SYNOPSYS®
Silicon to Software™

Addressing Processing, Safety and Security Needs for Evolving Automotive SoCs

Rich Collins, Director of Product Marketing, ARC Processors

Synopsys ARC® Processor Summit 2022

Agenda

- **Functional Safety Trends**
- **Functional Security Introduction**
- **ARC Functional Safety Processors**
- **Functional Safety Software and Tools**
- **Reference Designs and the Road Ahead**
- **Summary**

Roadmap to Automation: Driver Driven to Driverless Vehicle

Driver Only

Drivers undertakes lane and holding lane changing activities

LEVEL 0

No intervening vehicle system active

Assisted Driving

Drivers carries out all lane holding or lane changes

LEVEL 1

Systems handles the other function

Partly Automated

System handles lane holding and lane changes in special application case

LEVEL 2

Systems handles lane holding and lane changes in a special application case

Highly Automated

Drivers needs no longer continuously monitoring the system. Must potentially be available to take over

LEVEL 3

Systems handles lane holding and changing in a specific application case. Detects limits of system and asks the driver to take over with sufficient warning

Fully Automated

No driver is necessary in special application

LEVEL 4

Systems handles lane system can handle all situation automatically in the specific application case sufficient warning

Driverless

LEVEL 5

Systems can handles all solutions automatically throughout the trip no driver needed

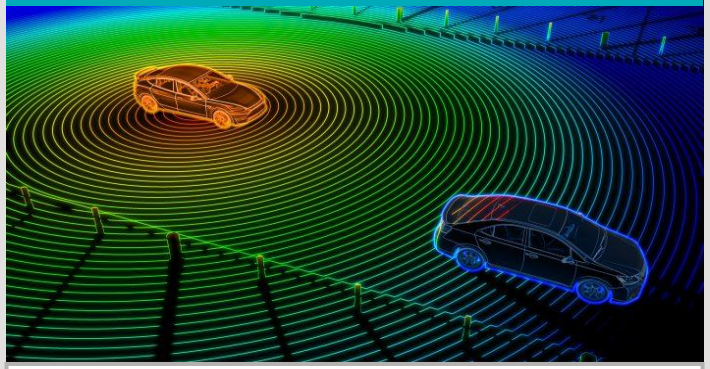
Source: Frost & Sullivan: VDA Automotive SYS Konferenz 2014

Roadmap to Automation – FuSa Applications

Embedded Vision

- Analyzes camera data for safety-enhancement and autonomous driving
- Expert-level accuracy in classifying objects in fractions of a second
- Example Use Cases:
  - Lane departure detection
  - Parking assist / self-parking

Radar/LiDAR



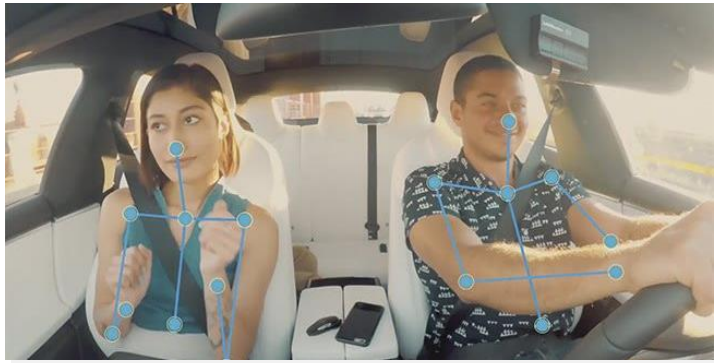
- Key components of Level 3+ and autonomous vehicles
- Essential in night driving, conditions of rain and fog
- Example Use Cases:
  - Blind spot detection
  - Collision avoidance systems

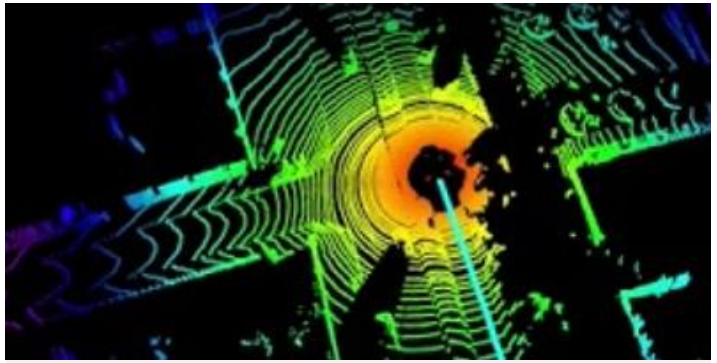
Factory Automation

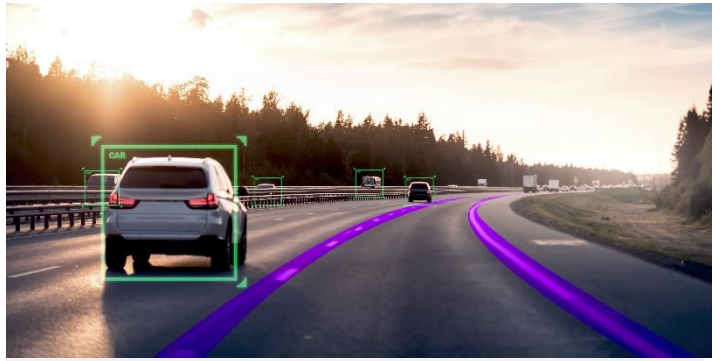
- Industrial standards & requirements similar to automotive
- Reduces the risk of injury, provides consistent quality, & minimizes waste
- Example Use Cases:
  - Industrial motor drives
  - Safety controllers

Automotive Applications Require Scalable NN Performance

High-end Vision Requirements on the Rise







Automotive in-cabin cameras

Automotive RADAR / LiDAR

Automotive rear cameras

Automotive side cameras

Automotive front cameras

<1 TOPS

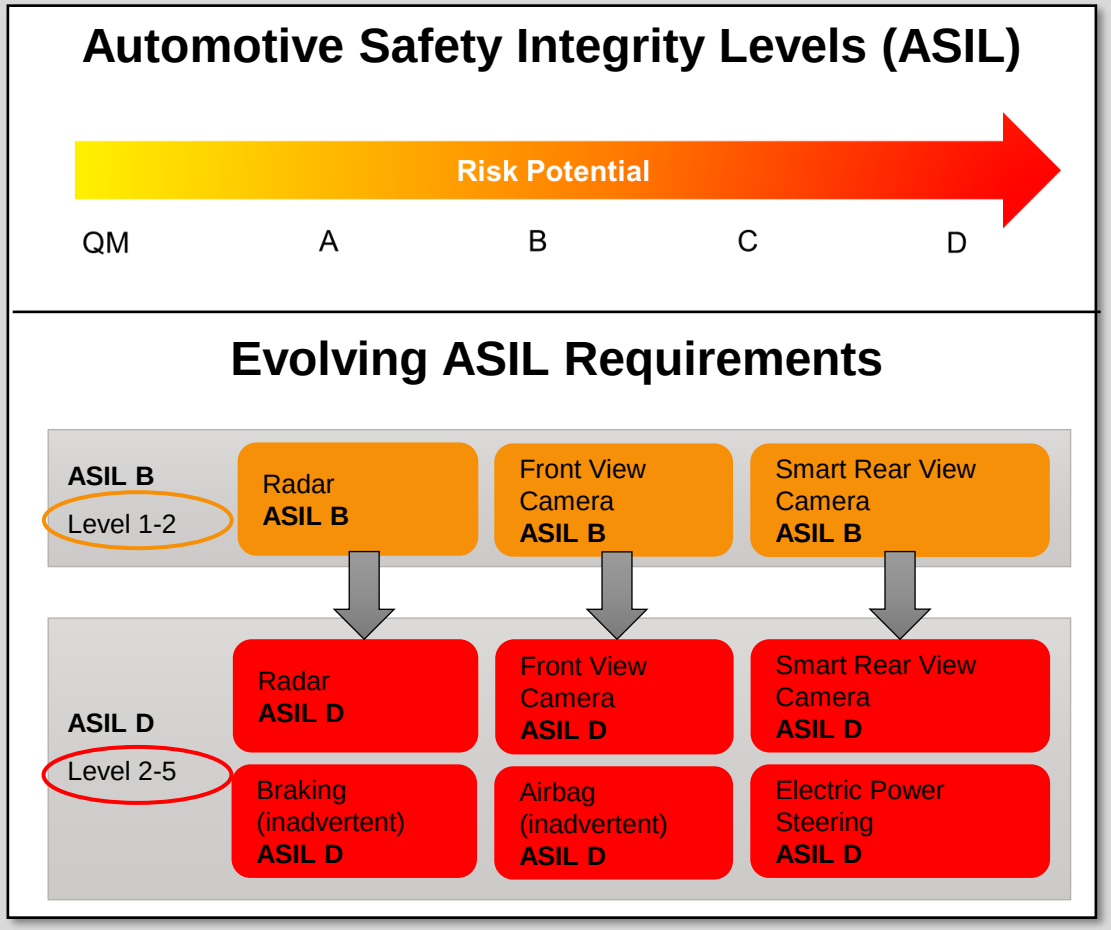
1 to 50 TOPS

50 to 1000+ TOPS

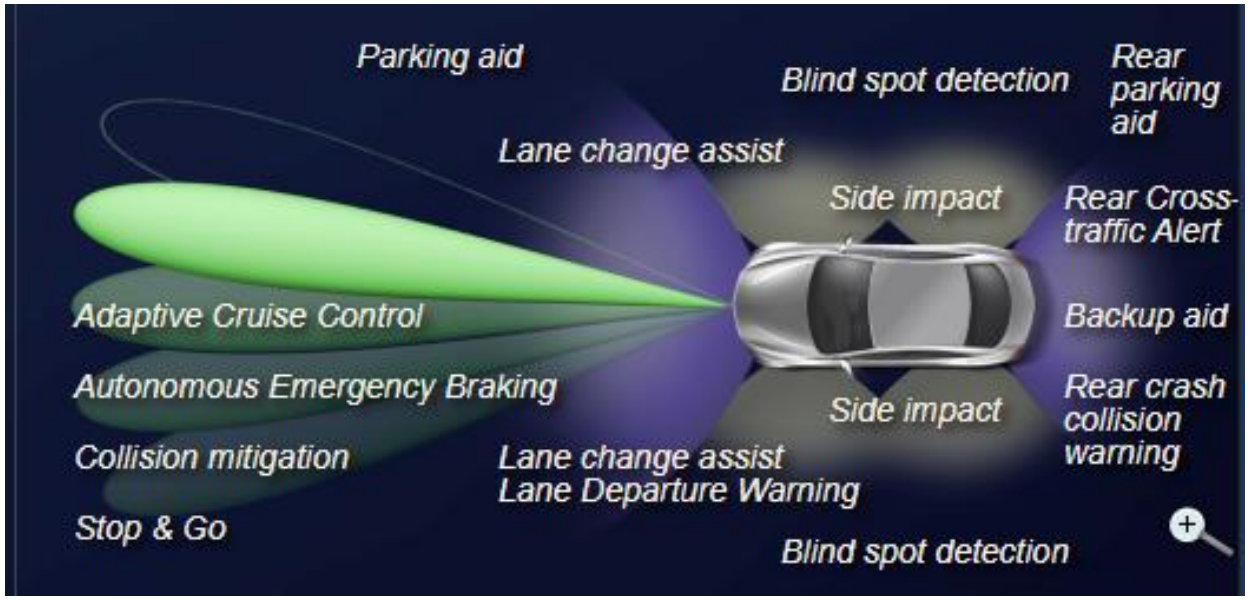
Automotive Functional Safety

ISO 26262 Standard Focuses on Safety-Critical Components

- "Safety-Critical" systems must be designed to minimize risk of catastrophic failures and respond to failures in a predictable manner
- ICs in these systems must meet ISO 26262 functional safety requirements
- Automotive Safety Integrity Level (ASIL) designates risk potential, from QM (lowest) to D (highest)



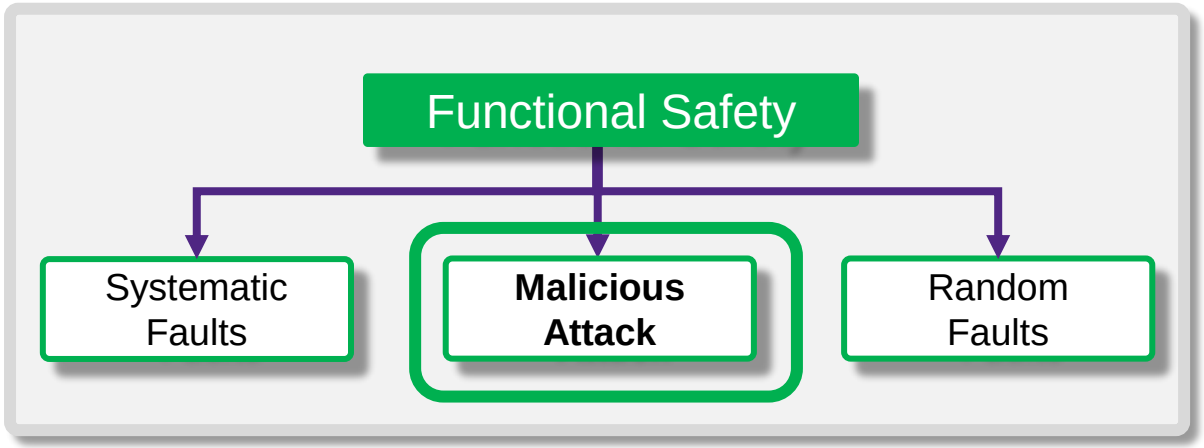
Automotive ADAS Safety Trends



Application	Level/ASIL 2015	Level/ASIL 2024
Adaptive Cruise Control (ACC)	Level 1-2/ASIL-B	Level 2-3/ASIL-C/D
Blind Spot Detect (BSD)	Level 1-2/ASIL-B	Level 2-3/ASIL-C/D
Forward Collison Warning (FCWS)	Level 1-2/ASIL-B	Level 2-3/ASIL-C/D
Lane Departure System (LDWS)	Level 1-2/ASIL-B	Level 2-3/ASIL-C/D

Functional Safety Gains a Partner

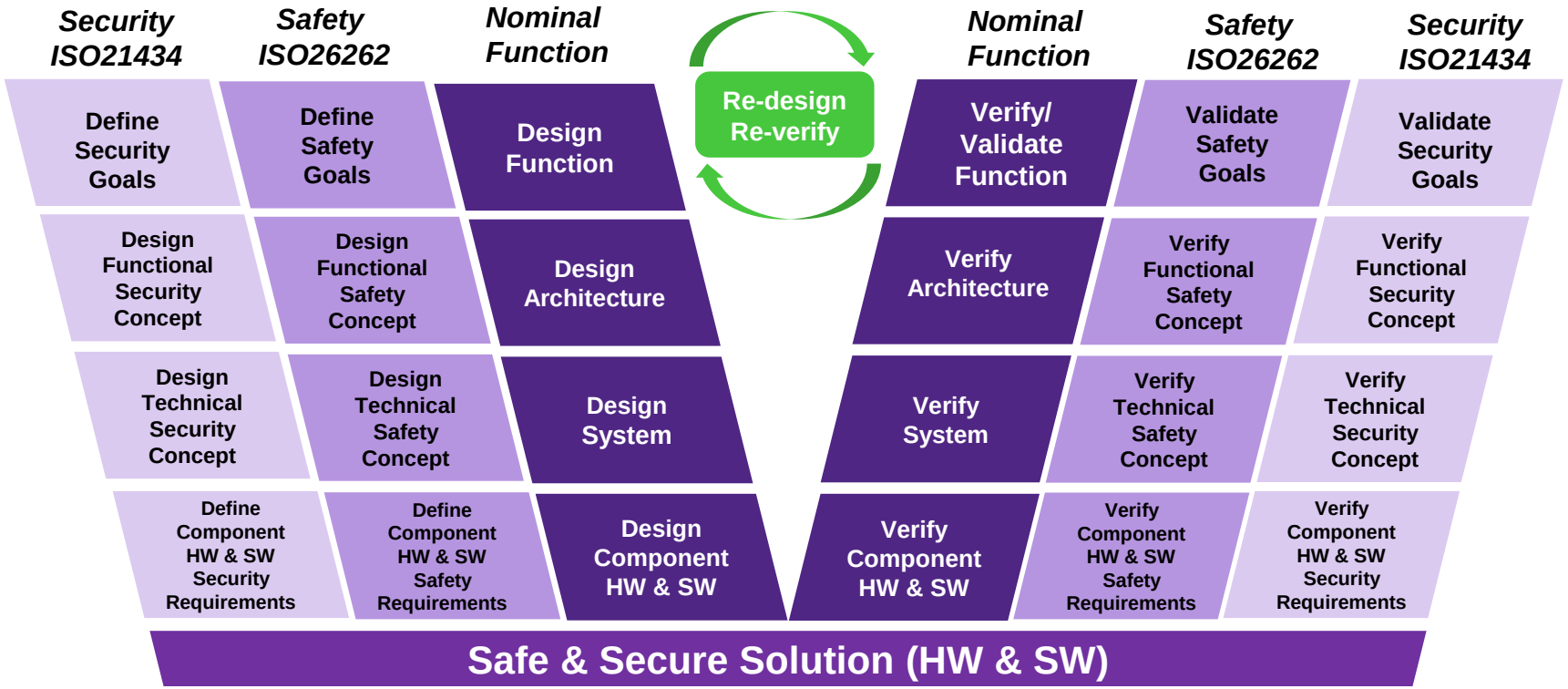
Protection from Malicious Attacks ISO 21434 / SAE J3101



Fault Type	Definition	ISO Standard
Systematic Faults	Applicable to HW and SW, introduced through development	ISO 26262
Random (Permanent) HW Faults	Occurs unpredictably during the lifetime of the product Fault stays until removed or repaired	ISO 26262
Random (Transient) HW Faults/Soft Errors	Occurs unpredictably during the lifetime of the product Fault occurs once and subsequently disappears, e.g. bit flip in SRAM or logic due to alpha radiation	ISO 26262
Malicious Attack	Can occur unpredictably during the lifetime of a hardware element	ISO 21434 / SAE J3101

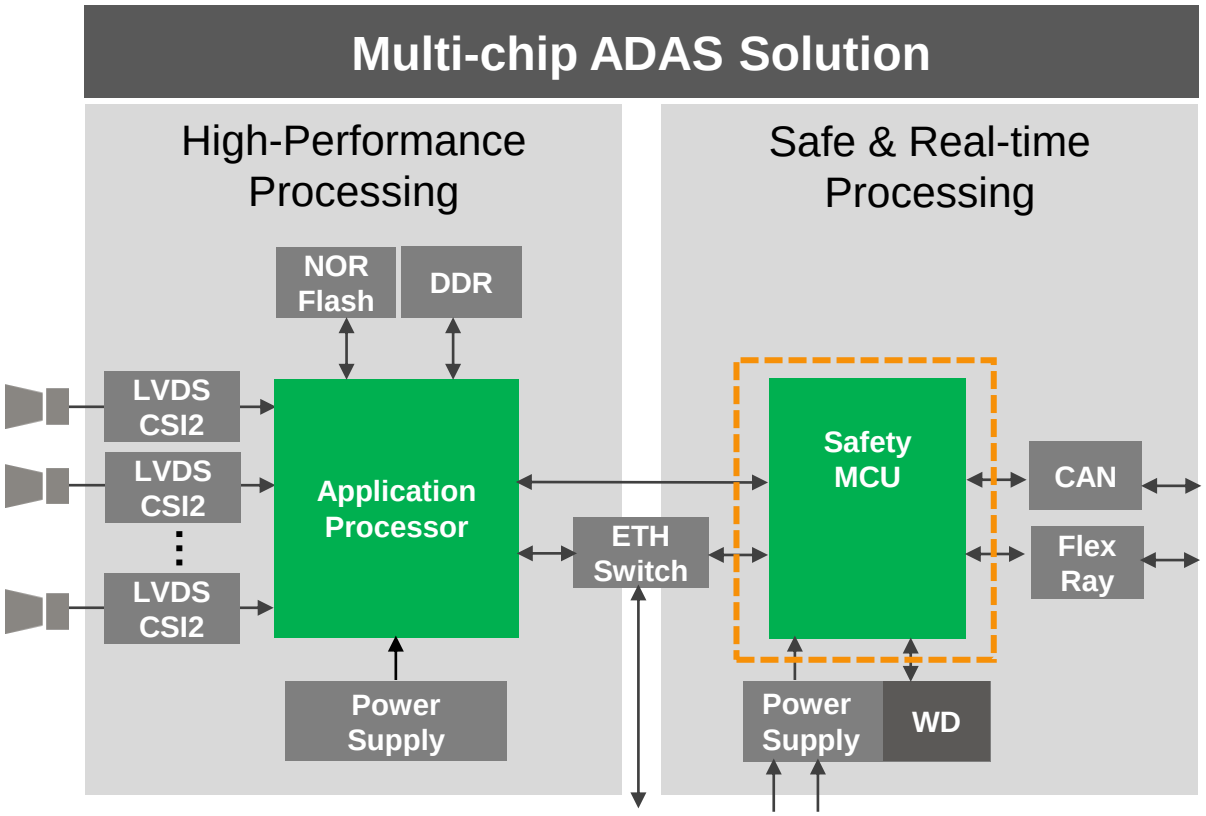
Safety & Security Go Hand-in-Hand

ISO26262 and ISO21434

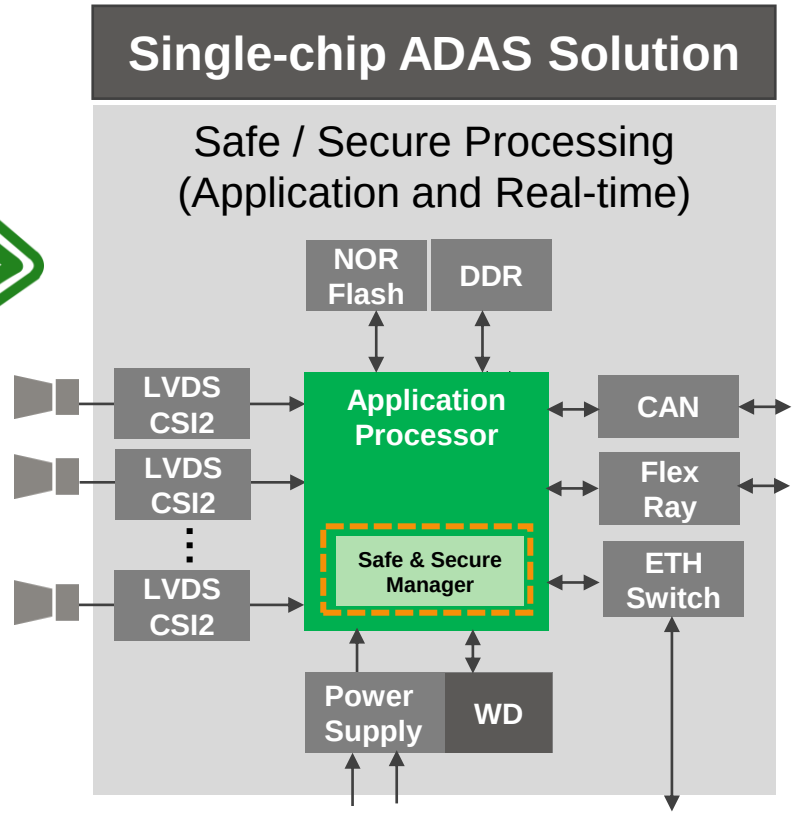


- Both standards provide a set of guidelines:
  - *ISO26262 (FuSa): Achieve safety goals while developing automotive solutions*
  - *ISO/SAE 21434: Protection against cyberthreats*
- Both processes start with detecting risks and threats, and finding a way to mitigate them
- As the automotive industry becomes increasingly reliant on software, vehicles need to be as cyber secure as they are safe

ADAS ICs Moving From Discrete to Integrated Safety/Security Solutions



3rd Party SoC's Used as Safety MCUs



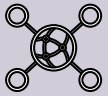
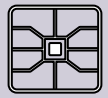
"Safety/Security Manager" Integrated On Chip

Integrated ISO26262 & ISO21434 compliant safety/security manager lowers system costs, reduces power & area

Synopsys Leveraging a Culture of Safety

Unmatched Investment in Automotive Grade IP

SGS TÜV SAAR ASIL D COMPLIANT Functional Safety ISO 26262 www.sgs-tuev-saar.com

	Synopsys Automotive IP
 **Interface**	• USB 2.0 & 3.0 / DisplayPort • Ethernet TSN / QoS • MIPI CSI-2/DSI & C/D-PHY; I3C • PCI Express 3.0, 4.0 & 5.0; CXL
 **Memory**	• Embedded Memories, TCAMs • LPDDR5/4/4X • NVM
 **Processors**	• ARC EV AI / ML Processors • ARC EM & HS FuSa Processors • ARC VPX Digital Signal Processors • ARC SEM Security Processors
 **Security**	• Hardware Security Modules (HSM) • Encryption & Decryption • Secure Boot and Access Control

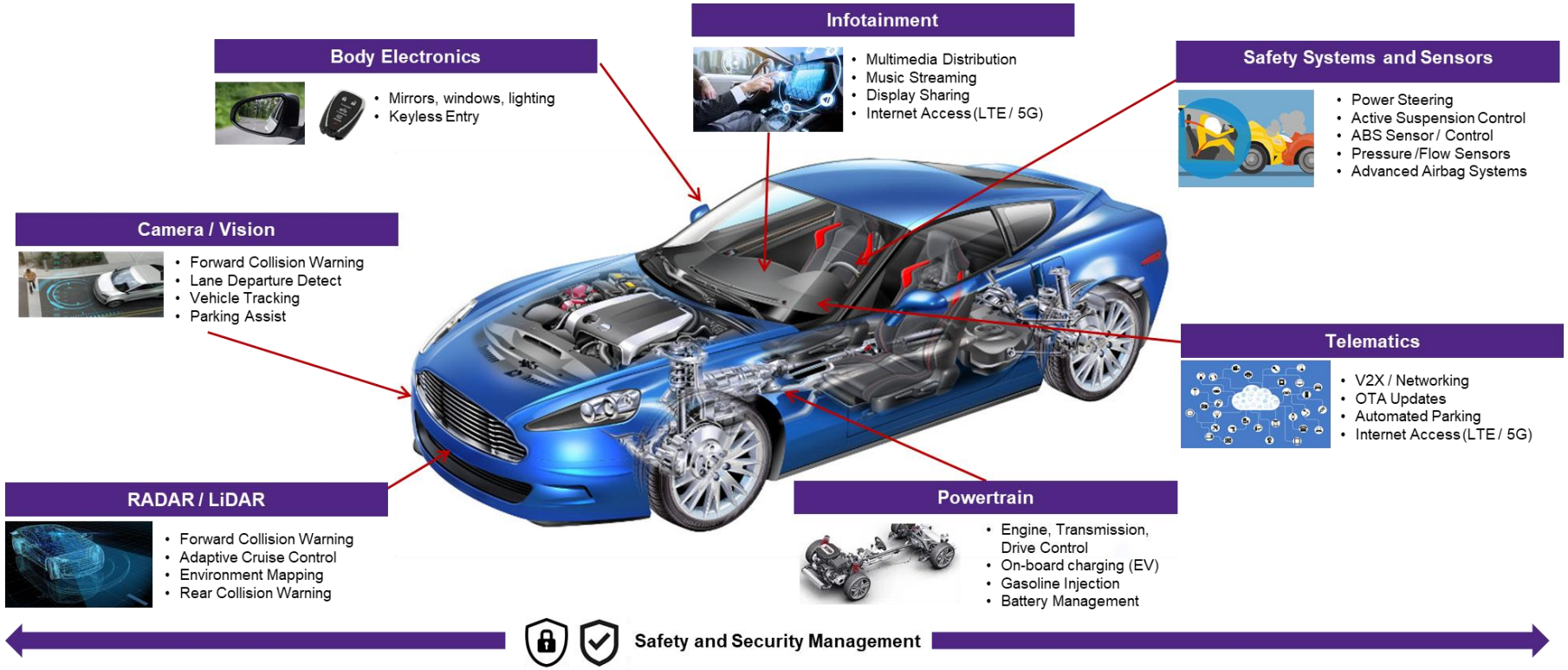
- Safety a major distinction between Synopsys and others – reducing risk and accelerating qualification for automotive SoCs
- ISO 26262 ASIL B & D Ready IP developed and assessed specifically for random hardware faults; AEC Q100 tested, w/Automotive QMS
- Industry's 1st ISO 26262 ASIL D Compliant processor IP for random hardware faults **and** systematic development flow
- Synopsys' safety philosophy is to follow the letter **and** intent of ISO26262 – not just provide bare minimums

Synopsys Processors and Tools Used Industry-wide

Adopted by 9 out of 10 Semiconductor Vendors

Automotive Semiconductor Market Share – 2020*	
1	Infineon Technologies
2	NXP
3	Renesas Electronics
4	Texas Instruments
5	ST Microelectronics
6	Robert Bosch
7	ON Semiconductor
8	Denso
9	Micron Technology
10	Intel

** Source: Gartner – April 2021*

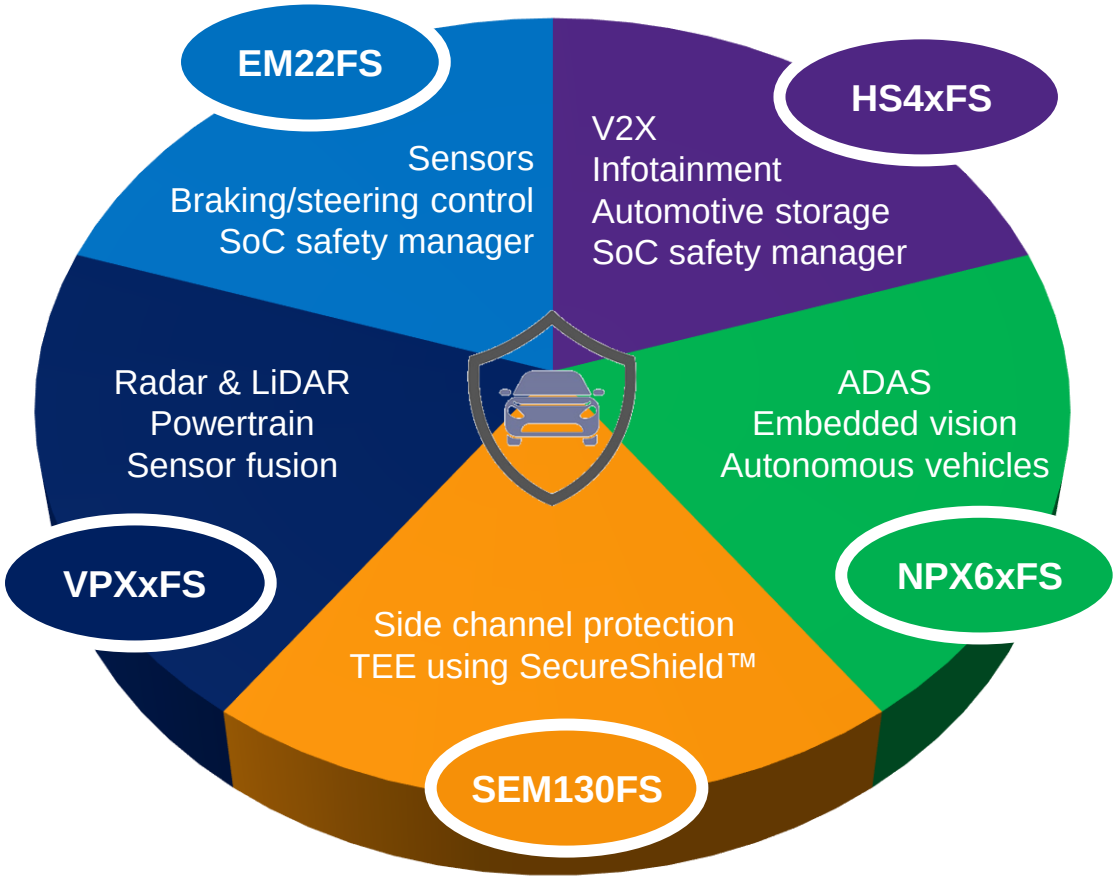


- 90% of top vendors leveraging Synopsys processor IP and tools with dozens of wins in EU, NA, JP and China
- Industry's 1st ASIL D compliant processor IP for systematic development flow & random hardware faults

ARC Functional Safety (FS) Processors

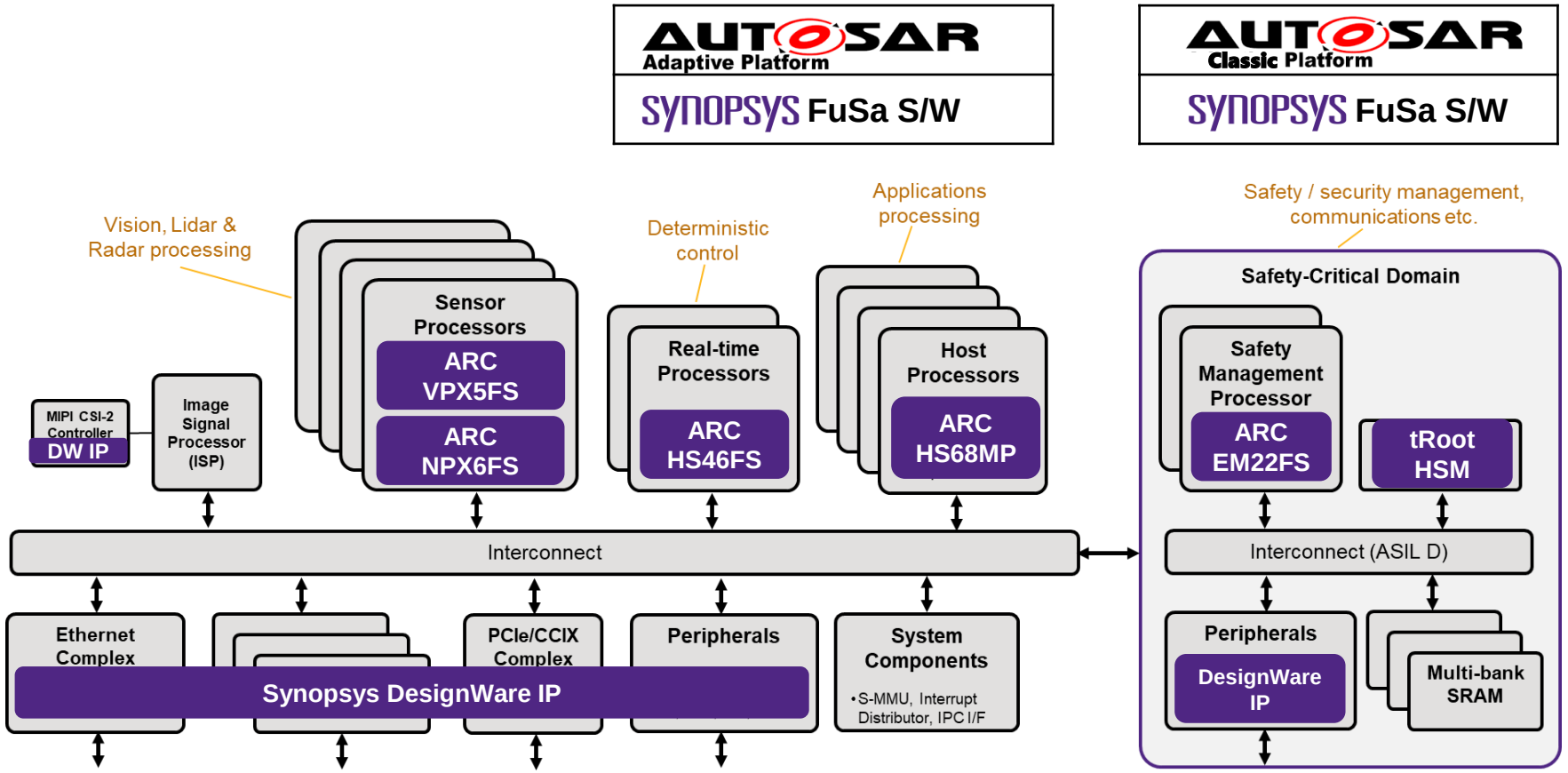
ISO 26262 ASIL Compliant Cores for Automotive Applications

SGS TÜV SAAR ASIL D COMPLIANT Functional Safety ISO 26262 www.sgs-tuev-saar.com



- Safety-enhanced cores span the ARC portfolio to address broad range of automotive applications
- Industry's First Processor IP Certified for Full ISO 26262 ASIL D Compliance
- ARC MetaWare Development Toolkit for Safety speeds ISO 26262-compliant software development
- FuSa Software Stack - ASIL certified embedded components for use in safety-critical applications
- Over 80 safety work products developed, accelerating customers' functional safety assessments

Synopsys “Safe and Secure” Architecture

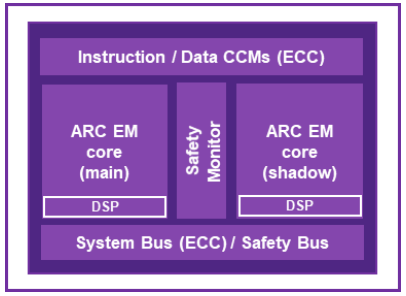


Synopsys Safe & Secure Architecture

- **Safety Manager (EM, HS) -** Monitors & manages system failures, real-time faults
- **Vision Processing for ADAS (VPX / NPX) -** Heterogeneous vector DSP + NN accelerator
- **DSP for Radar/LiDAR (VPX / EV) -** Floating point, linear algebra for greater accuracy
- **Real Time and Host Processors (HS) –** Safety-enhanced multicore processors for real-time control and advanced automotive applications
- **HSM (tRoot/SEM) –** Protects against malicious attacks, secure boot/updates
- **FuSa S/W -** ASIL-D certified libraries, runtime, Software Test Libraries

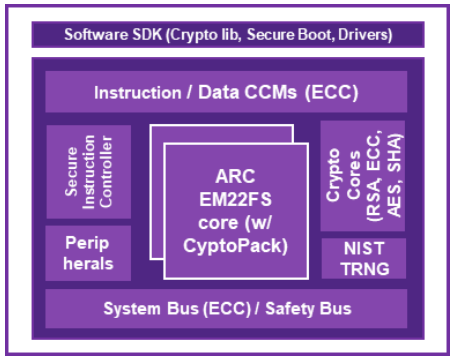
Safety, Security Management & Real-Time Control

ARC EM Safety Processor, tRoot HSM, ARC HS4xFS Real-time Processor



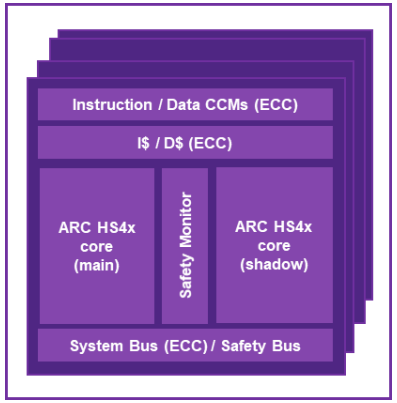
EM22FS Safety Management Processor

- Dual-core lockstep implementation with hybrid mode support
- Dedicated safety monitor validates DCLS operation and collects SoC level error info
- ECC for closely coupled memories, MPU, user Programmable Watchdog Timers
- FuSa safety management S/W stack available



tRoot Hardware Security Module

- Scalable cryptography: custom instructions (CryptoPack) to crypto cores with side channel protection
- NIST-compliant TRNG
- Secure Instruction Controller with side channel protection for secure external memory access
- Software: secure applications SDK, crypto library, device drivers & reference designs

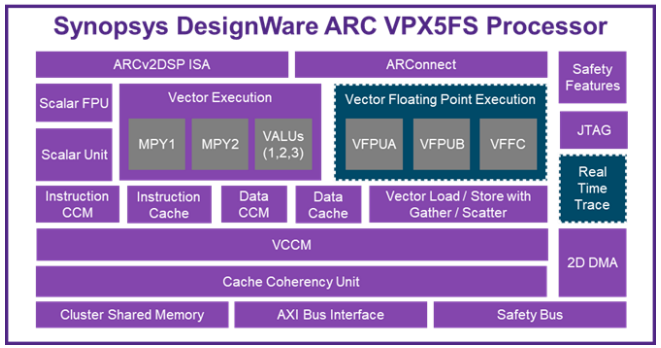


HS4xFS Safety Enhanced RT Controller

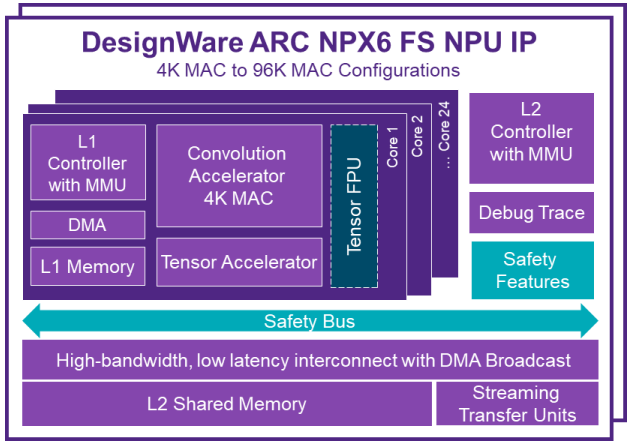
- Dual-issue, 10-stage pipeline processor, configurable in lockstep or hybrid modes
- Single-core and quad-core options (DCLS)
- Industry leading integrated H/W safety features
- 20% higher single core performance than Cortex-R52

ADAS Vision, Radar/Lidar and Application Processing

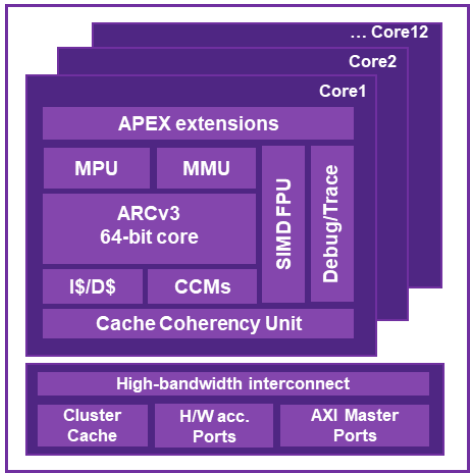
ARC VPX5FS DSP, NPX6FS NPU and HS6x Processor



VPX5FS DSP



NPX6FS Neural Processing Unit



ARC HS6x Host Processor

- Multicore vector DSP addresses ADAS sensors (LiDAR, RADAR), powertrain, sensor fusion, etc.
- SIMD/VLIW design for massive parallel processing
- Multiple vector FP engines for high precision results

- Addresses AI and vision applications: augmented reality, ADAS, surveillance, etc.
- 1 to 24 core scalable NPU up to 96K MACs executes graphs for object detection and scene segmentation up to 340 TOPS
- Automatic graph partitioning using MetaWare MX for improved performance, bandwidth, latency

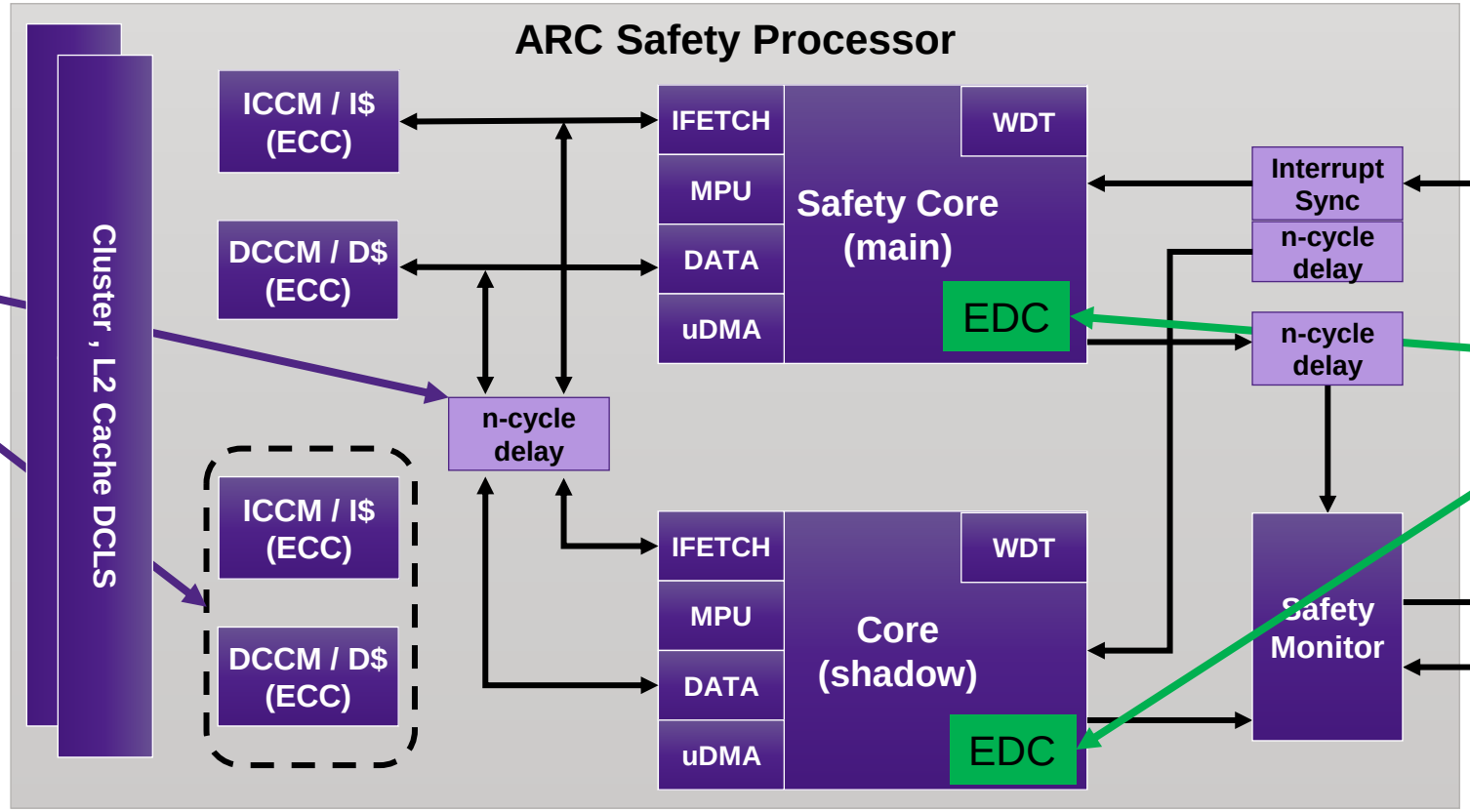
- ARCv3 64-bit multi-core processor
- Configurable as real-time and/or application processor
- Support for up to 12 CPU cores and up to 16 user hardware accelerators
- 35% lower power (uW/MHz) than Cortex-A65AE

ARC FS Safety Processors – Safety Hybrid Mode

Configurable for ASIL-D (DCLS) or Dual-Core Independent ASIL-B

ASIL-D Mode:
Single Core Lock-step Protection providing Transient and Stuck at Fault protection

ASIL-B Mode
Dual-core Performance with ASIL-B Transient and Stuck at fault protection

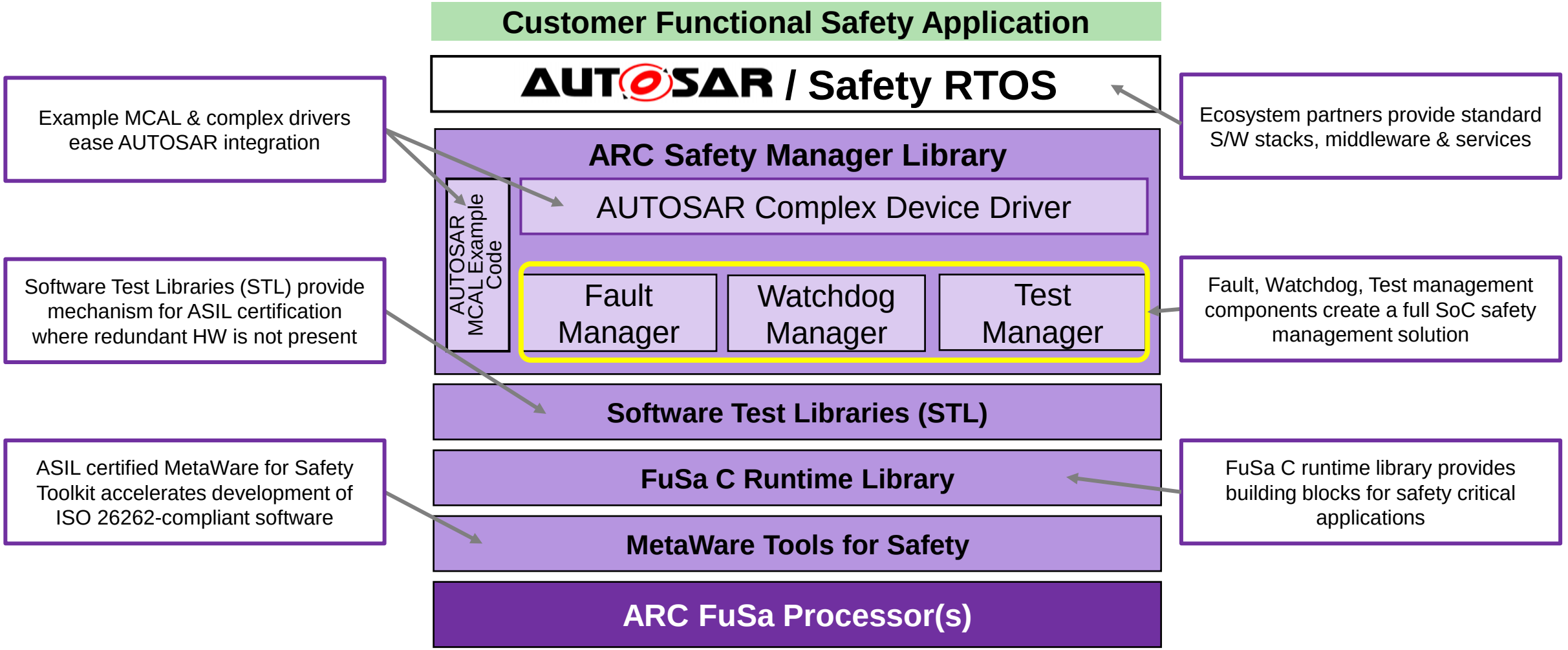


ASIL-B Mode:
EDC: Transient fault Pipeline Protection
STLs: stuck at fault protection

Flexible architecture to allow customers to balance safety levels with performance requirements

Functional Safety Software / Tools Complement ARC FS Processors

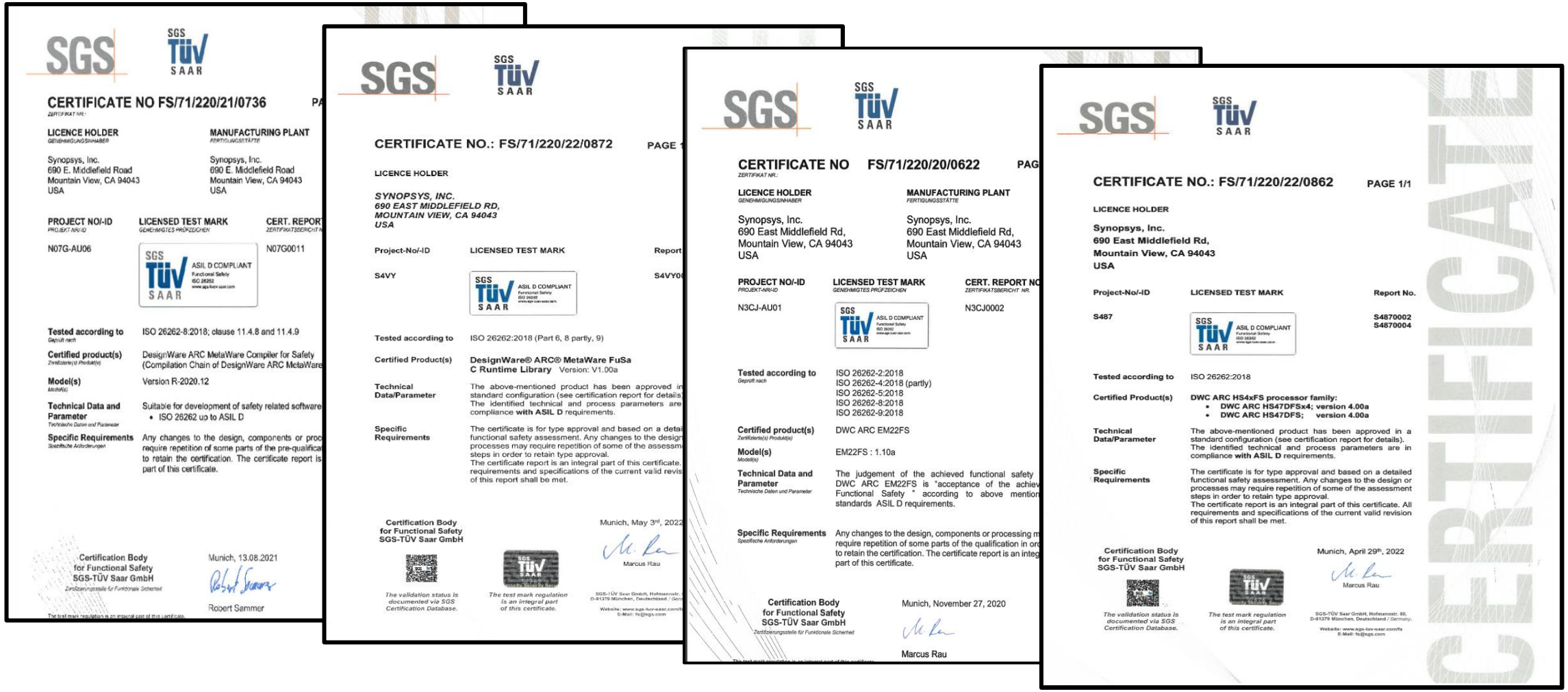
Industry Leading Safety Management Solutions



ARC ISO26262 Certifications

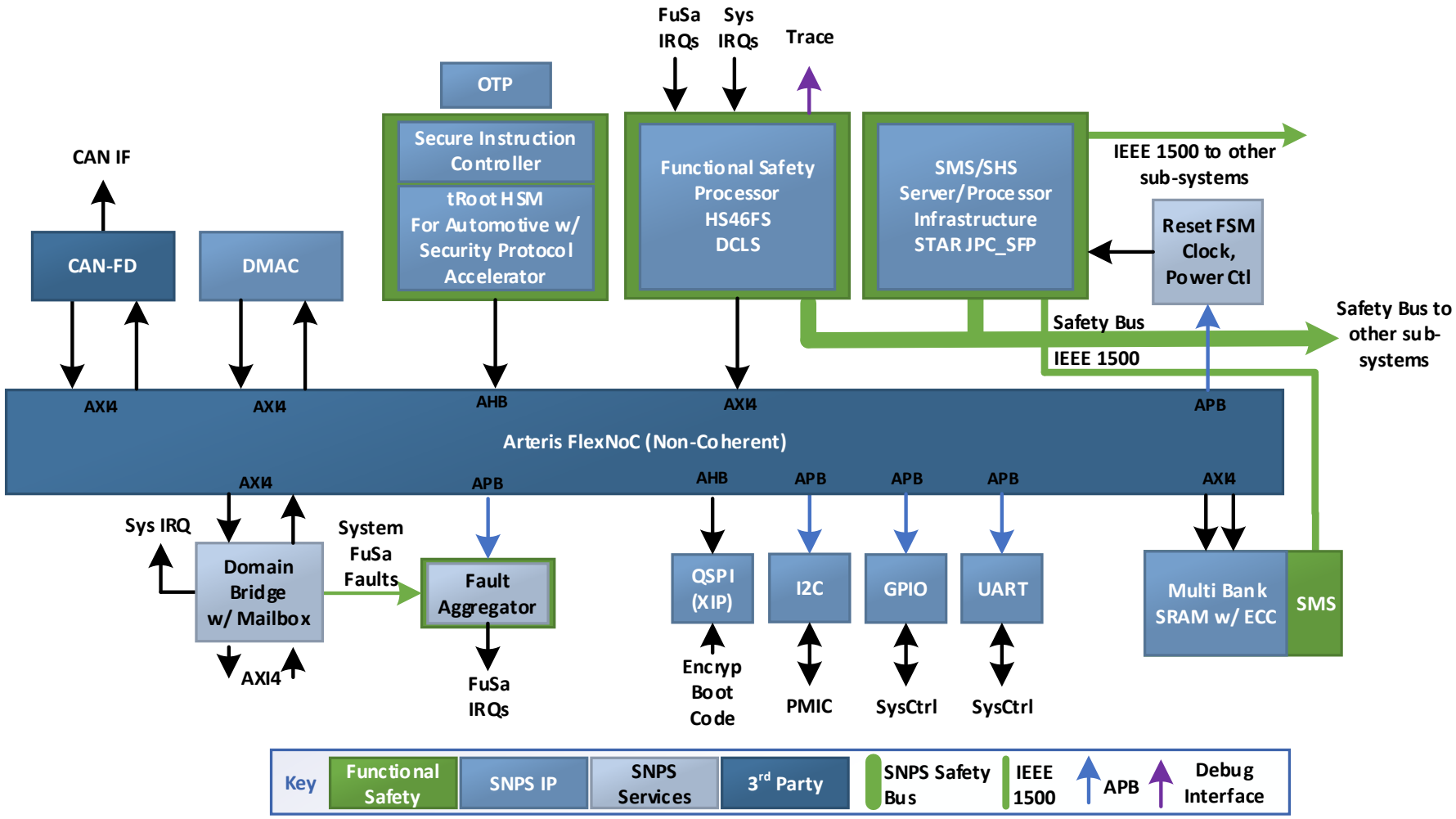
ASIL D Compliance with SGS-TuV

SGS TÜV SAAR
ASIL D COMPLIANT
Functional Safety
ISO 26262
www.sgs-tuev-saar.com



MetaWare Compiler **FuSa C-runtime library** **ARC EM22FS** **ARC HS4xFS**

Synopsys Safety and Security Subsystem Reference



tRoot HSM - Critical Security Management

- Efficiently manages secure boot and updates for tRoot and other processors
- Provides secure debug, key management, cryptography & authentication

SoC Safety Manager

- Responsible for SOC "safety" bring-up
- Boot-time (POST): LBIST, MBIST, IP BIST
- Periodic test management
- Monitors and executes Safety escalations
- Error injection for Safety Mechanism Testing

Safety Bus

- Safety Manager informed of errors via dedicated Safety Bus
- Ability to monitor other ASIL cores and IP
- Interconnect to SHS Architecture

ASIL Certified Processors and IP

- Lockstep-capable processors with native Safety Bus interface support ASIL B and D
- Safety certified interface, test & peripheral IP

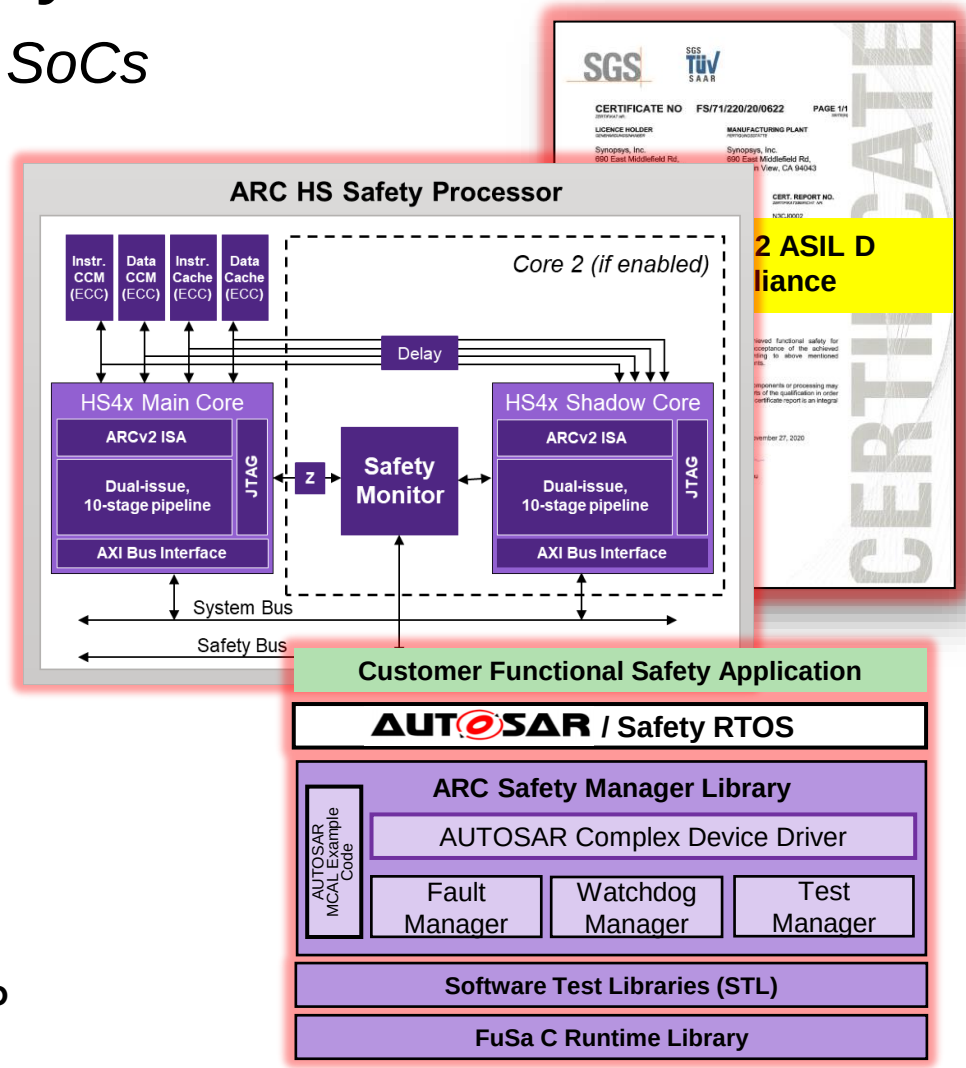
Hierarchical Safety Management

- STAR Memory (SMS) & STAR Hierarchical (SHS) Systems
- Safety wrappers connect ECC data & address monitors

Industry Leading ARC Functional Safety Processors

***Minimal Risk & Design Effort** Solution for Automotive SoCs*

- **Hardware**: Industry's First Processor IP Certified for **Full** ISO 26262 ASIL D **Compliance**
  - *ARC Safety Processors comply with the latest version of the automotive standard, **ISO26262:2018***
  - *ARC Safety Processors meet **both** stringent **random** hardware fault detection and **systematic** functional safety development requirements*
- **Software:** Functional Safety Software Stack provides Industry Leading Safety Management & Development Solutions
- **Tool Chain:** ASIL D Compliant ARC MetaWare Toolkit for Safety speeds development of safety critical software
- **Work Products:** Over 80 work products developed. Common safety process flow and review across all Synopsys' automotive IP



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