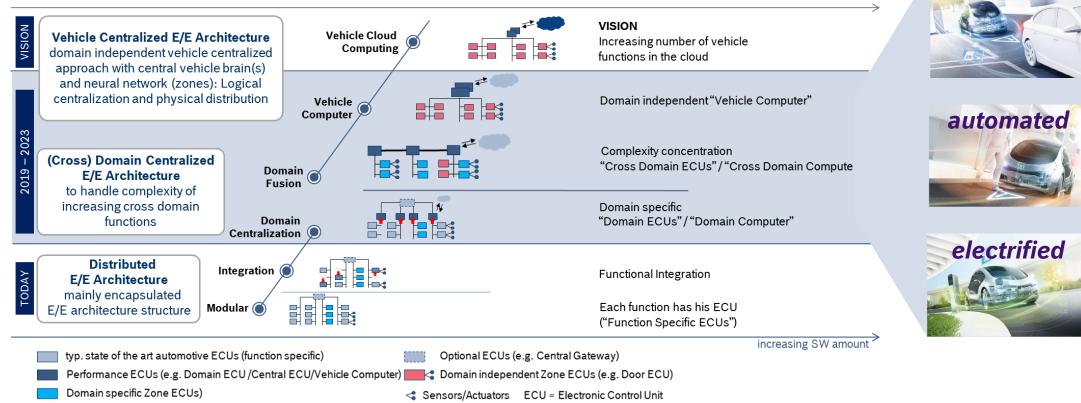
THE FUTURE AUTOMOTIVE OPERATING SYSTEM

ROBERT BOSCH GMBH – GUNNAR PIEL



VRTE - Vehicle Runtime Environment E/E architecture roadmap



Vehicle Computer as integral part in 2019ff. New architectures vary with legacy constraints.

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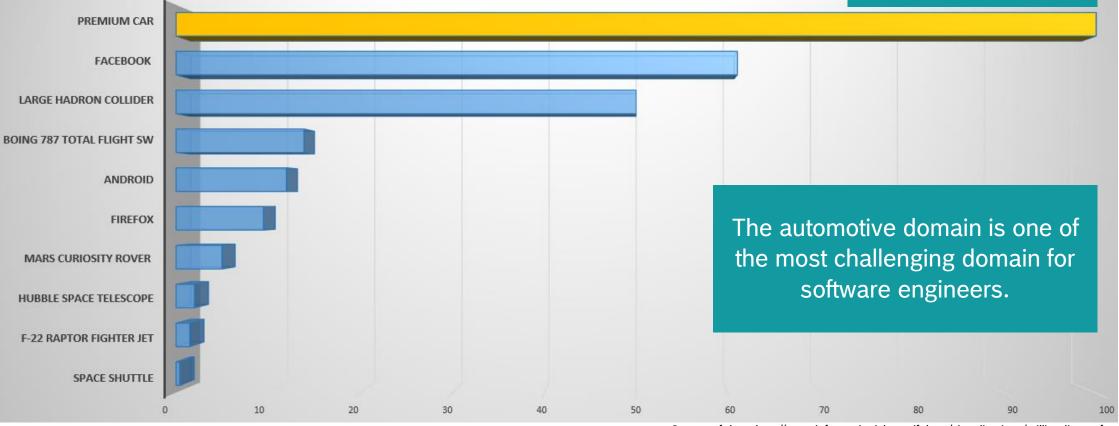


connected

VRTE - Vehicle Runtime Environment Total Amount of Software in Modern Cars

SW Code Base in Million Lines of Code

... and its still growing



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Source of data: http://www.informationisbeautiful.net/visualizations/million-lines-of-code/

VRTE - Vehicle Runtime Environment Software in centralized EE-architecture

EE-architecture

FCT

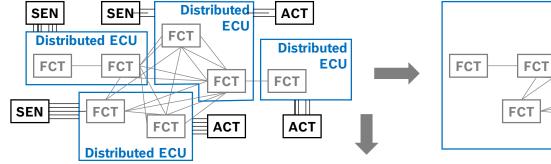
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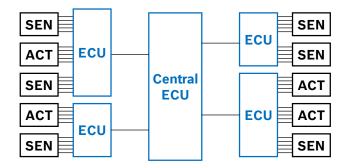
Central ECU

FCT

Further logical centralization due to increasing interconnection of functions (highly interconnected, distributed functions more complex than integration)

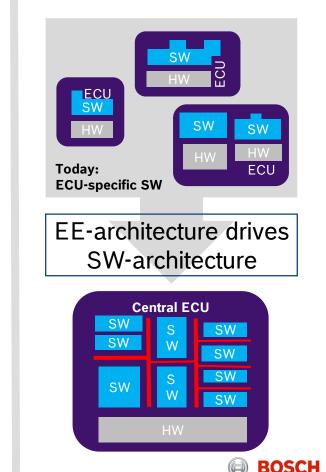


Physical distribution into Central ECU & deeply embedded ECUs

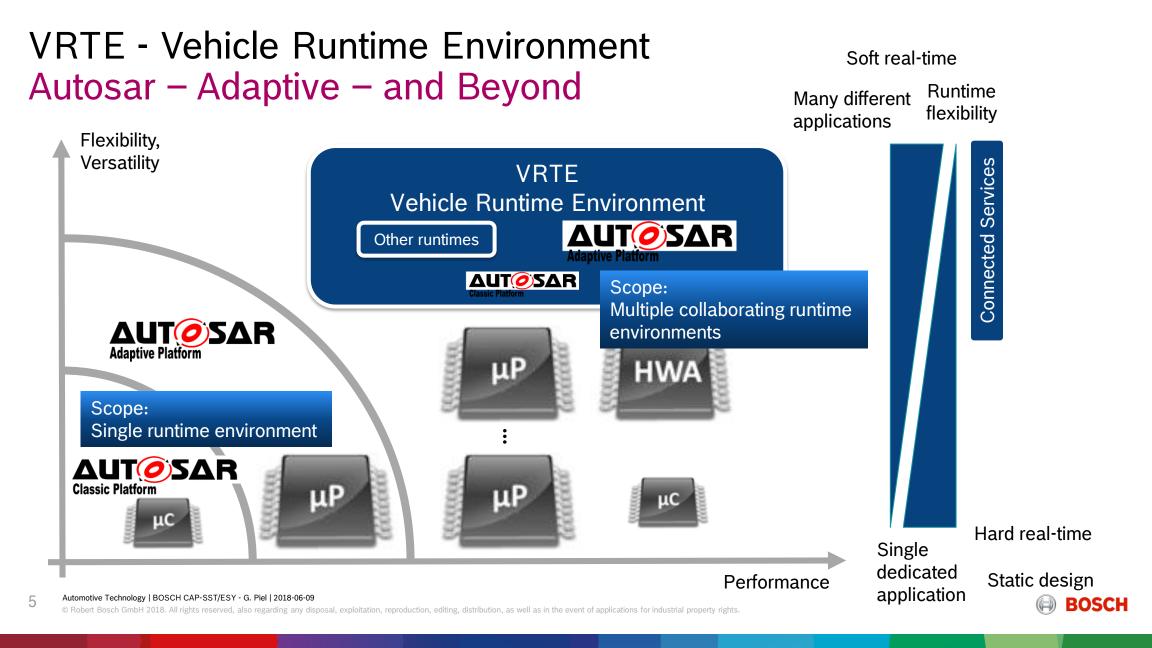


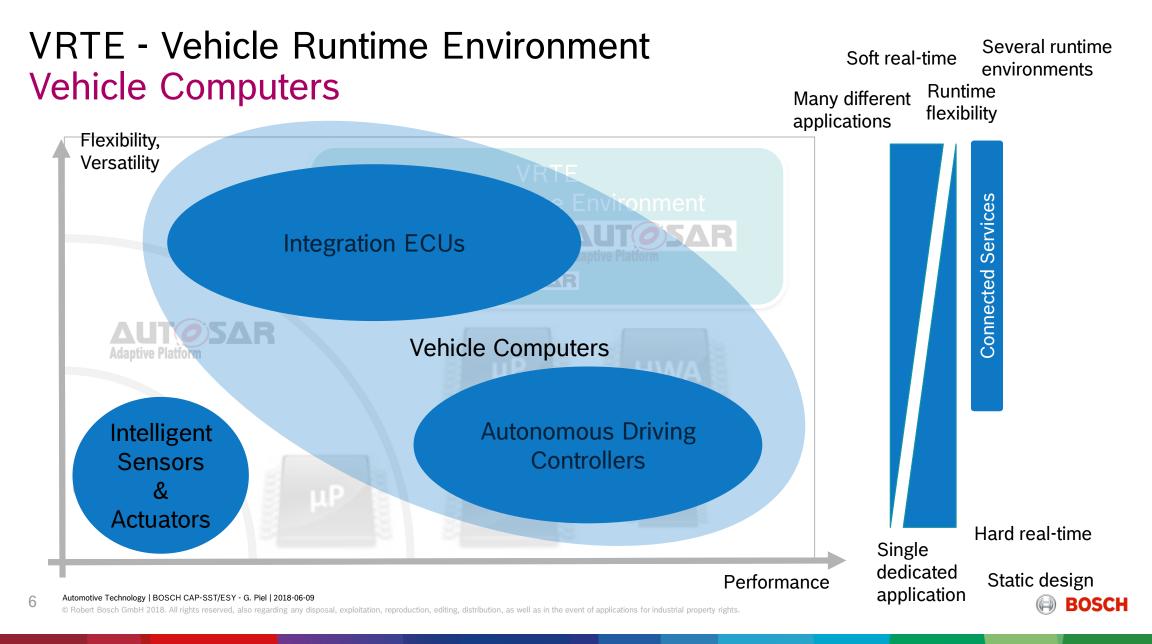
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SW-architecture





VRTE - Vehic	le Runtime Environm	System of systems	 Reuse SW systems Cross-domain/BU Strong collaboration
Most importa	nt features		Demands organizational changes
HW – SW separation	 Standard HW HW sourced separately from SW SW business 	Dependability	 Availability Safety Security
SW/ integration	 □ High computing performance, µP □ Many different applications □ Heterogeneous real-time, safety & security properties □ Many different SW suppliers □ Different SW development processes, tools & SW lifecycles □ Service oriented architecture □ Delta V&V 		 Real-time Fault tolerant SW systems
SW integration		HW acceleration	AI, Neural networksGraphics sharing
		Portability	 HW & VMM & OS independence Service orientation architecture Communication channel independence
SW customization	 Lifetime SW modifications & extensions e.g. security patches Dynamic SW composition 	Networking	 Gbit Ethernet Deterministic communication (TSN) Time synchronization
Connectivity	 FOTA, SOTA Cloud services V2X Security 	IT-like SW	 OSS & COTS SW Heterogeneous processes Continuous delivery Service oriented architecture Tools
Tooling & SDK	 □ High UX □ Efficient development → TTM □ Modular & integratable tool chain 	Migration	 Integration of legacy SW Porting of legacy SW
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VRTE - Vehicle Runtime Environment What drives VRTE architecture

Freedom from risk

Health and safety risk mitigation (Functional safety) VRTE enables SW and HW development to support safety goals up to ISO26262 ASIL D.

Reliability

Fault tolerance

VRTE provides freedom from interference by preventing individual SW faults from compromising the whole SW system.

Security

Integrity VRTE contributes to maintain the integrity of the SW with respect to growing security risks

from connectivity and complex SW systems by tightly controlling individual privileges.

Compatibility

Interoperability

VRTE contributes to the interoperability of SW components from different internal and external suppliers as well as interoperability between established SW de facto-standards such as Autosar Classic, Autosar Adaptive, Genivi etc.

Maintainability

Reusability

VRTE is designed to be used in many different ECU products by various Bosch divisions. It is offered as infrastructure SW product to the open market.

Portability

Adaptability

VRTE is designed to be easily adaptable to evolving HW platforms, usage scenarios, products and new SW components.

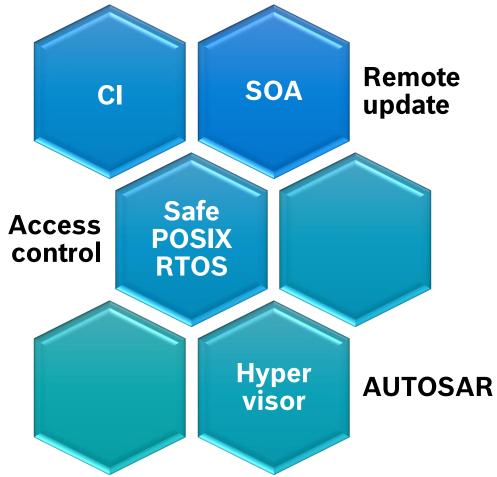
Priority / Precedence

Terminology according to ISO25010 software quality.

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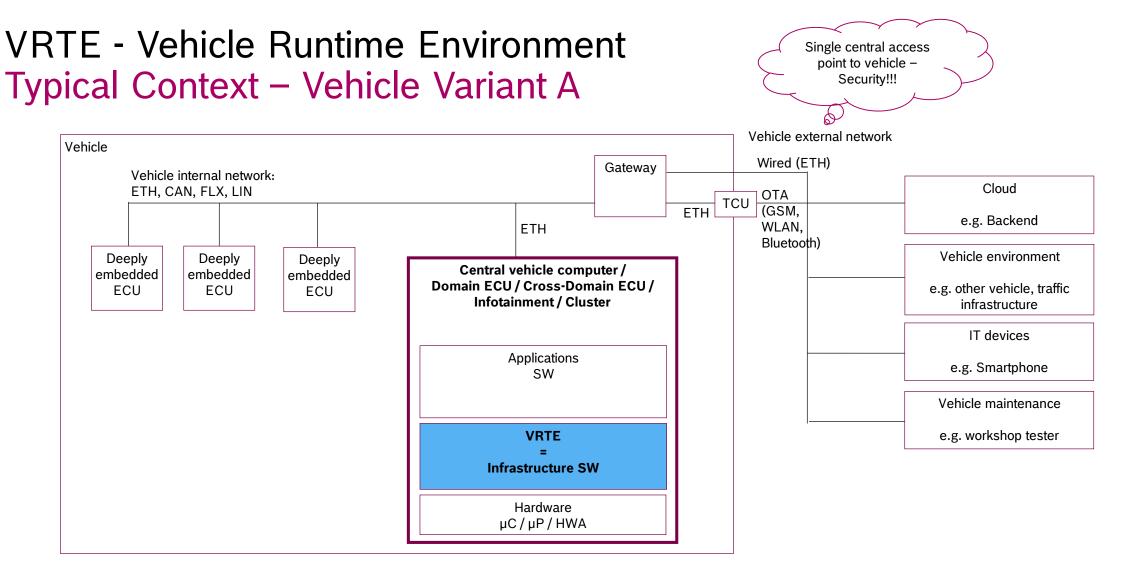


VRTE - Vehicle Runtime Environment Key SW technologies



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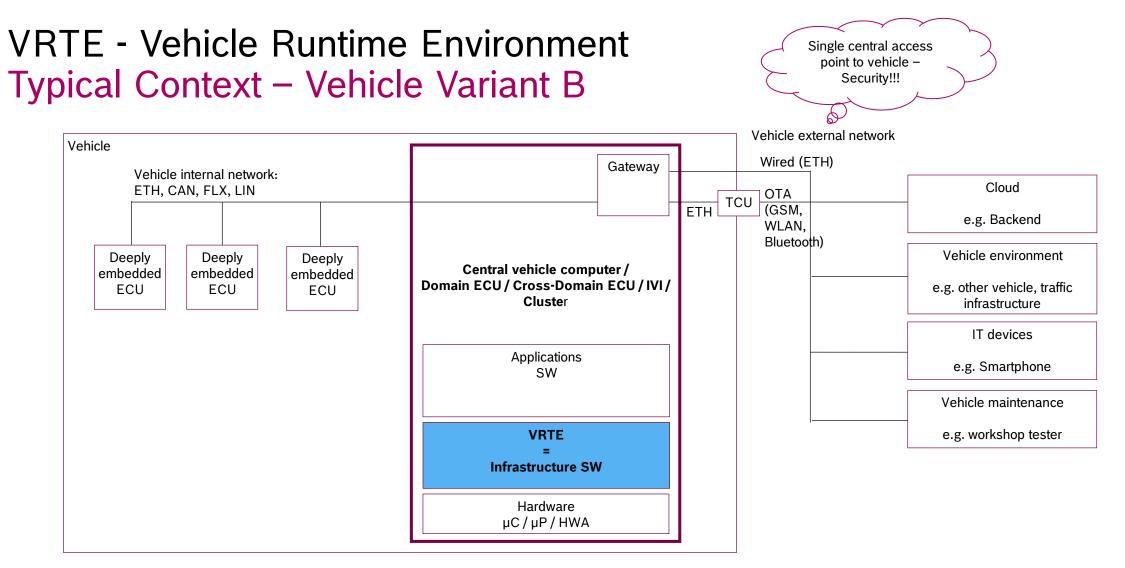




TCU: Telematics control unit OTA: Over the air ETH: Ethernet µC: Microcontroller µP: Microprocessor HWA: Hardware accelerator

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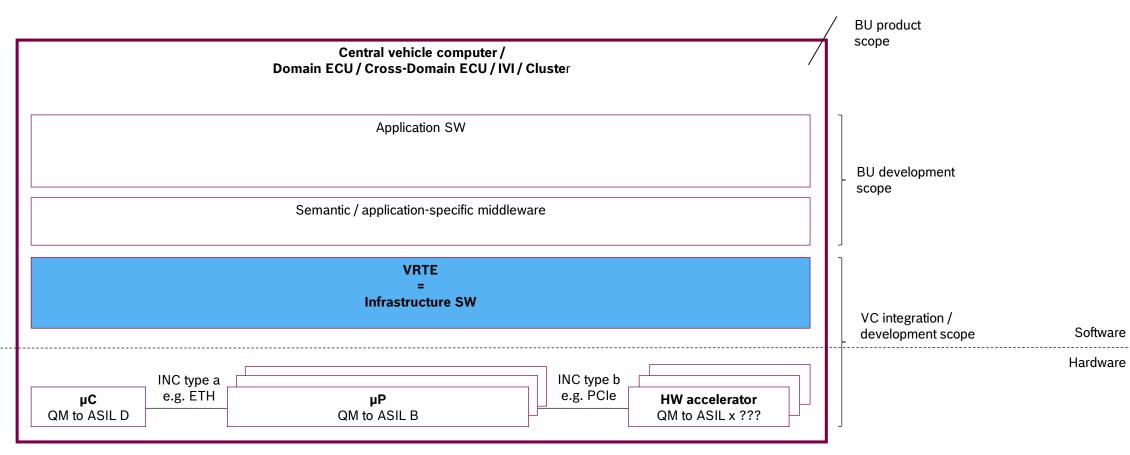


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VRTE - Vehicle Runtime Environment Typical Context – SW & HW



BU: RB business unit VC: RB Vehicle computer campus μ C: Microcontroller μ P: Microprocessor INC: Inter-node communication ETH: Ethernet PCIe: PCI express

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VRTE - Vehicle Runtime Environment Functional Layers

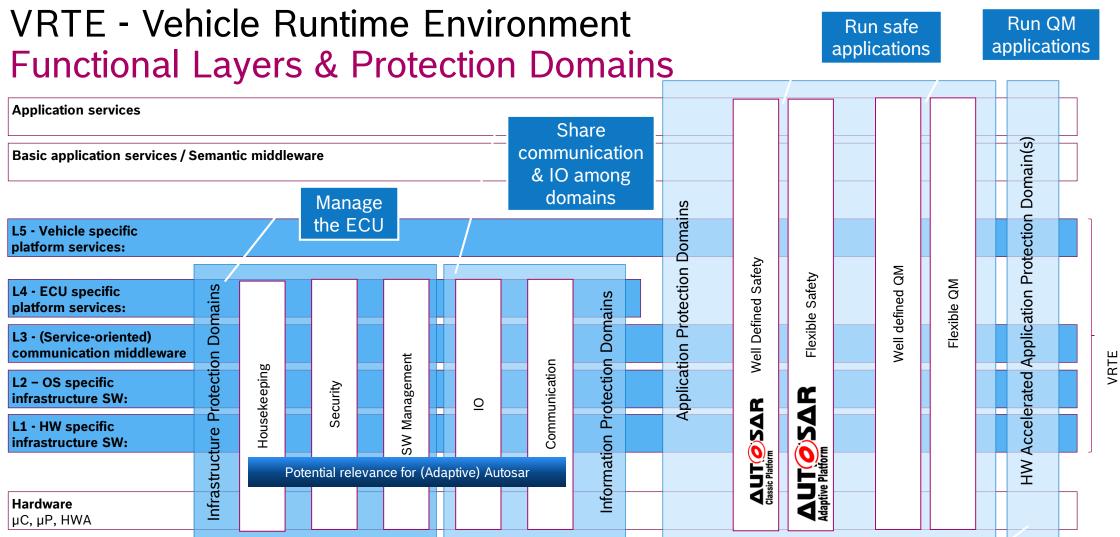
	Application services			
	Basic application services / Semantic middleware			
Ē		_		
Realized as services	L5 - Vehicle specific / cross-ECU infrastructure services: Services managing the ECU grid of the vehicle.			
	L4 - ECU specific infrastructure services: Services managing one specific ECU.			
Realized as hierarchical - layers	L3 - Communication specific infrastructure SW: Manages control and data flow between SW components.		- VRTE	
	L2 - OS specific infrastructure SW: Essential SW that complements the actual OS kernel (aka scheduler) and abstracts OS specific properties towards the higher layers.		Dependency to OS	
	L1 - HW specific infrastructure SW: SW that interacts directly with HW and abstracts it towards the higher layers.		Dependency to HW	

Hardware		
μC, μP, HWA		

μC: Microcontroller μP: Microprocessor HWA: Hardware accelerator

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μC: Microcontroller μP: Microprocessor HWA: Hardware accelerator IO: Input/output

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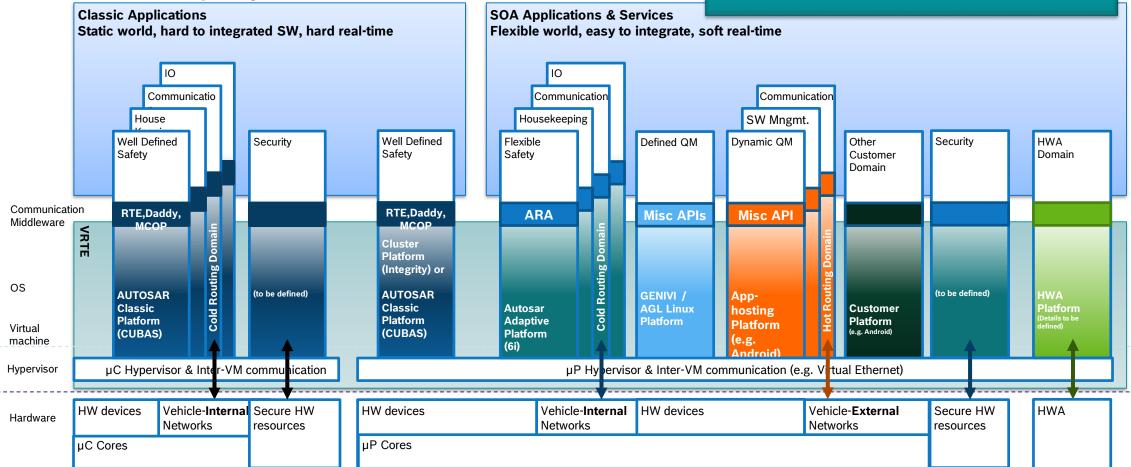
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Run applications

on HWA

VRTE - Vehicle Runtime Environment Domain deployment overview

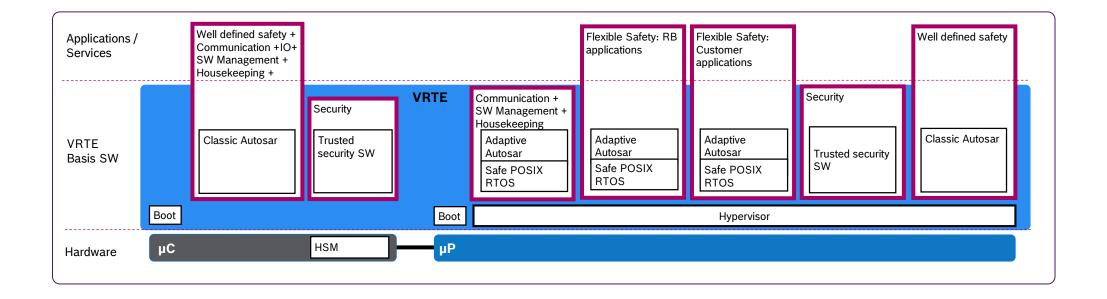
This is a 150% architecture. It is tailored for specific products.



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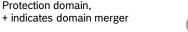
Autosar – Adaptive – and Beyond First deployment scenarios



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Legend





Thank You! Parkhaus

