Designing Smarter, Safer Cars with Embedded Vision Using Synopsys EV Processor Cores

SYNOPSYS®

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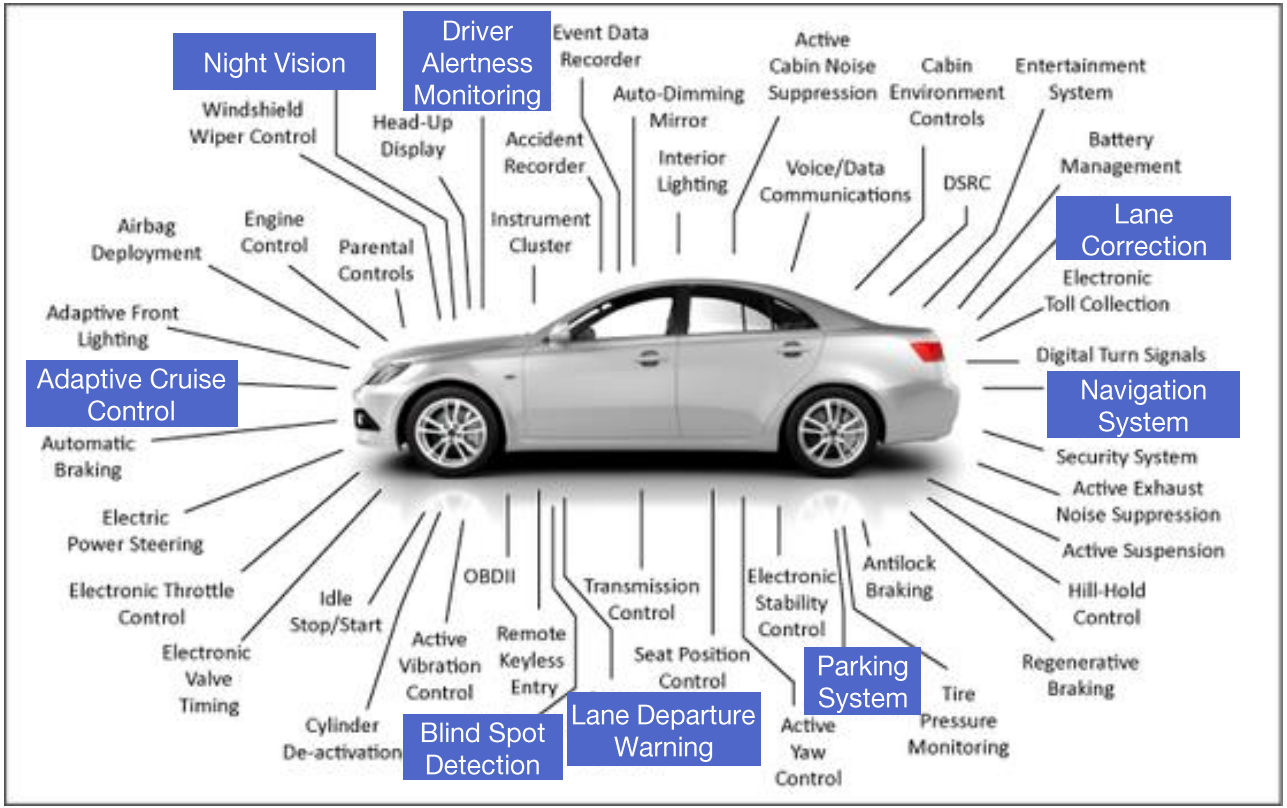
Processor Applications in a Car



Source: http://www.chipsetc.com/computer-chips-inside-the-car.html

Automotive Safety Integrity Level (ASIL)

ISO 26262:2011

embedded VISION SUMMIT 2018

Probability of Exposure + **Controllability by Driver** + **Severity of Failure** = **ASIL**

E0	Combination of Very low Probabilities
E1	Very Low Probability *(less often than once a year for the great majority of drivers)*
E2	Low Probability *(a few times a year for the great majority of drivers)*
E3	Medium Probability *(once a month or more often for an average driver)*
E4	High Probability *(almost every drive on average)*

C0	Controllable in general
C1	Simply controllable *(99% or more of all drivers are usually able to avoid a harm)*
C2	Normally controllable *(90% or more of all drivers are usually able to avoid a harm)*
C3	Difficult to control or Uncontrollable *(Less than 90% of all drivers are usually able or barely able to avoid a harm)*

S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries (survival possible)
S3	Life threatening injuries (survival uncertain), fatal injuries

		C1	C2	C3
S1	E1	QM		
	E2			
	E3			A
	E4		A	B
S2	E1			
	E2			A
	E3		A	B
	E4	A	B	C
S3	E1			A
	E2		A	B
	E3	A	B	C
	E4	B	C	D

Automotive ASIL Requirements

Near Future: Driver + Semi-autonomous Capability

ASIL B/C

Driver Assist

- Radar Acc **ASIL C**
- Front View Camera **ASIL B**
- Smart Rear View Camera **ASIL B**

ASIL D

Driver safety-critical

- Braking (inadvertent) **ASIL D**
- Airbag (inadvertent) **ASIL D**
- Electric Power Steering **ASIL D**
- Radar Acc **ASIL D**
- Front View Camera **ASIL D**
- Smart Rear View Camera **ASIL D**

Design Challenges for Automotive Devices

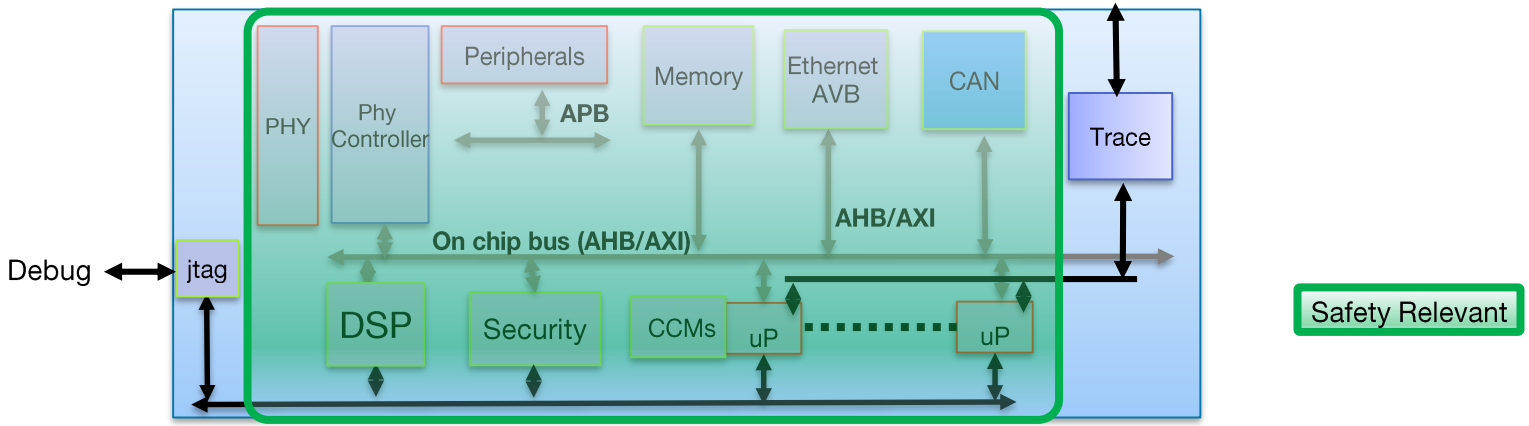
- Auto electronics increasingly complex – Vision, Radar, Lidar
- **Increasing safety requirements (ASIL-B -> ASIL-D)**

Trend	10 years ago	Now	+10 years
Electronics content	<20%	35%	50%
Lines of code	<10M	100M	>300M
User role in safety	Monitor	Driver Assisted	Driver Independent
Connectivity	None	Down-stream	2 way

Source: PWC 2015 auto trends, IEEE Spectrum, and Synopsys

REQUIRED: Safety Ready Vision Processor and SoC Architectures

Automotive SoCs Require ISO 26262 Functional Safety Compliance



- Goal is to minimize the susceptibility to random hardware failures by:
  - Defining the functional requirements
  - Taking necessary design measures
  - Applying rigor to the development process
  - Applying systematic analysis methods

DesignWare ARC Processor IP

Unrivaled Efficiency for Embedded Applications

EM Family

- Optimized for **ultra low power** IoT
- 3-stage pipeline w/ high efficiency DSP
- Power as low as 3uW/ MHz
- Area as small as 0.01mm^2 in 28HPM

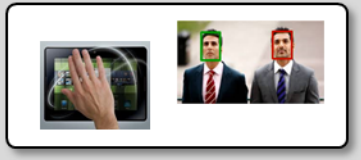
SEM Family

- **Security** processors for IoT and mobile
- Protection against HW, SW, and side channel attacks
- SecureShield enables Trusted Execution Environments

HS Family

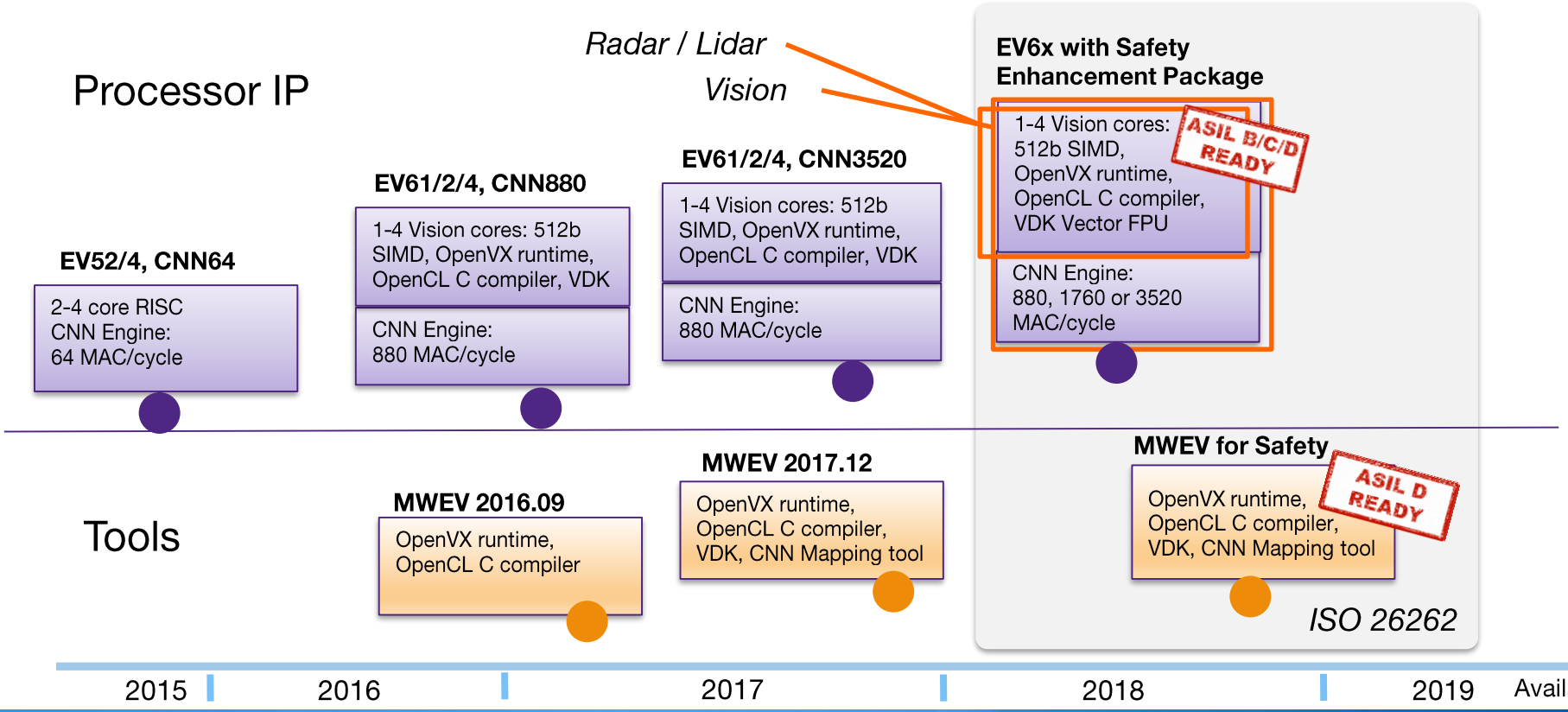
- **Highest performance** ARC cores to date
- High speed 10- stage pipeline
- SMP Linux support
- Single, dual, quad core configurations

EV Family



- Heterogeneous multicore for **vision** processing
- State-of-the-art convolutional neural network (CNN)
- High productivity, standards-based tool suite

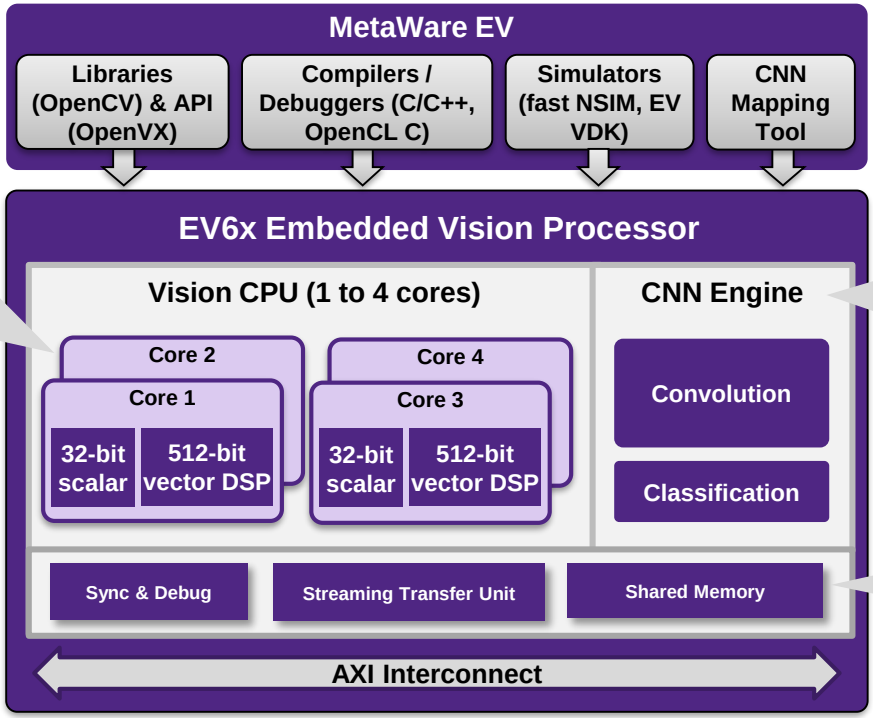
DesignWare IP Embedded Vision for Automotive



DesignWare EV6x Embedded Vision Processor IP

Scalable Hardware-Software Solution for High Accuracy Vision Processing

Wide Vector DSP Processing
Up to 256MACs/cycle

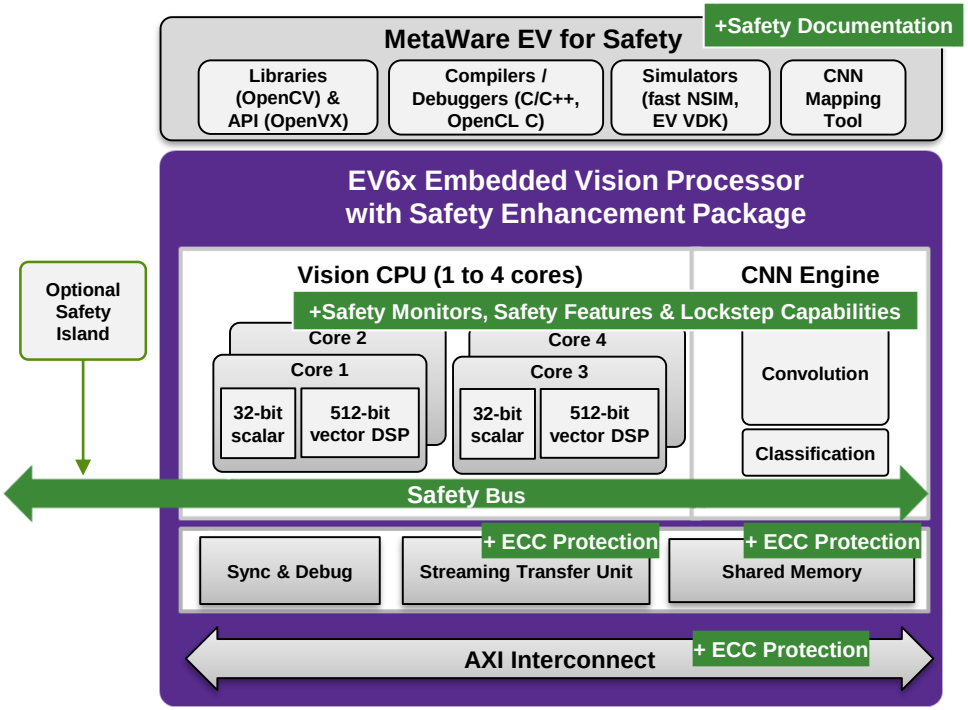


High-performance CNN Engine
- Up to 3520 MACs/cycle
- Supports 8 or 12 bit processing

Shared Memory
- Low latency access from all EV cores

EV6x Processor for Safety

ASIL D Ready Embedded Vision Processing Architecture



- **EV Safety Features**
  - Integrated ECC memories (Address + Data) protection – ASIL-D ready
  - Dedicated Safety Monitor and Watchdog timer
  - Dual Core Lock Step Scalar Processor Cores
- **Optional ASIL D Safety Island**
  - Responsible for EV Processor “safety” bring-up
  - Boot-time LBIST & MBIST control
  - Monitors and executes Safety escalations
- **State-of-the-Art Safety Bus Architecture**
- **MetaWare EV for Safety**

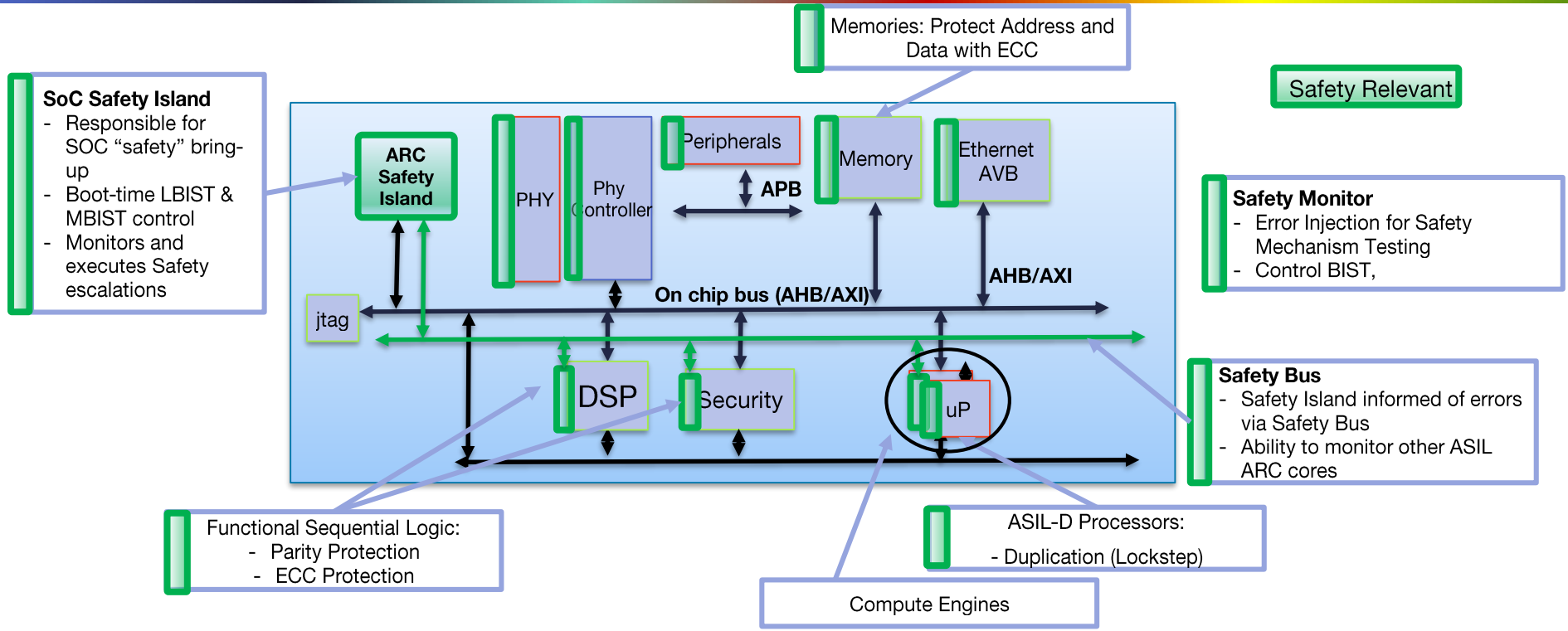
Effectiveness of Diagnostics

ISO 26262 Guideline for Safety Mechanism to Detect Failures of Elements

Diagnostic Type	Effectiveness	Notes
HW Redundancy	High - 99%	5.D.2.3.6
Configuration Register Test	High - 99%	5.D.2.3.7
Parity Bit - per Word	Medium - 90%	5.D.2.5.2
EDC on Memory	High - 99%	5.D.2.4.1
Multi-bit HW redundancy	Medium - 90%	5.D.2.7.2
Timeout monitoring	Medium - 90%	5.D.2.7.8
Frame Counter	Medium - 90%	5.D.2.7.7
Information Redundancy	Medium - 90%	5.D.2.7.6, 5.D.2.7.5
Combination of Timeout monitoring, Frame Counter and information Redundancy	High - 99%	5.D.2.7.5 to 5.D.2.7.8
Self-test supported by Hardware	High - 99%	5.D.2.3.2

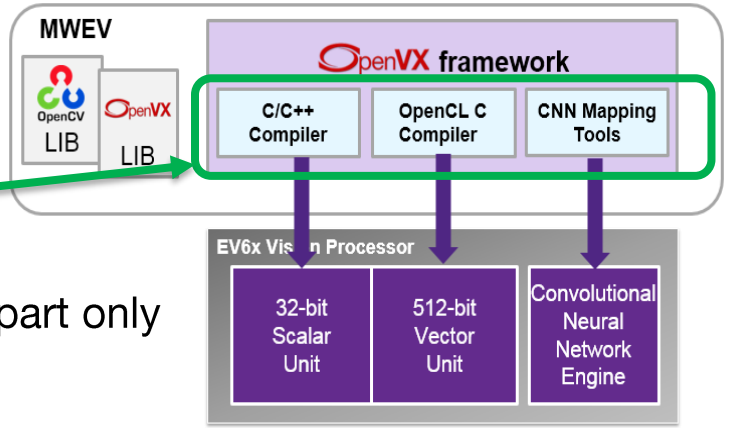
Source: ISO 26262-5 Annex D

ISO26262 Compliant ADAS SoC Safety Architecture



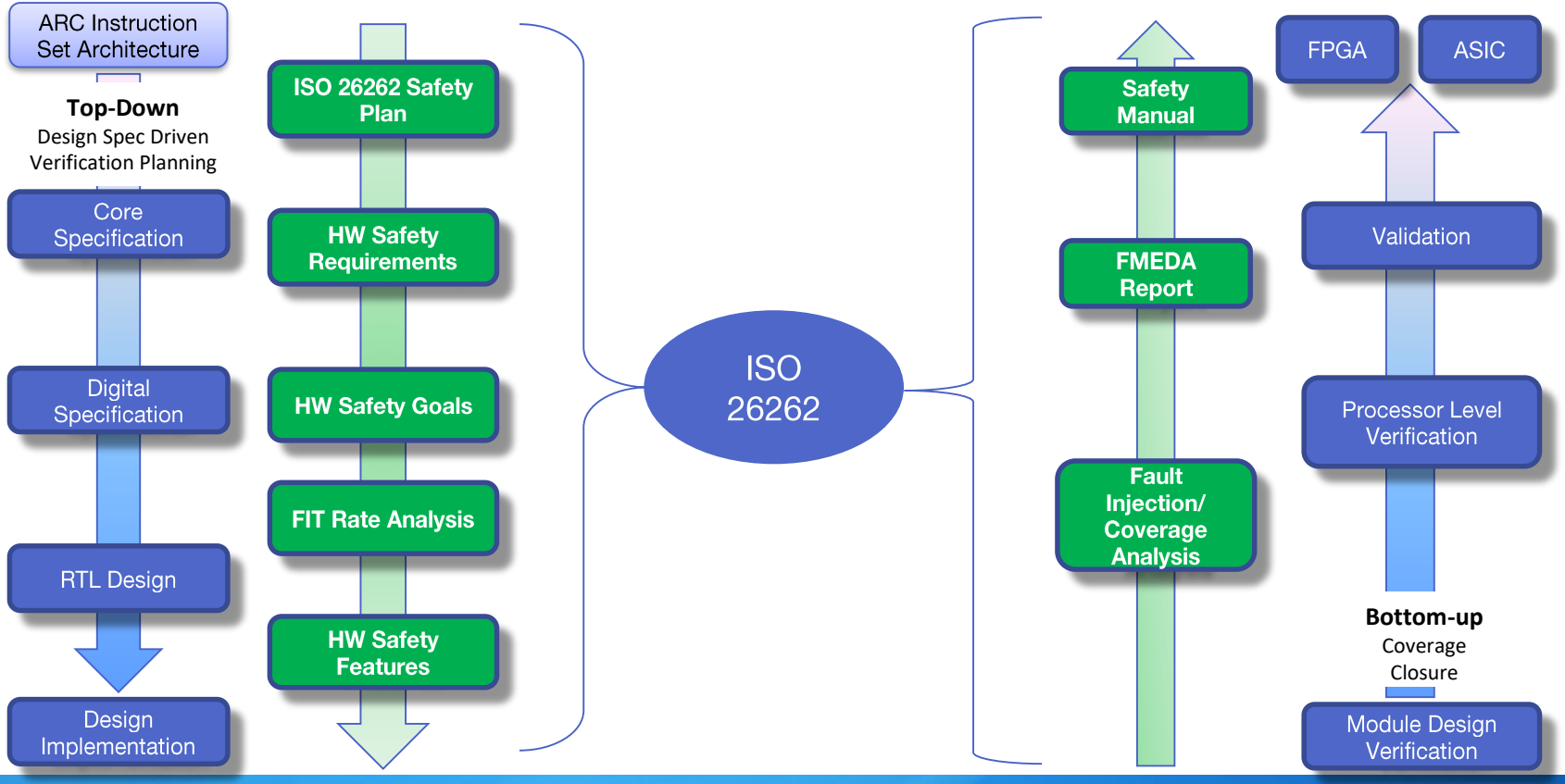
Scaling the Safety Architecture across the ADAS SoC

MetaWare EV for Safety



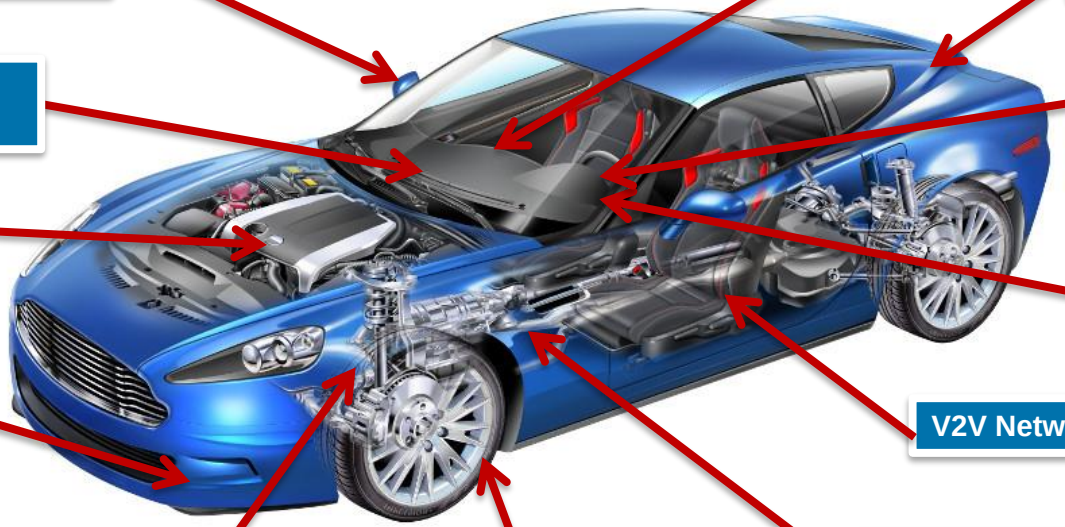
- **MetaWare EV for Safety**
  - All three code generator components will be safety certified according to ISO 26262-8, clause 11
    - C/C++ Compiler
    - OpenCL C compiler toolchain
    - EV CNN SDK – mapping tool (code generator) part only
  - **Includes EV runtime software implementation based on OpenVX SC**
    - Based on OpenVX 1.1 specification
    - OpenVX SC defines modifications to OpenVX targeted at safety critical systems
    - Leverages OpenVX 1.2 import/export extension to define a run-time-only "deployment feature set" exported as verified graph in binary format

Adapting SoC Design Development to ISO26262



Synopsys ARC Processor Presence in Automotive

Sample of ARC & EV Application Usage



Infotainment

Keyless Entry

Control for mirror, window, lighting, etc

ADAS

Gyros, Accelerometers

Power Steering

Pressure/Flow Sensors

Airbag sensor/control

Radar

V2V Networking

ABS Sensor/ Contrl

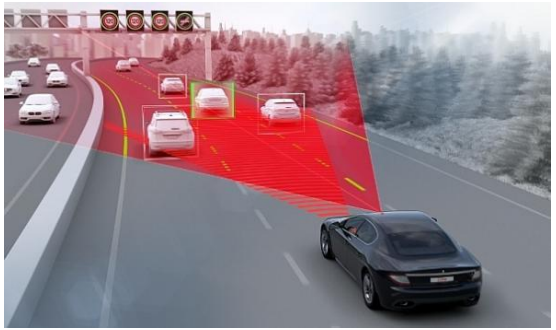
Temp/Pressure Sensors

Powertrain

EV6x Customer Case Study: Automotive Radar SoC

Advanced Driver Assistance System (ADAS) for Vision

- Product: 4D high-resolution automotive radar SoC for autonomous vehicles
- Requirements:
  - High level of processing capabilities
  - Integrated safety features to detect & prevent system failures
- Chose Synopsys due to high performance & ASIL D Ready safety features
  - ASIL D Ready EV62 Embedded Vision Processor & ARC EM6 Safety Island
    - Support lockstep operation to enable the highest automotive safety level
  - ASIL D Ready ARC MetaWare EV Development Toolkit for Safety



- Comprehensive safety documentation, including FMEDA reports, facilitate chip- & system-level ISO 26262 ASIL D & B compliance

Summary

- **ADAS: Fastest growing automotive application: 25% CAGR '14-21**
- **Synopsys provides ISO 26262 Safety Features integrated into Automotive IP**
  - Embedded Vision for Automotive Processors
  - ARC EM & HS ARC Safety Ready Processors
- **Synopsys Provides Comprehensive Portfolio of Development and Verification Tools**
  - Tailored for Automotive SoC Development
- **Quality & Safety Culture**
  - 30 years of Quality culture
  - Safety council including >20 safety managers

www.synopsys.com/designware

Resources

- Visit **www.synopsys.com/EV**
- Visit the Synopsys booth to check out demos:
  - *Accelerating Android Neural Network Performance with DesignWare EV6x*
  - *Real-Time Object Classification & Tracking with DesignWare EV6x*
  - *AI, 3D Imaging & SLAM on-a-Single Chip for Embedded Markets (by Inuitive)*
  - *Face Recognition for Driver Monitoring System (by PathPartner)*
- Limited space available for tomorrow's Synopsys Workshop – **See me to sign up!**

Thank You

SYNOPSYS®

Fergus Casey, R&D Director