



# AUTOSAR Software Overview

## AMF-AUT-T0022

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Field Applications Engineer



September 2013

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# Freescale in Automotive

## • Freescale Leadership in Driving Standards

- First semiconductor supplier to join the AUTOSAR partnership
- Active member of JASPAR
- Member of GENIVI
- Co-founded Open Alliance on Ethernet for Automotive

## • Broadest Automotive MCU Product Portfolio

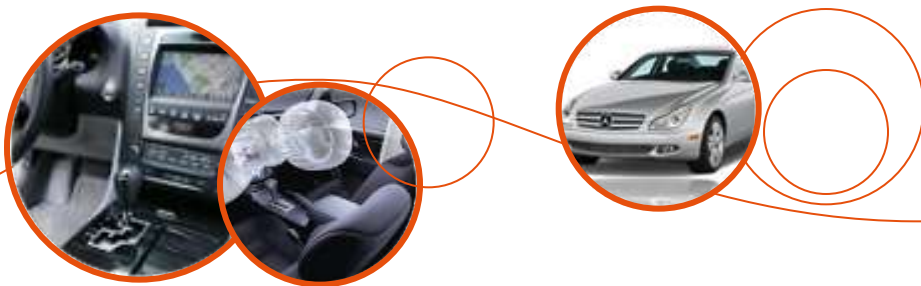
- Auto-qualified products (8/16/32-bit MCUs & MPUs) span body electronics, powertrain, safety and chassis and driver information systems.

## • Customer Relationships

- Freescale has solid, long-standing customer relationships with nearly every automotive manufacturer and Tier 1 supplier in the world

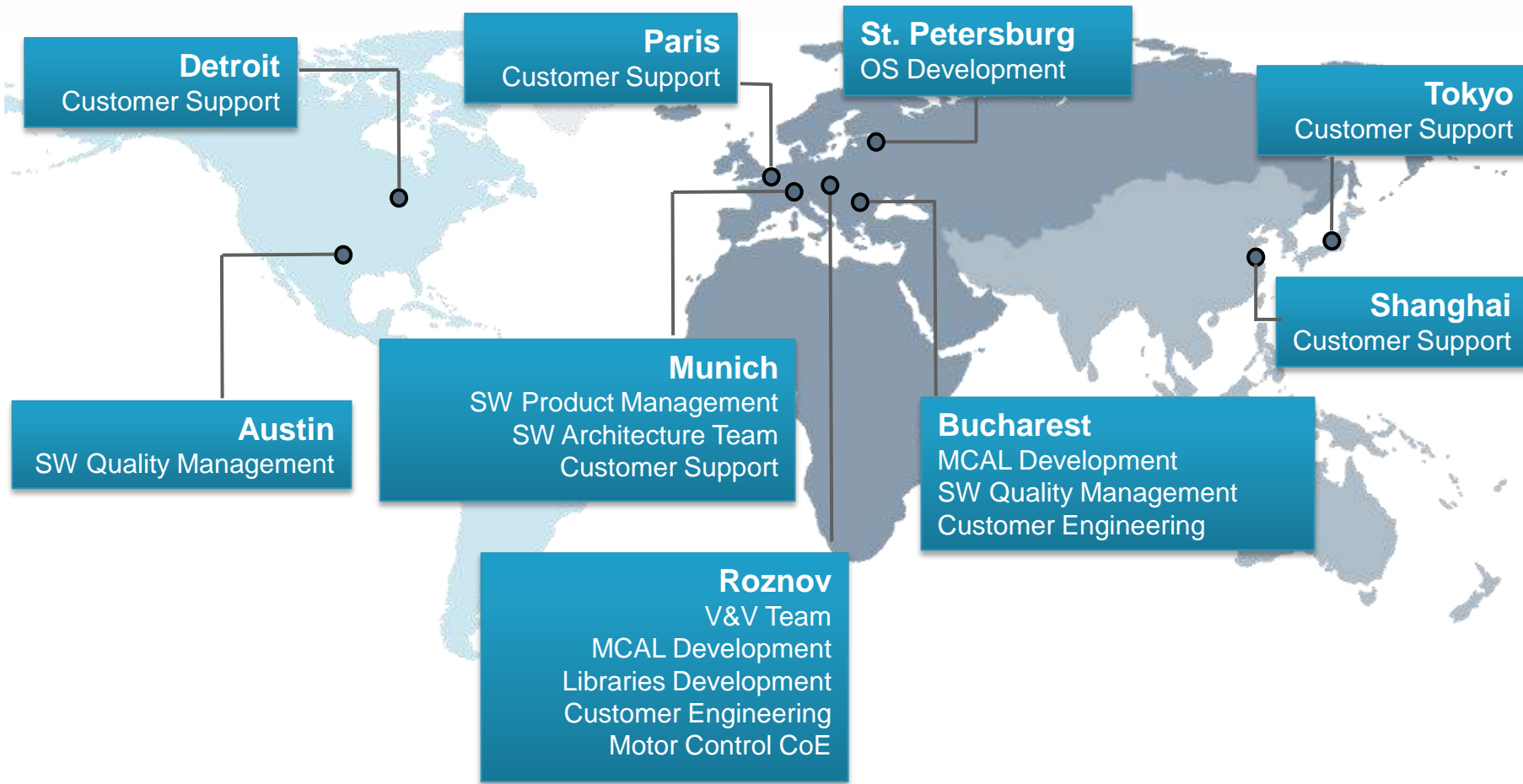
## • Long-term Global Presence

- Freescale has what it takes to meet the stringent requirements of the global automotive market





# Freescale Automotive Software - Global Support

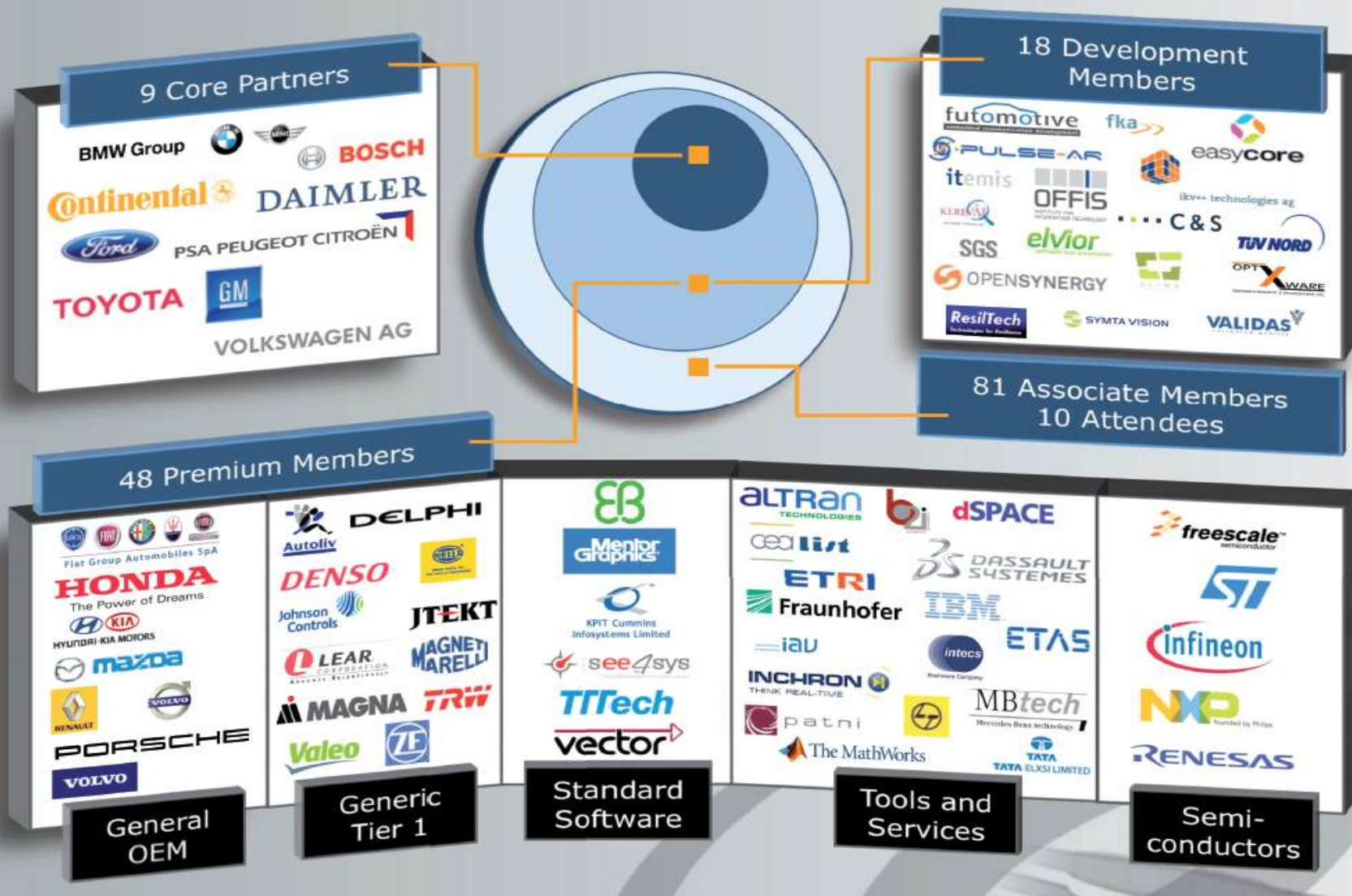


# 32-bit Automotive Software Product Overview by Segment

	Body	Chassis/Safety	Powertrain
	560xB/C/D, 564xB/C, 5668G	560xP, 560xE, 564xL, 567xK	563xM, 564xA, 567xF
AUTOSAR 3.x AUTOSAR 4.0	MCAL OS	MCAL OS	MCAL OS
Non-AUTOSAR (Prod Code)		Eth Streaming SW Camera Appl SW	
Non-AUTOSAR (Demo Code)	Flash / EE Drv	Flash / EE Drv Motor Control Lib	Flash / EE Drv eTPU Lib
Safety	Instruction based Core Self Test (e200 cores)		
		Core Self Test 60%	

Not all shown products are available for all MCUs











# AUTOSAR – Global Automotive Software Standard

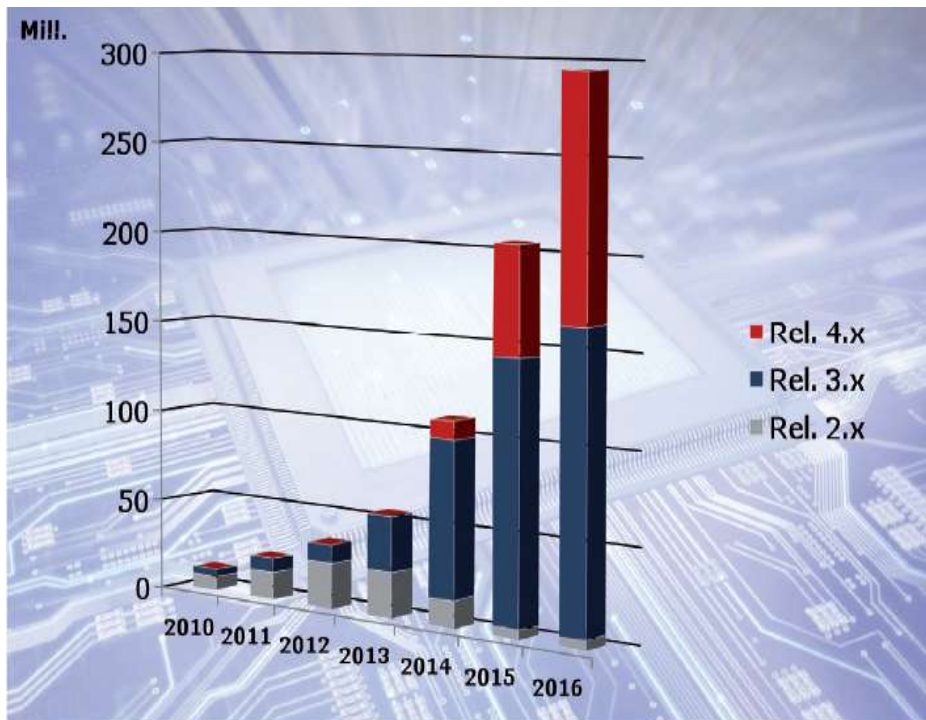
- **Benefits for car manufacturer**

- Establish development distribution among suppliers
- Compete on innovative functions with increased design flexibility
- Simplify software and system integration
- Reduce cost of overall software development

- **Benefits for supplier**

- Reduce version proliferation
- Reuse software modules across car manufacturers
- Increase efficiency of application development

Volume of ECUs with AUTOSAR



- Members represent about 80% of worldwide car production.
- In 2016 approx 25% of ECUs will be based on AUTOSAR.

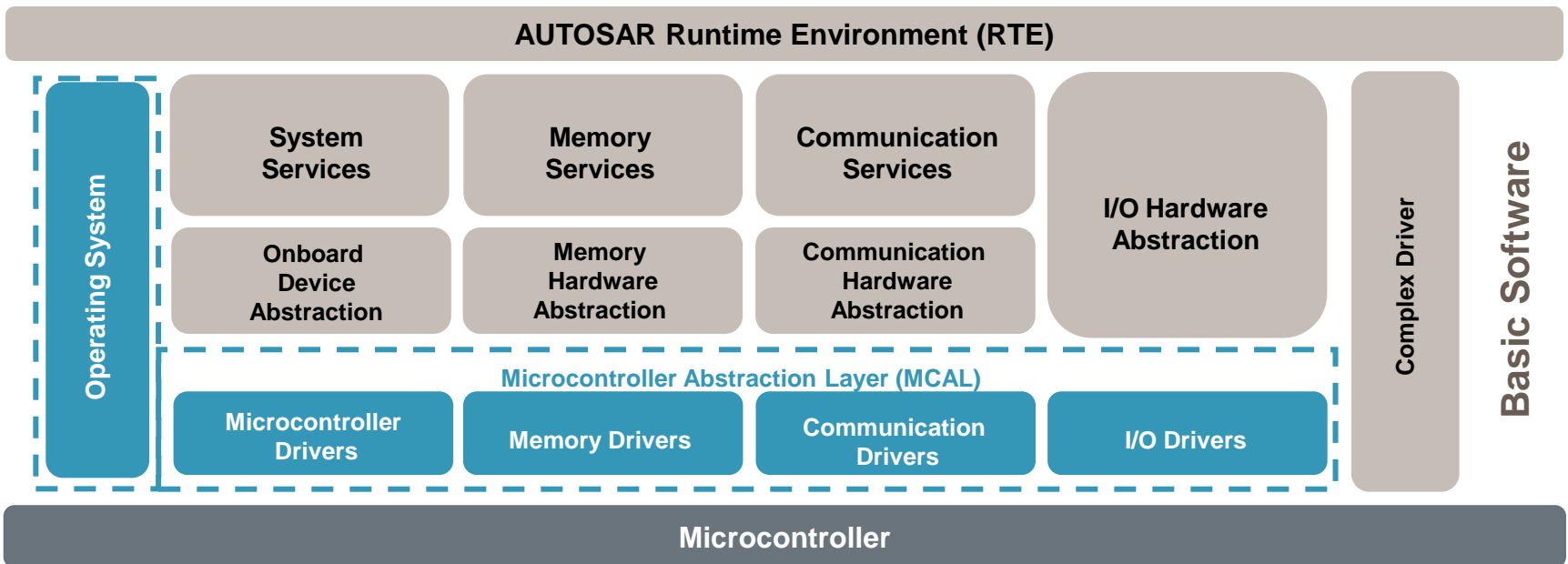
Source: AUTOSAR

Source: AUTOSAR Development Partnership



# Freescale AUTOSAR Products

- Freescale offers cost effective production-ready MCAL and OS
- What the customer gets:
  - From Freescale (shaded blue below): MCAL (source code), OS (source code) and supporting Configuration Tool (executable).
  - From Partners (Elektrobit, Vector, KPIT, etc.) – The rest of AUTOSAR basic software as needed. Partner does integration (Freescale IP + Partner IP + Customer IP)

















# AUTOSAR and ISO26262



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# ISO 26262 : Automotive Norm on Functional Safety

- ISO 26262 is a Functional Safety standard applicable to automotive systems. This norm is an adaptation of the Functional Safety standard IEC 61508.
- ISO 26262 is applied to ensure that electronic systems in automotive applications are completely safe. Thus it covers functional safety aspects of the **entire development process, including requirements specification, design, implementation, integration, verification, validation, and configuration.**

Figure 1: Functional Safety Standards Details

Standards Defined			Level Comparison		Failure Measures		New Policy
IEC 61508	Generic industry standard, applicable to electrical/electronic/programmable electronic safety-related systems		No direct correlation for SIL and ASIL levels		<b>IEC 61508</b>		<ul style="list-style-type: none"> <li>• <b>Information</b> is more structured in ISO 26262</li> <li>• <b>Concept of safety culture</b> exists in ISO 26262</li> <li>• <b>Terminology</b> is well defined in ISO 26262 (safety plan, safety case, work products, confirmation measure, etc.)</li> <li>• <b>Roles and responsibilities</b> are better defined in ISO 26262, (PM, safety manager)</li> </ul>
	<b>Integrity levels</b>	SIL 1, SIL 2, SIL 3, SIL 4	<b>SIL (IEC)</b>	<b>ASIL (ISO)</b>	<b>SIL</b>	<b>Random HWFR target</b>	
	<b>Publication date</b>	More than 10 years ago	4	D	4	$\geq 10^{-9}$ to $< 10^{-8}$	
ISO 26262	Automotive industry standard, adaptation of IEC 61508 for electronic systems in road vehicles		3	C	3	$\geq 10^{-8}$ to $< 10^{-7}$	
	<b>Integrity levels</b>	ASILA, ASILB, ASILC, ASILD	2	B	2	$\geq 10^{-7}$ to $< 10^{-6}$	
	<b>Publication date</b>	Target end 2011	1	A	1	$\geq 10^{-6}$ to $< 10^{-4}$	
					<b>ISO 26262</b>		
					<b>ASIL</b>	<b>Random HWFR target</b>	
					D	$< 10^{-8} h^{-1}$	
					C	$< 10^{-7} h^{-1}$	
					B	$< 10^{-7} h^{-1}$	

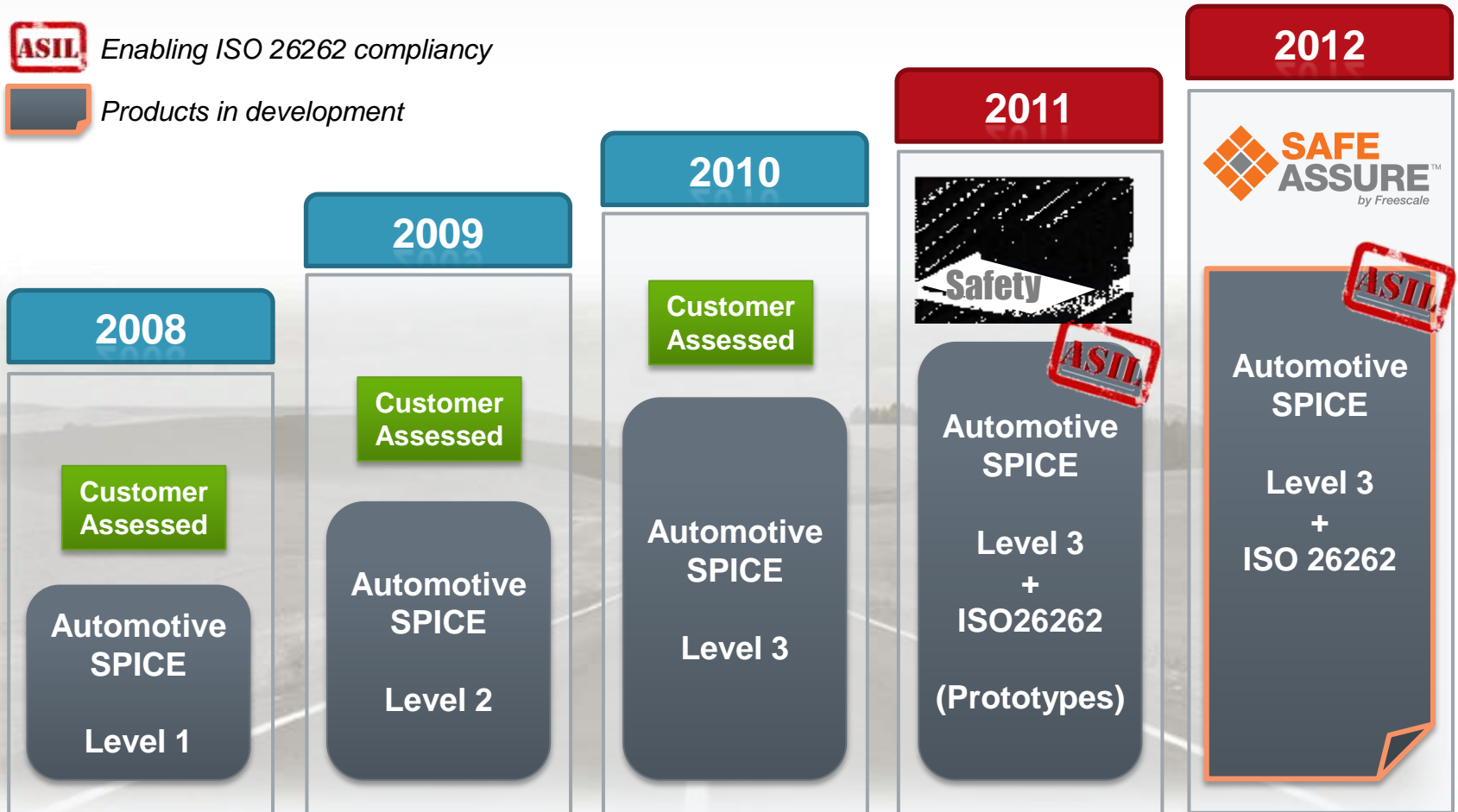
Source: Adressing the Challenges of Functional Safety in Industrial and Automotive Markets, White Paper, 2012, [www.freescale.com](http://www.freescale.com)



# Automotive Software Development Process Evolution

**ASIL** Enabling ISO 26262 compliancy

Products in development





# ICE Capability Level 3 in all Process Areas (HIS-Scope) – since 2010

ID	Process Name	Assessment					Cap. Level
		PA 1.1	PA 2.1	PA 2.2	PA 3.1	PA 3.2	
MAN.3	Project Management	F	F	F	L	F	3
ENG.4	Analysis	F	F	F	F	F	3
ENG.5	Software Design	F	F	F	F	F	3
ENG.6	Software Construction	F	F	F	F	F	3
ENG.7	Software Integration Test	F	F	F	L	L	3
SUP.1	Quality Assurance	F	F	F	F	F	3
SUP.8	Configuration Management	F	F	F	F	F	3
SUP.9	Management	F	F	F	F	F	3
SUP.10	Change Request Management	F	F	F	F	F	3

F: Fully achieved  
L: Largely achieved



# Summary

- Freescale’s mission is to be the **benchmark provider for silicon and software** that enables our customers to build scalable platforms for automotive body, powertrain, safety and chassis, and driver information systems.
- Since several years Freescale successfully delivers production ready AUTOSAR MCAL and OS software. Freescale now expands its software roadmap to support our SafeAssure program, as well as Automotive Ethernet, Motor Control, and Radio solutions.



**Silicon + Software + Services + Support**

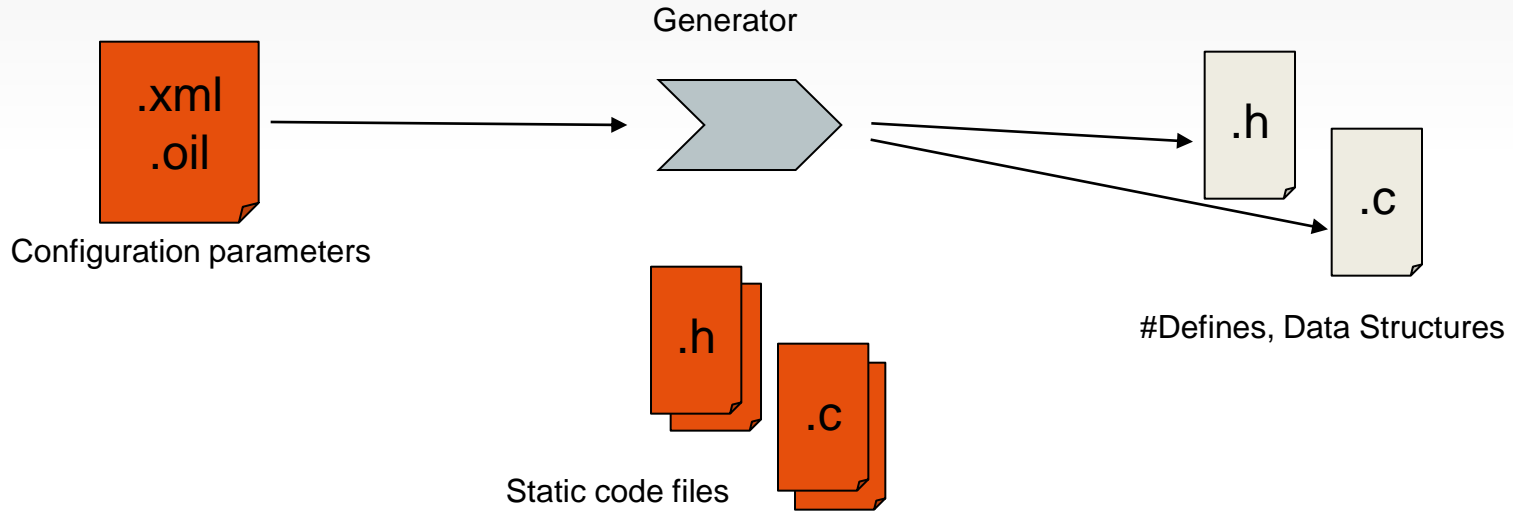
# AUTOSAR Configuration Methodology / Tool







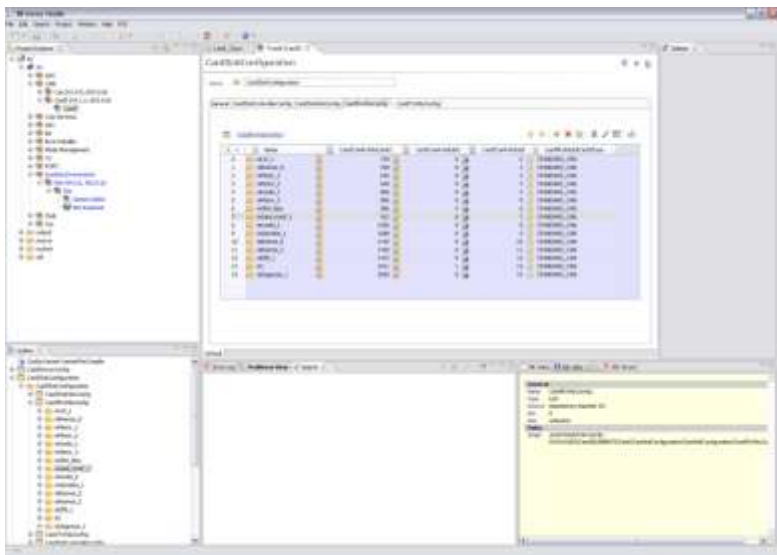
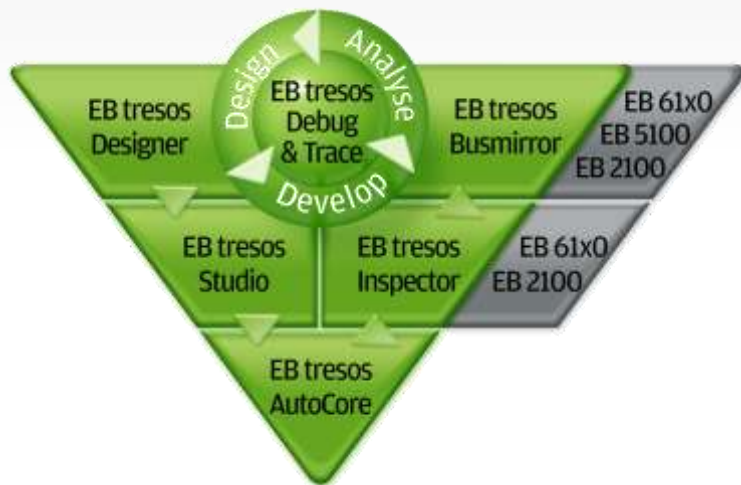
# Static configuration



- Static configuration allows to change code behaviour dependent on configuration parameters
- Functionality can be designed to be statically defined instead of definition during runtime, e.g. Creating tasks in configuration instead of during runtime with a function
- ⇒ lower memory footprint, faster execution, scalable/tailored to the application needs

# EB tresos Studio

- EB tresos Studio is an easy-to-use tool for ECU standard software configuration, validation and code generation
- Full support for the AUTOSAR standard
- Full support for the Freescale AUTOSAR software and the EB tresos AutoCore



Source: Elektrotbit

- Integrated, graphical user interface
- Based upon Eclipse and open standards
- Online-help and parameter-specific help



# Freescale AUTOSAR Integration Partners

Freescale AUTOSAR Integration Partners receive Freescale MCAL and OS releases for pre-integration into their proprietary AUTOSAR BSW products



All MCAL and OS releases





All MCAL and OS releases

On demand delivery





On demand delivery

On demand delivery





On demand delivery

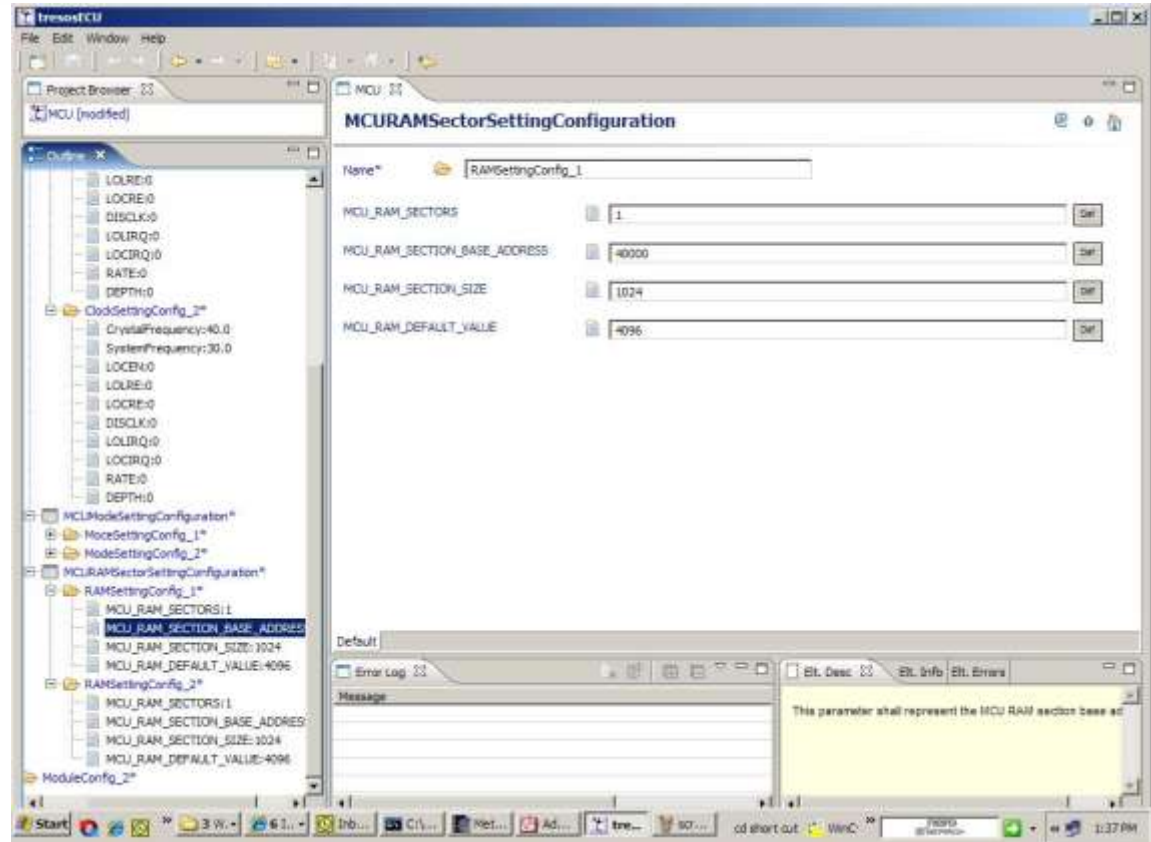


On demand delivery

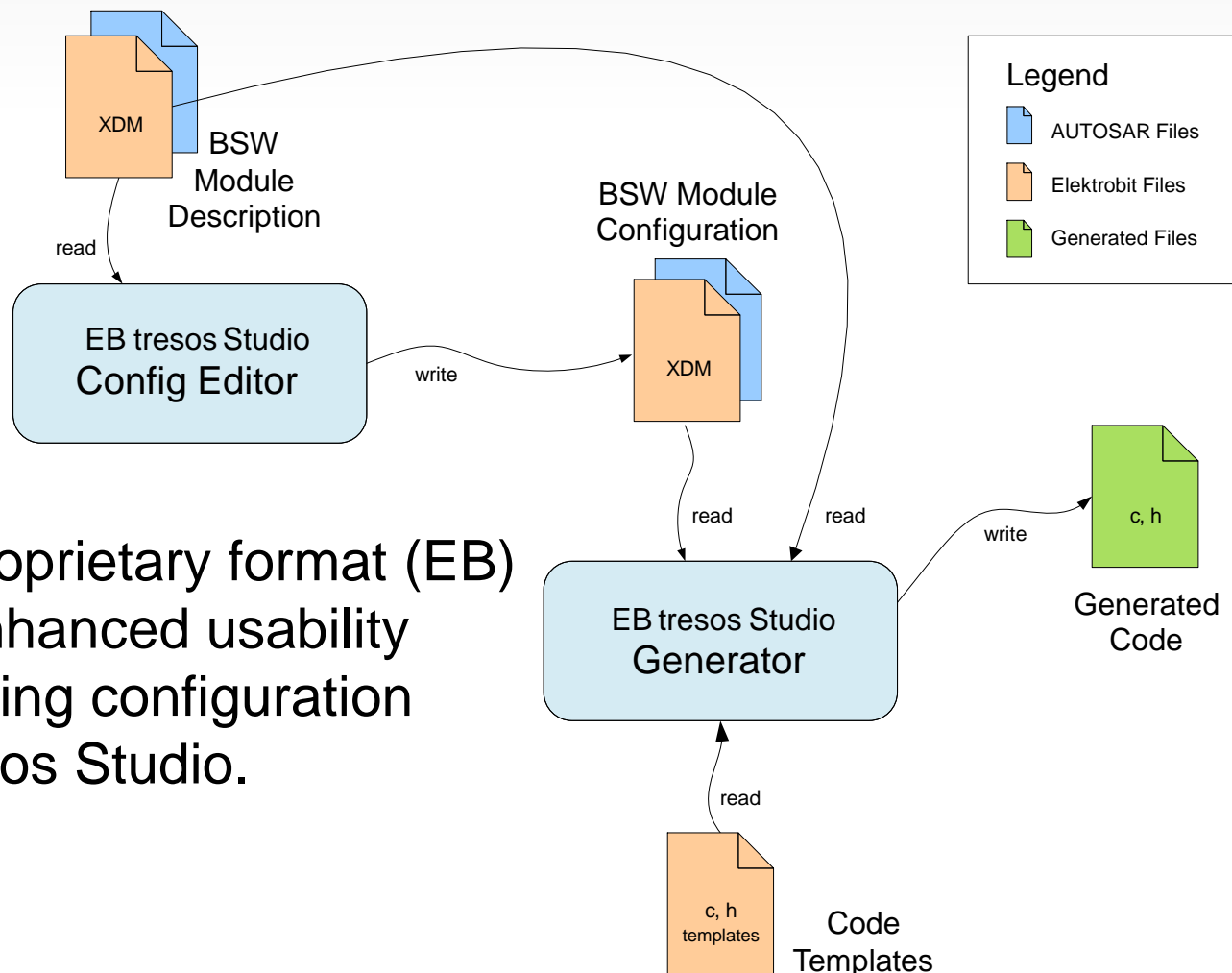
# AUTOSAR BSW Configuration Tool

## Example: tresos® ECU

- Graphical representation of ECU configuration description (ECD)
- Import/export of ECD
- Easy configuration of AUTOSAR BSW using pre-compile methodology



# Parameter Description Files – XDM

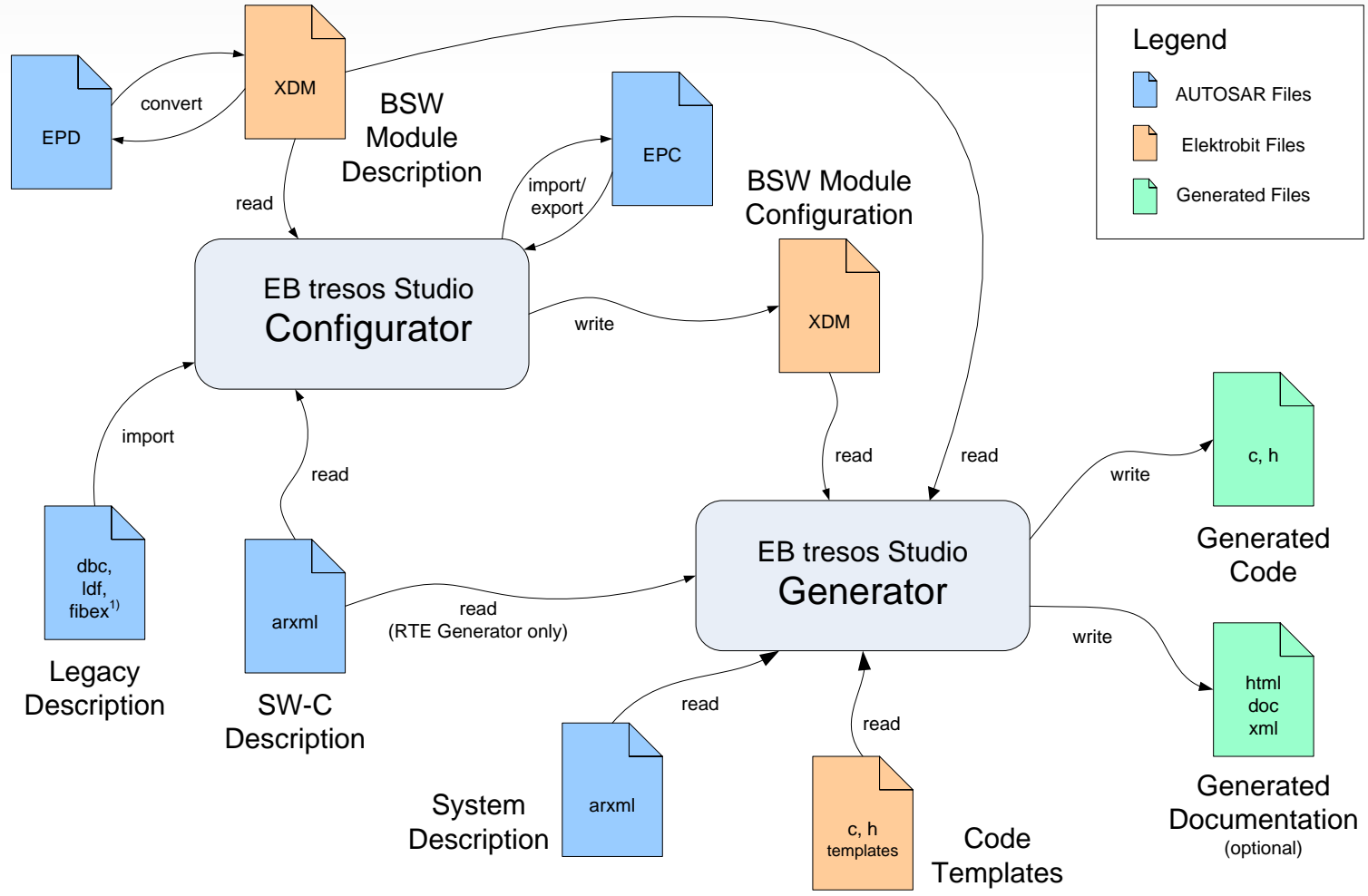


XDM is a proprietary format (EB) providing enhanced usability features during configuration with EB tresos Studio.

Source: Elektrobit



# Parameter Description Files – Beyond MCAL



<sup>1)</sup> currently in development

Source: Elektrobit







# Parameter Definition

Jump to link

Parameter "OsCounterType"

```
<ENUMERATION-PARAM-DEF>  
<SHORT-NAME>OsCounterType</SHORT-NAME>  
<DESC>This parameter contains the natural type or unit of the counter.</DESC>  
<ORIGIN>AUTOSAR_ECUC</ORIGIN>  
<LITERALS>  
<ENUMERATION-LITERAL-DEF>  
<SHORT-NAME>HARDWARE</SHORT-NAME>  
</ENUMERATION-LITERAL-DEF>  
<ENUMERATION-LITERAL-DEF>  
<SHORT-NAME>SOFTWARE</SHORT-NAME>  
</ENUMERATION-LITERAL-DEF>  
</LITERALS>  
</ENUMERATION-PARAM-DEF>
```

... and its corresponding entry in the description file (\*.EPD)

Elt. Desc  
Elt. Info  
Elt. Errors

This parameter contains the natural type or unit of the counter.

Source: Elektrotbit



# Software Release Framework



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# Microcontroller Abstraction Layer











# MCAL

## Port and Dio Modules



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# Port/Dio Module Functional Overview

## Port

- Initialization of all pins and ports of the Mcu
- Reinitialization with alternate configurations at runtime possible
- Reconfiguration of pins at runtime
- Port Pin Function Assignment (GPIO, Adc, SPI, PWM, ...)
- PadSelection implicitly via HW assignment
- PortPin is the only structural element

## Dio

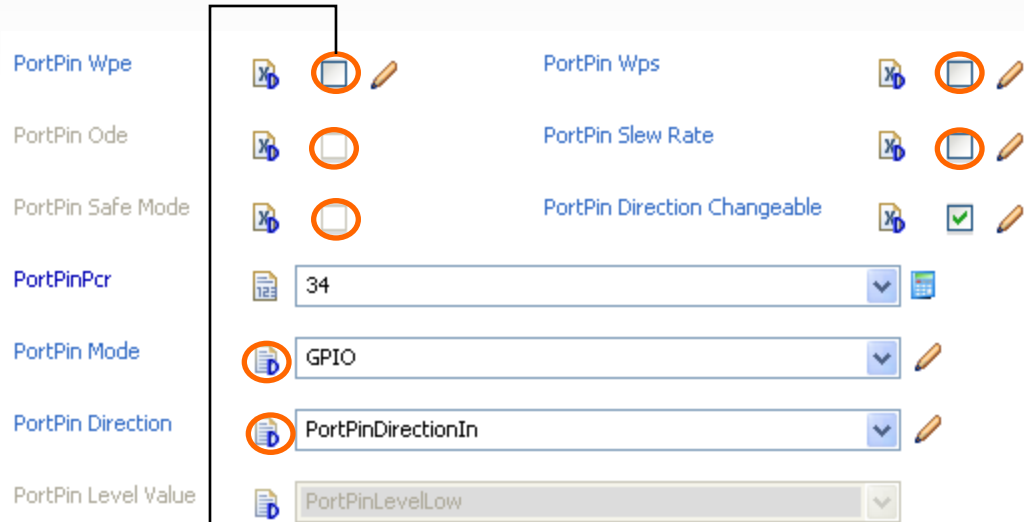
- No initialization (done by Port)
- Provides APIs to read and write GPIO ports/pins
- Requires an initialized Port module
  - pins/ports need to be initialized via Port module
  - no formal connection between Port and Dio Ecu Configurations
- API synchronous and unbuffered
- Consistent read and write services (interruptible read-modify-write not allowed)
- Structural Elements:
  - Channel (single pin)
  - ChannelGroup (adjacent pins in the same port)
  - Port (aggregates Channels and ChannelGroups)

<b>Driver:</b>	<b>Name for a Port Pin:</b>	<b>Name for Subset of Adjacent pins on one port</b>	<b>Name for a whole port</b>
DIO Driver	Channel	Channel Group	Port
PORT Driver:	Port pin	--	Port



# NXP Port Module Pin Configuration

```
typedef struct
{
    uint8 SIUPin; /* Pin Defined on Part SIULx */
    uint16 PCR; /* Pad Control Register */
    sint8 PDO; /* Pad Data Output */
    boolean DC; /* Direction changeable */
} Port_LLD_PinConfigType;
```



## Pad Configuration Register PCR

Pad type	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PAD with GPIO and digital alternate function		SM C	APC		PA[1:0]	OBE	IBE				OD E			SRC	WP E	WP S
PAD with slew rate control		SM C	APC		PA[1:0]	OBE	IBE				OD E			SRC	WP E	WP S
PAD with GPIO and analog functionality		SM C	APC		PA[1:0]	OBE	IBE				OD E			SRC	WP E	WP S
PAD dedicated to ADC		SM C	APC		PA[1:0]	OBE	IBE				OD E			SRC	WP E	WP S

- SMC – Safe Mode Control
- APC – Analog Pad Control
- PA – Output Pad Assignment
- OBE – Output Buffer Enable
- IBE – Input Buffer Enable
- ODE – Open Drain Enable
- SRC – Slew Rate Control
- WPE – Weak Pull Up/Down Enable
- WPS – Weak Pull Up/Down Select



