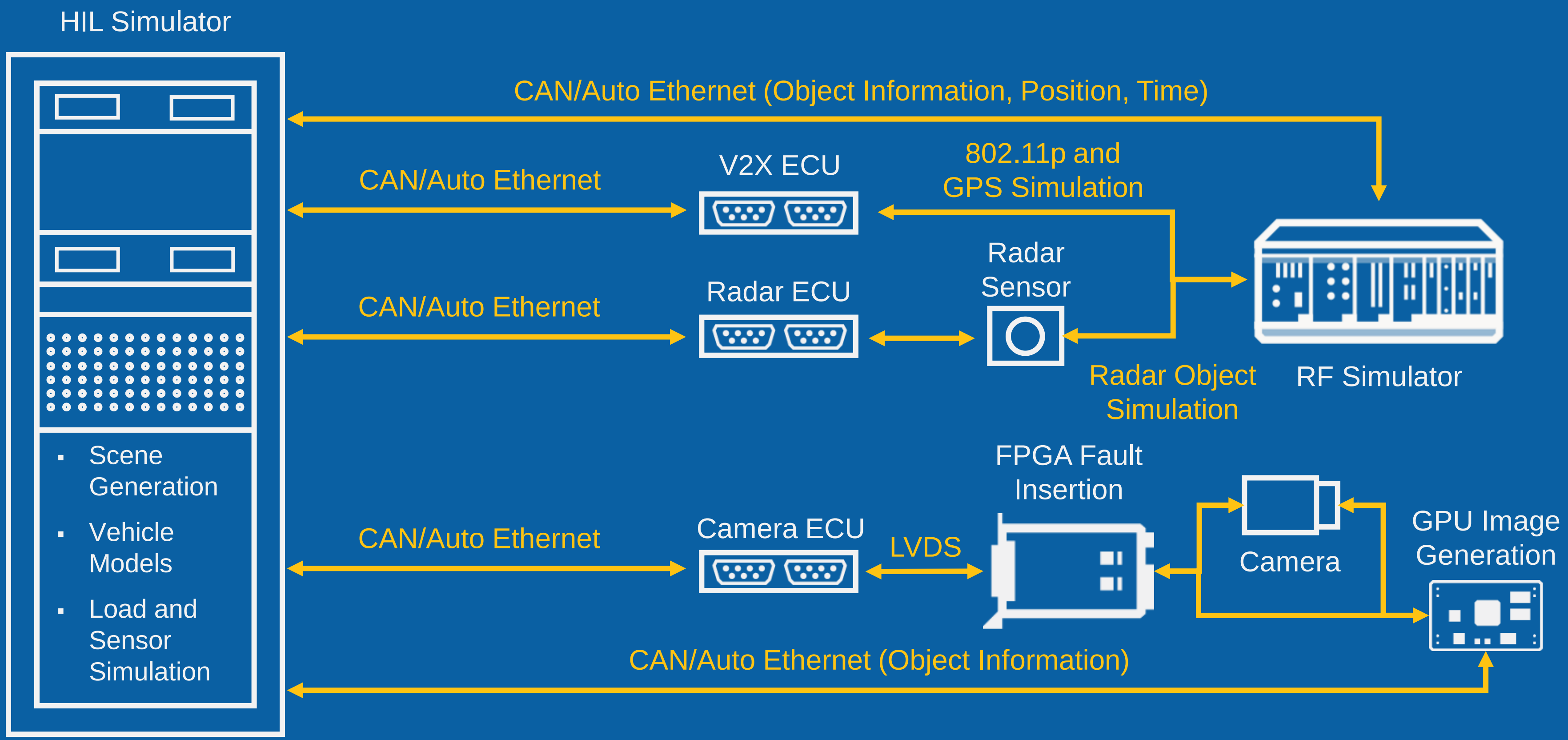

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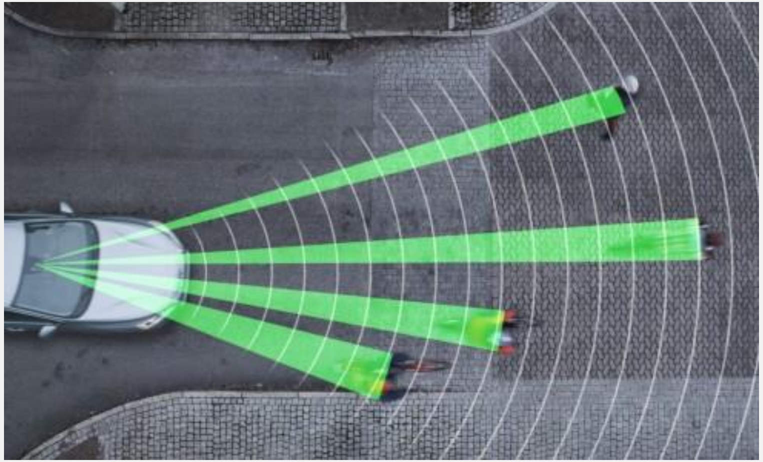
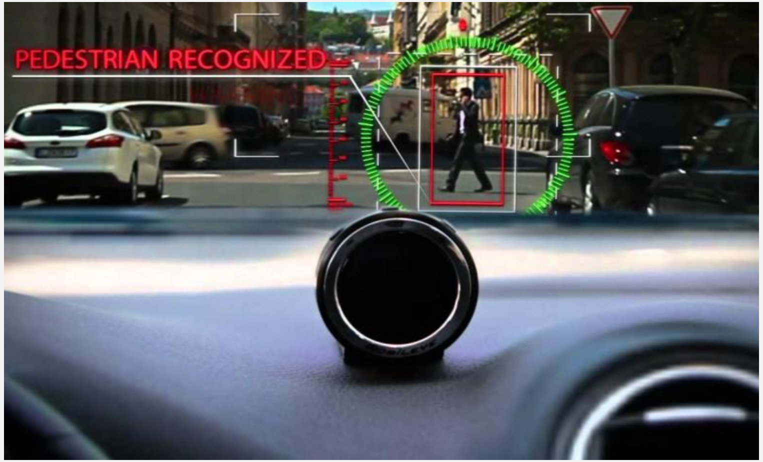
RF Simulator
FPGA Fault Insertion
CAN/Auto Ethernet
Camera ECU
LVDS
Camera
GPU Image Generation
CAN/Auto Ethernet (Object Information)

Sensor Fusion

Cameras and Radar Working Together



Object Detection Using Radar



Object Classification Using Cameras

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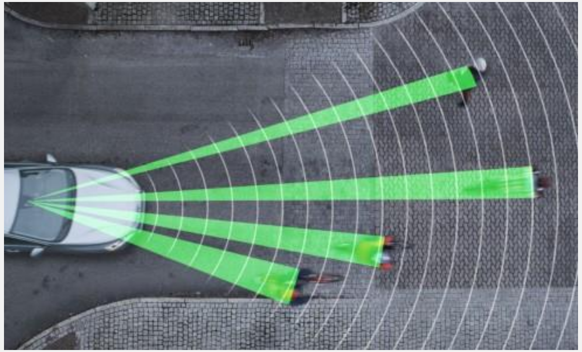
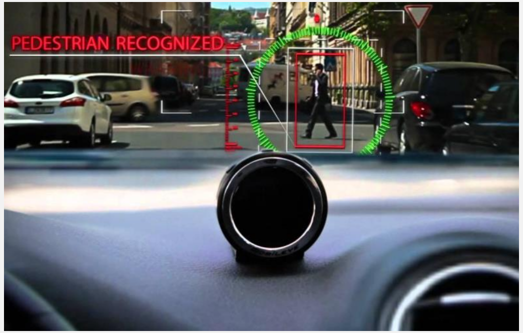
Cameras and Radar Working Together



Object Detection Using Radar

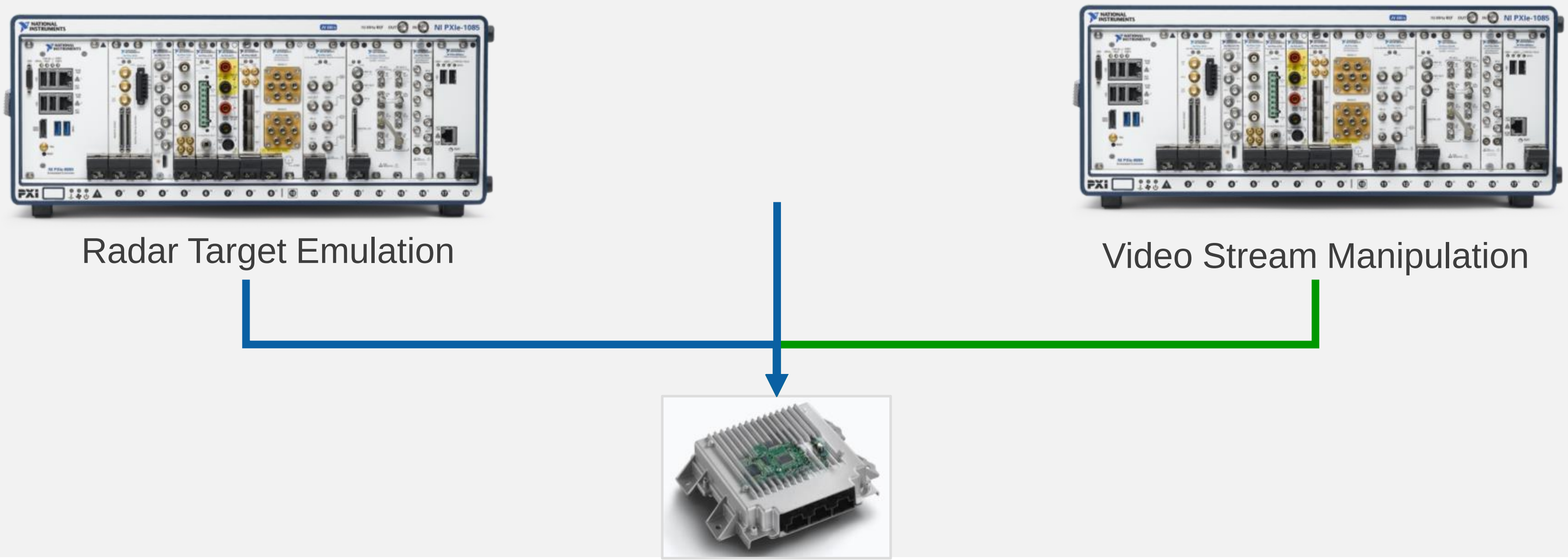
Synchronization



Object Classification Using Cameras

ADAS ECU for Safety Operations

Testing Sensor Fusion Embedded Software



ADAS ECU for Safety Operations

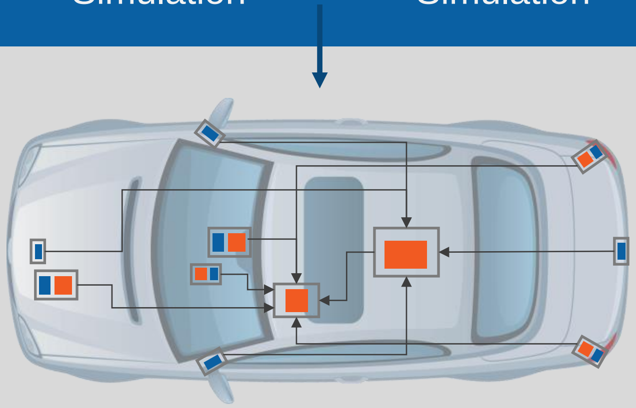
Hardware-in-the-Loop Test

CAN Interface

GNSS Simulation

Radar Target Simulation

Image Simulation



Camera

Radar

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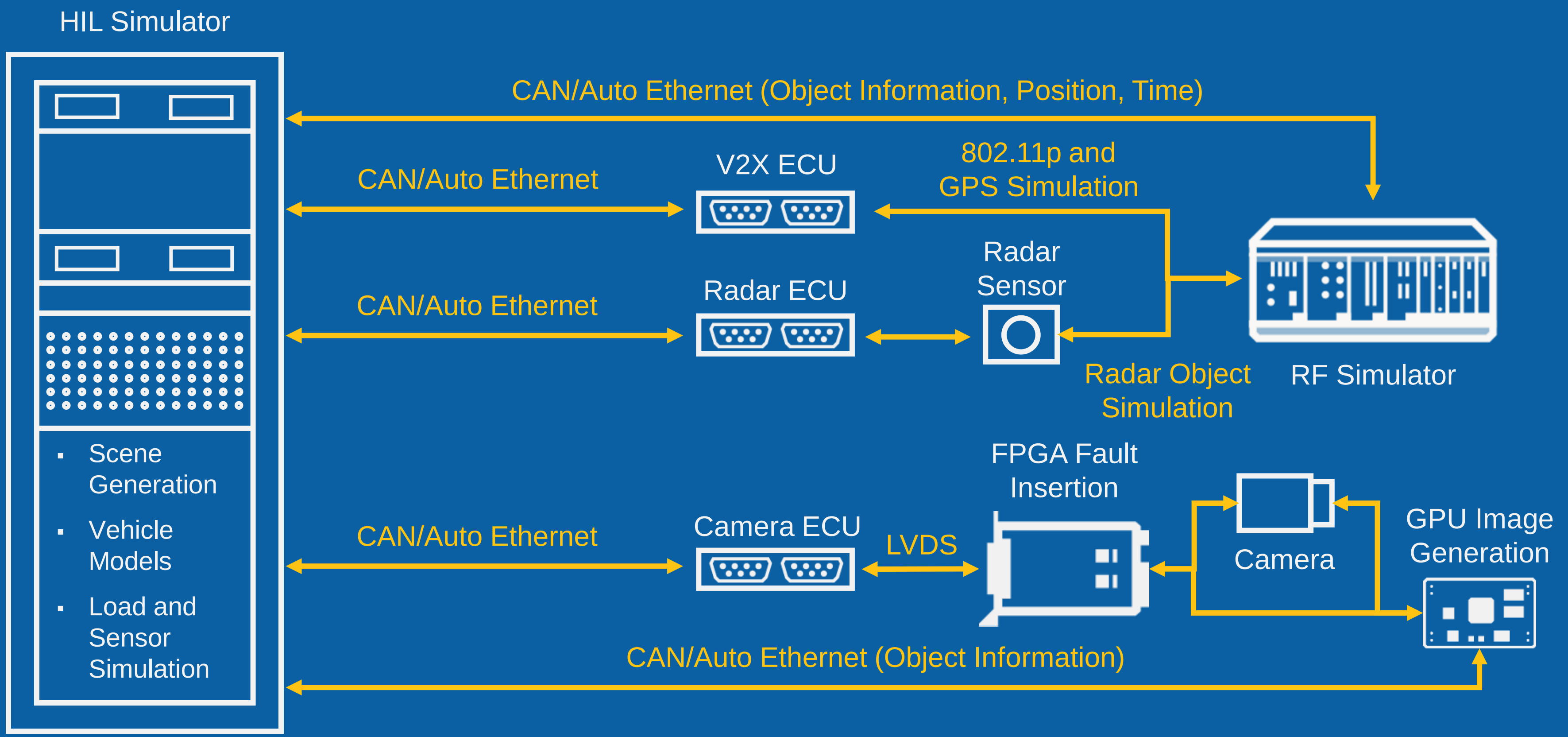
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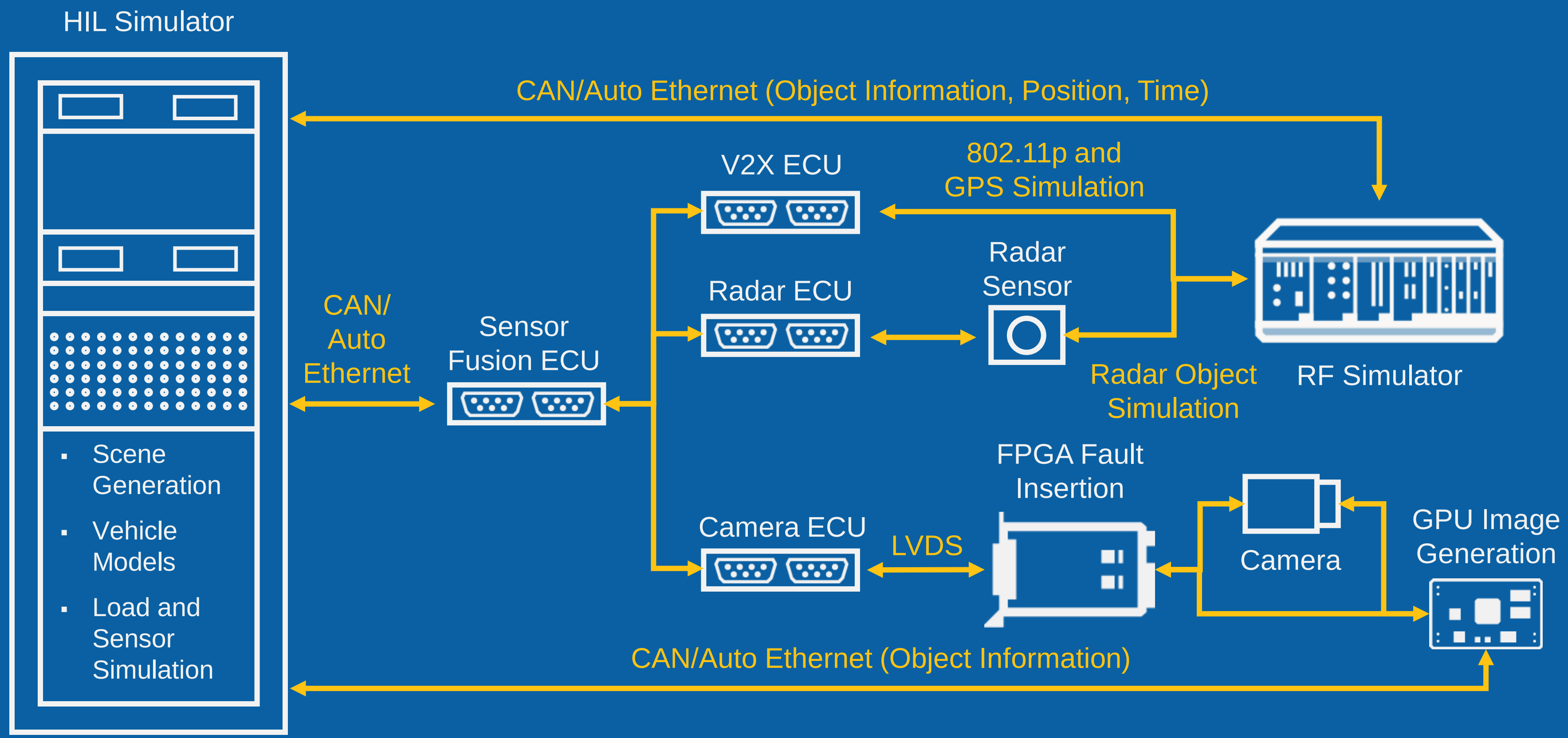
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