**Sub-track I –
Smart Mobility Presentation**

ST automotive solutions empower the transition to e-mobility

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Marketing Manager

STMicroelectronics

ST automotive solutions

Leading solutions across a comprehensive portfolio
www.st.com/automotive

Powertrain for ICE

Body & convenience

Chassis and safety

In-vehicle infotainment

Telematics and networking

Electromobility

ADAS

Mobility service

Automotive product portfolio

Automotive microcontroller (MCU)

SPC5 32-bit microcontroller
For a wide range of automotive applications: gateways, e-mobility, ADAS, engine, transmission, body, chassis, safety…
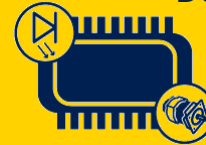
Protected switches & LED drivers ICs

VIPOWER extended offer of smart drivers for loads from 12V up to 48V loads & best in class **LED driver** tailored for car lighting systems

Motor drivers ICs

Motor drivers ICs
Cover an extensive range of voltage and current ratings of brushed DC motors, stepper motors, & brushless DC motors

Power management ICs

DC-DC converters, linear voltage regulators, power management ICs, system basis chips

Infotainment

Best in class **audio amplifier** as well as **Accordo** dual core processor for car radio and display audio applications.

ADAS applications

Automotive radars, vision, TESEO GNSS
Offer goes beyond vision addressing V2X solutions, high performance MCUs and precise positioning

Powertrain, chassis & safety ICs

Dedicated portfolio of **engine control** systems (ICE/HEV), **airbag** driver, **transmission, and battery management systems**

Power discrete devices

MOSFET, IGBT, ultra-fast diodes, rectifier diodes, SiC diodes, Schottky diodes, thyristors, protections
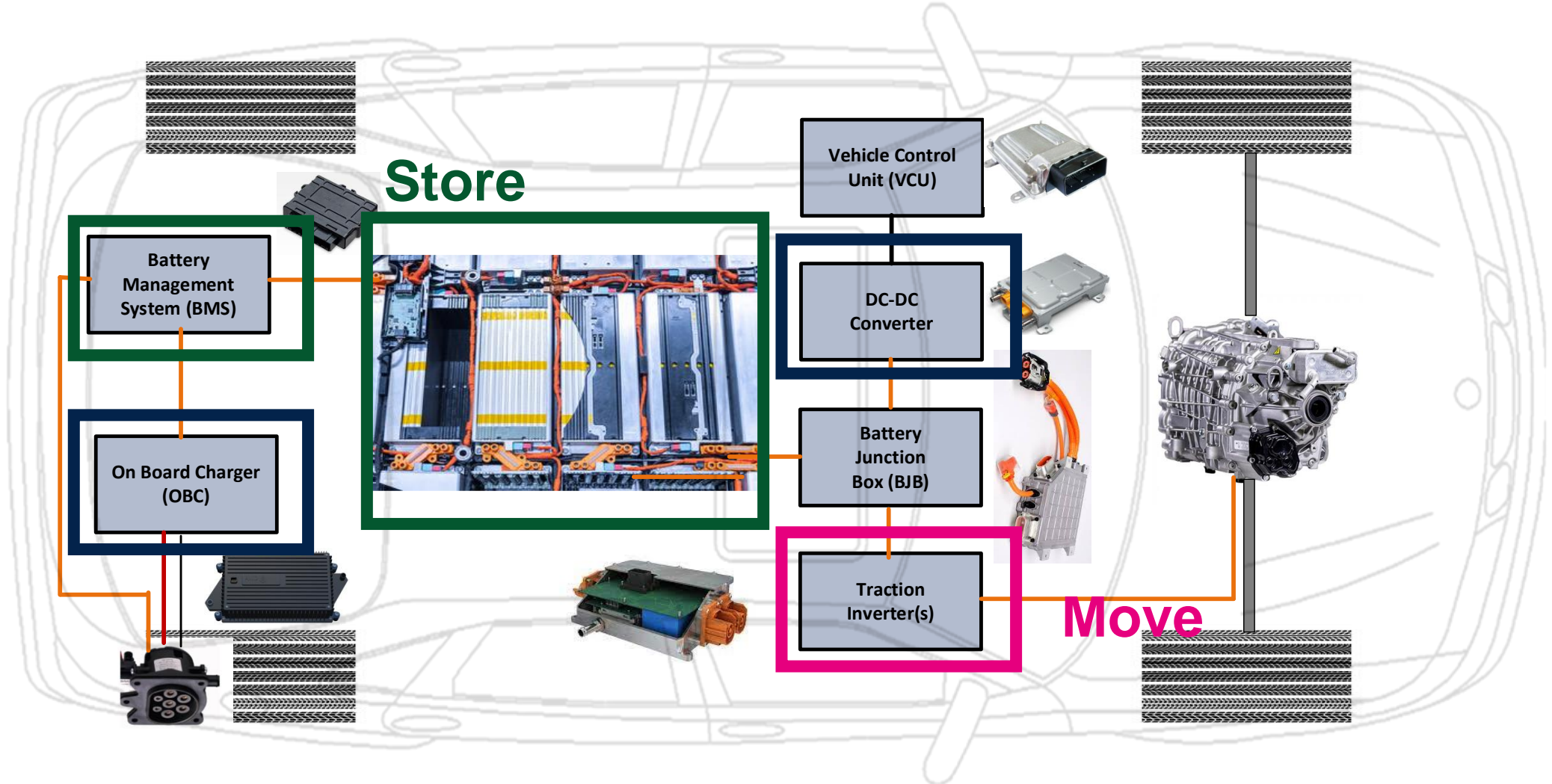Wide offer of automotive grade discrete devices

Embedded controllers and use cases

Store

Charge

Move

Battery Management System (BMS)

On Board Charger (OBC)

Vehicle Control Unit (VCU)

DC-DC Converter

Battery Junction Box (BJB)

Traction Inverter(s)

Embedded controllers and key performance indicators

Charge	Store	Move
Power Conversion	**Energy Storage**	**Power Consumption**
Systems • Chargers • DC-DC Converter	• Battery Management	• Inverters • Sensors • Motors/Actuators
KPIs • Efficiency • Emissions/THD • Power Density • Specific Power • Safety	• Safety • Service Life • Efficiency • Charge Time • Utility	• Efficiency • Power Density • Specific Power • Peak Power • Safety

ST engineers develop automotive grade products with these KPIs in mind

Stellar family: A unified computing platform

Software-defined vehicles
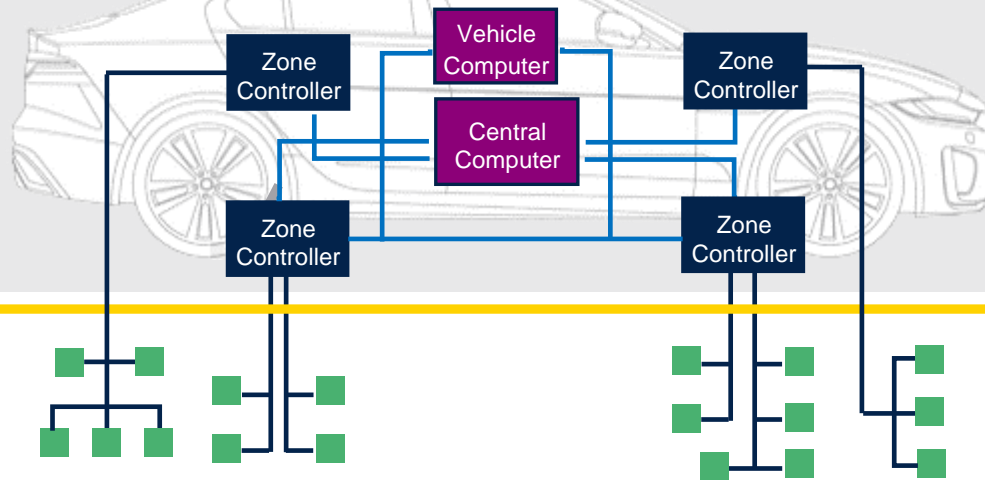Lead transformation towards lean & smart architecture

Stellar platform

Complete value chain for EVs
from integration & control to efficient energy management

Control & Computing

Vehicle Computer

Central Computer

Zone Controller

Zone Controller

Zone Controller

Zone Controller

Actuators & Sensors

Functions Integration

Stellar SR6P
Integration platform
Motion control

| Domain Controller | ICE/EV |
| BMS | Transmission |

Stellar SR6G
Integration platform
Gateway & Body

| Central Gateway | Zone Controller |
| Body integration | Domain Controller |

Actuation

Stellar SR5E
Analog performance

| Traction Inverter | OBC |
| BMS | DC/DC |

SR6 - Stellar integration platform
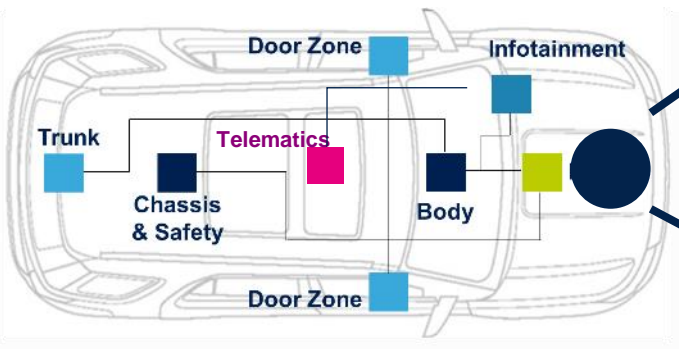
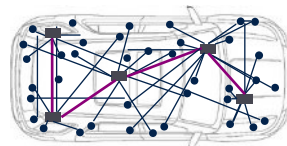**Distributed Architecture**

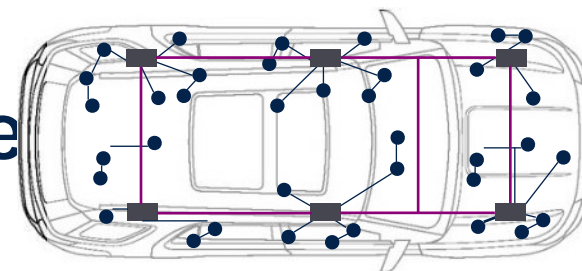**Higher Integration Architectures**

2017   2021   2024/5

Investing since 2017 on Integration Platforms

Domain
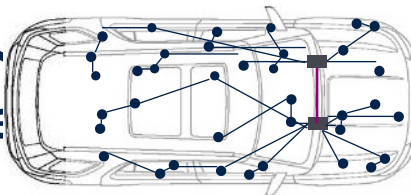
x10
Car Computational Power

Zone

Centralize

- **Extensible Integration Computing** platform

- Covers traditional to emerging market segments (Electrification, Zone ctrl)

- oriented to **software-defined cars** (OTA, Virtualization,..)

- **Portable** and Scalable

SR6 P and G proto-devices available for pre-development in vehicles
Three devices in execution ready in 2022/23 & more devices planned

SR6 – Stellar P/G integration MCU innovation with value

Future-proof Open Architecture
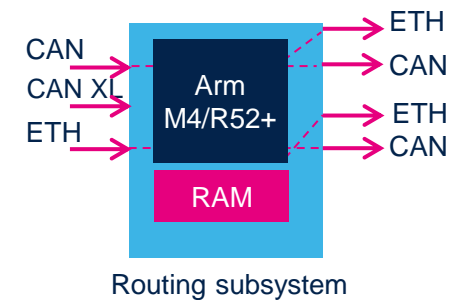
ARM Cortex

6x R52+ @400MHz

7 -16K DMIPS

Safe Network on chip

HSM w. ASILD AES HW Sec. Module

Top Real-Time performance combined with **lower power, fast start-up** and **Safety, advanced Security**

Extensible Memory & efficient OTA

Built-in **memory duplication provision** for OTA ("X2 mode")

No cost overhead No Downtime for running SW code

Current

Current image

Next image

20MB + 20MB

20MB

Run Mode | OTA Mode

Efficient routing Accelerators

CAN
CAN XL
ETH

Arm M4/R52+

RAM

ETH
CAN
ETH
CAN

Routing subsystem

Ultra real-time IN/OUT data processing

Accelerators offloading application cores
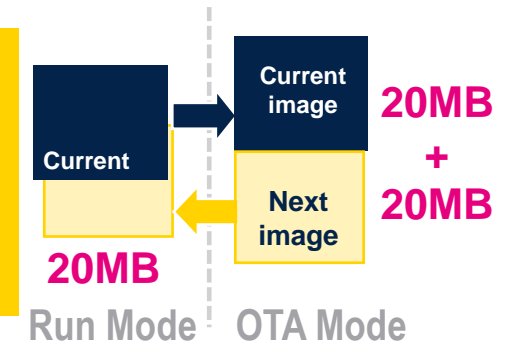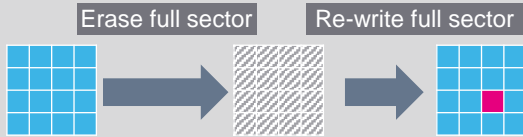
Multi-Application Integration

HW virtualization to ensure **safety, and freedom from interference**

Virtual ECU1 — VM1 — ASIL B — RTOS A — task1 task2

Virtual ECU2 — VM2 — ASIL D — RTOS B — task2 task1

Virtual ECUn — VMn — ASIL D — RTOS n

Hypervisor

Cortex R52 — EL1 MPU — EL2 MPU

Cortex R52 — EL1 MPU — EL2 MPU

Stellar

Stellar Integration MCU

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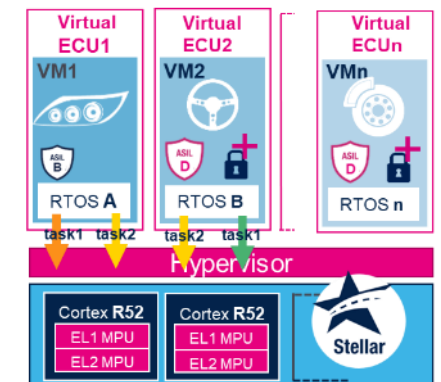
SR6 - Stellar P/G integration MCU game-changing NVM capabilities

	Flash	PCM
Write granularity	Erase full sector then program — Erase full sector → Re-write full sector	Revolutionary Programming — Single-bit alterability — 1 bit write
Retention	250 kcy write/**sector** ≥ 10 Y 1 kcy write/**sector** ≥ 25 Y	250 kcy write/**cell** ≥ 10 Y 1 kcy write/**cell** ≥ 25 Y
Programming speed	200 kB/s 4.00s/MB erasing +1.12s/MB program	**x4.5 Faster** (no erase time) — **900 kB/s** 1.12s/MB program
OTA	$$ Expensive External flash or A/B swap / NVM divided by 2	**OTA built-in** — X2 mode[*] Dynamic memory doubling — **Zero downtime OTA**
Automotive Quality	<1 ppm even at high temperature - up to 150/165 °C Tj Long lifetime profile (e.g., 20k-40kh) Soldering robustness: 3x JEDEC reflows	

(*) PCM unique OTA-X2 mode: memory size extended x2 for new image storage.
Traditional Flash requires external flash/ A/B swap to handle the new and old SW images

Best cost trade-off for long-term reliability & memory duplication for OTA updates

PCM offers a **built-in memory duplication** for OTA implementation

No memory waste caused by A/B swap approach

In operation update with **no down time**

NORMAL operation	OTA X2 mode operation	NORMAL operation
Nominal Size **20MB**	**Double Capacity** **20MB + 20MB**	**Nominal Size** **20MB**
(2cells/bit) **Execute**	(1cell/bit) **Execute** (1cell/bit) **Update**	(2cells/bit) **Execute**
Car lifetime retention	OTA Update retention	Car lifetime retention

Configuration example

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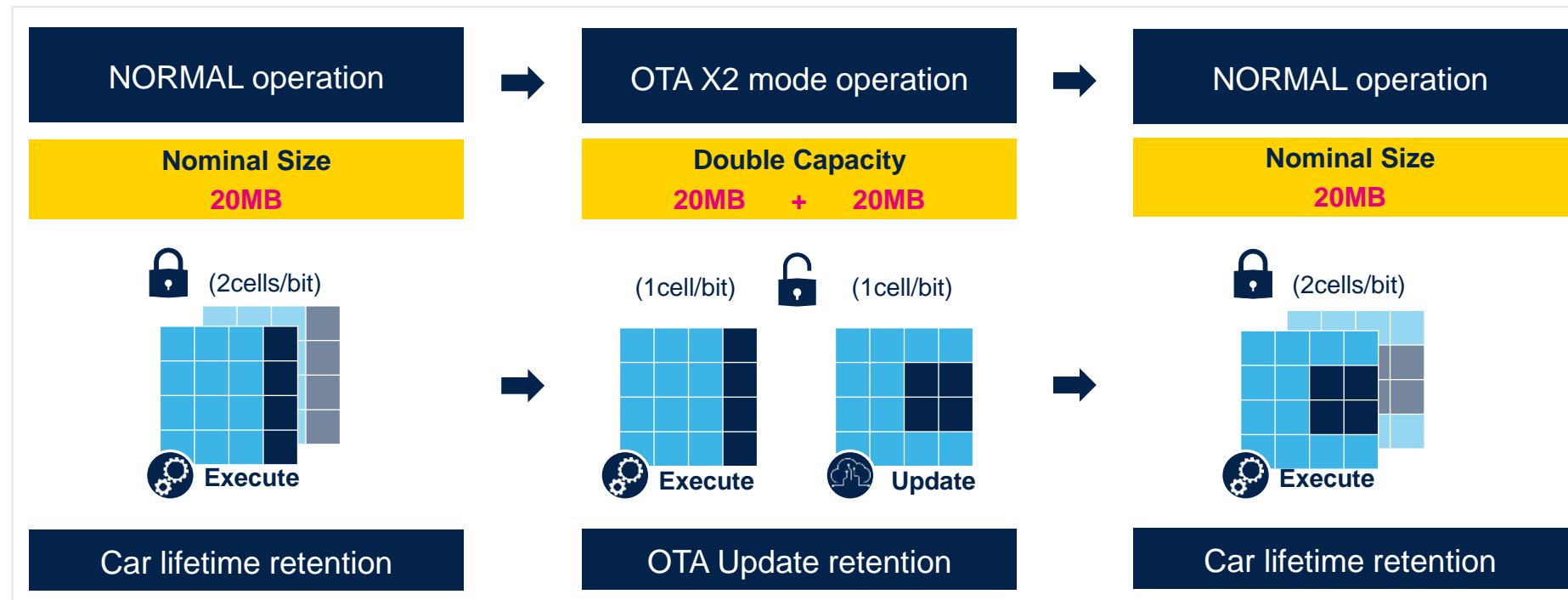
Wide bandgap (WBG) companion chip

FAST Acquisition Actuation Protection

Today's MCUs have limitations to support full Switching Frequency range requested by new wide bandgap technologies needed for new Electric Vehicle's higher Power Efficiency.

STELLAR ARM® MCUs have been carefully optimized to **best leverage SiC & GAN Power products** with upmost Control Loop capabilities, together with all state-of-the-art Automotive requirements (Safety, Security, OTA, SW Packages, ...)

From ICE to EV MCU:
Switching Performance boost to maximize Power Efficiency

Core Processing & PWM — ICE MCU / STELLAR MCU — **1.5** times faster

Peripherals Access — **4** times faster

Analog & Protection — **5** times faster

x5 → Switching Control Frequency

along with state-of-the-art **Safety & Security**
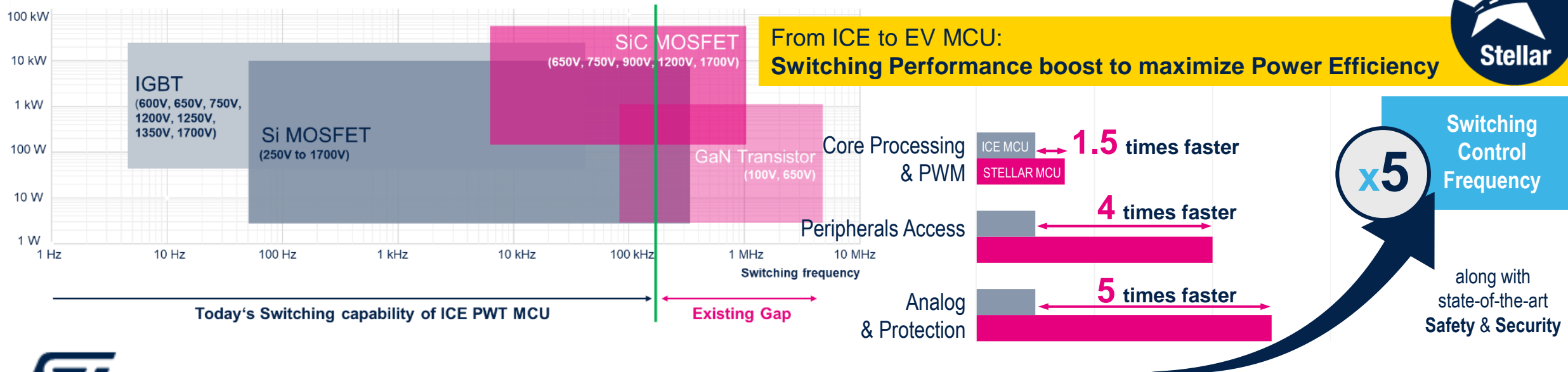
Stellar E MCU series innovation

Stellar · **Safety Ready** · **SR5E1x**

Characteristics → **Enable** → **Address KPIs**

High-performance COMPUTE
2x 32-bit Arm® Cortex®-M7 @300Mhz
Configured in split-lock or lockstep
CORDIC math acceleration

Fast Transient Response

High Switching Speed

High-performance ANALOG
5 x 12-bit @ 2.5 Msps SAR
2 x 16-bit ΣΔ
10 x 12-bit DAC
8 x 50 ns Comparators

Protection

High-performance PERIPHERALS
High Resolution Timers (104 ps)
Motor Control Timers
32-bit Timers
16-Bit Timers

Adaptive Dead Time

Fast Control Loop

CONNECTIVITY
CAN FD
LIN
SPI
I2C
I2S

Tight HW/SW Coupling

OBC
- Efficiency
- Emissions/THD
- Power Density
- Specific Power
- Safety

BMS
- Safety
- Service Life
- Efficiency
- Charge Time
- Utility

TRACTION
- Efficiency
- Power Density
- Specific Power
- Peak Power
- Safety

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Compilers, debuggers and probes

Stellar E1 toolchains and debug environment

	Fast prototyping	Advanced solution
Compilers	arm gcc	arm clang / HIGHTEC / Green Hills SOFTWARE, INC. / IAR SYSTEMS
IDE	ST life.augmented StellarStudio	Green Hills SOFTWARE, INC. / HIGHTEC / IAR SYSTEMS — planned
Debuggers Probes	ST life.augmented StellarLink / SEGGER / IAR SYSTEMS — planning	LAUTERBACH DEVELOPMENT TOOLS / pls Development Tools — link / iSYSTEM

**Introducing -
the combo (OBC+DC-DC) solution**
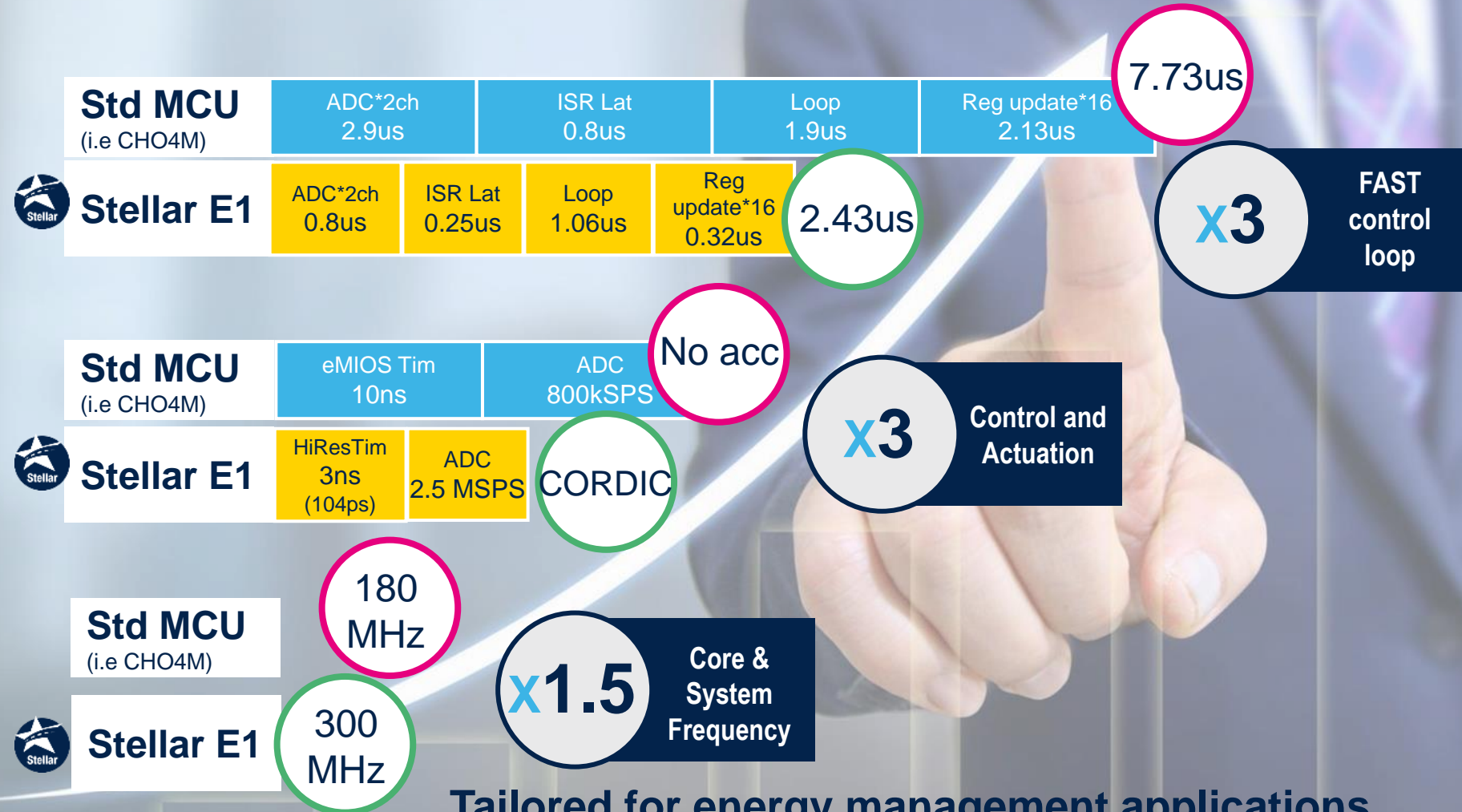
Combo solution
Stellar-E redefines low latency embedded control

Stellar E

Best leverage SiC & GaN power products

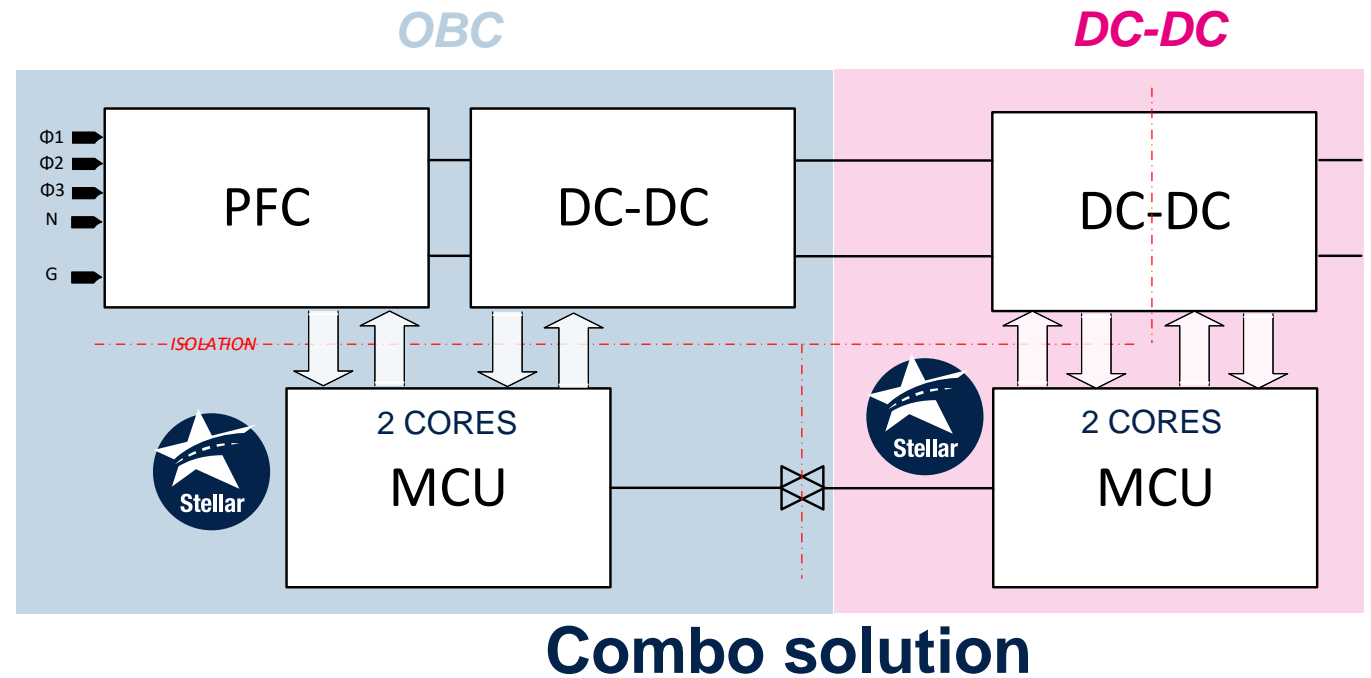**Including MATLAB generated code for OBC system**

Std MCU (i.e CHO4M)	ADC*2ch 2.9us	ISR Lat 0.8us	Loop 1.9us	Reg update*16 2.13us	7.73us
Stellar E1	ADC*2ch 0.8us	ISR Lat 0.25us	Loop 1.06us	Reg update*16 0.32us	2.43us

x3 FAST control loop

Std MCU (i.e CHO4M)	eMIOS Tim 10ns	ADC 800kSPS	No acc
Stellar E1	HiResTim 3ns (104ps)	ADC 2.5 MSPS	CORDIC

x3 Control and Actuation

Std MCU (i.e CHO4M)	180 MHz
Stellar E1	300 MHz

x1.5 Core & System Frequency

Tailored for energy management applications

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Combo solution overview is the slide title.
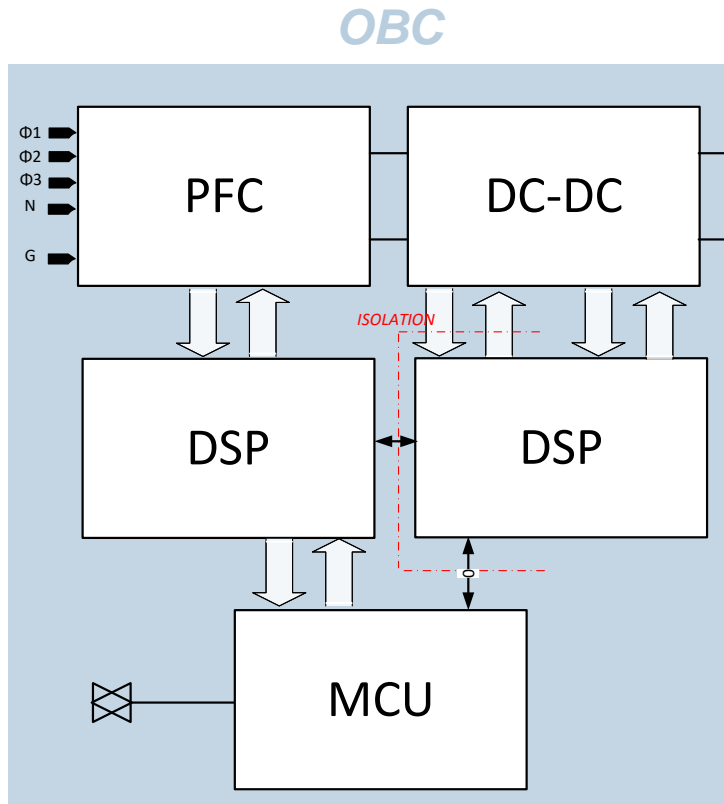
Conventional approach

Combo solution

Combo solution hardware components

Algorithm/Control
32-Bit Microcontroller
Stellar SR5E1E7

DIGITAL

Bridges and Switches
1200V SiC
SCTW100N120NG2AG

Gate Drivers
STGAP, L9501

POWER

LV MOSFETS
STH315N10F7

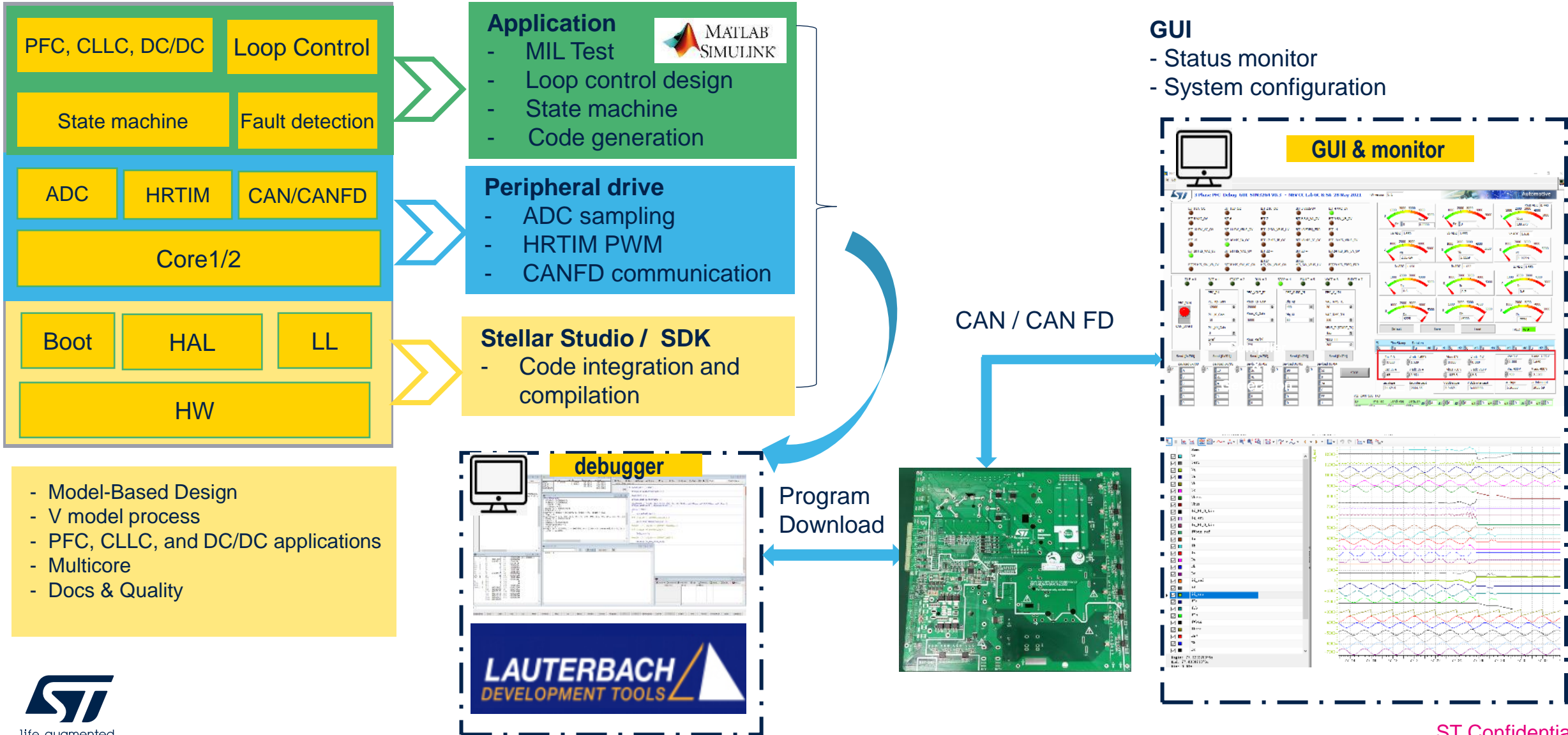## Sensing/Feedback
Analog
TSV791IYLT, TSV911IYLT,
TSC 2011IYDT

ANALOG

OBC

DC-DC

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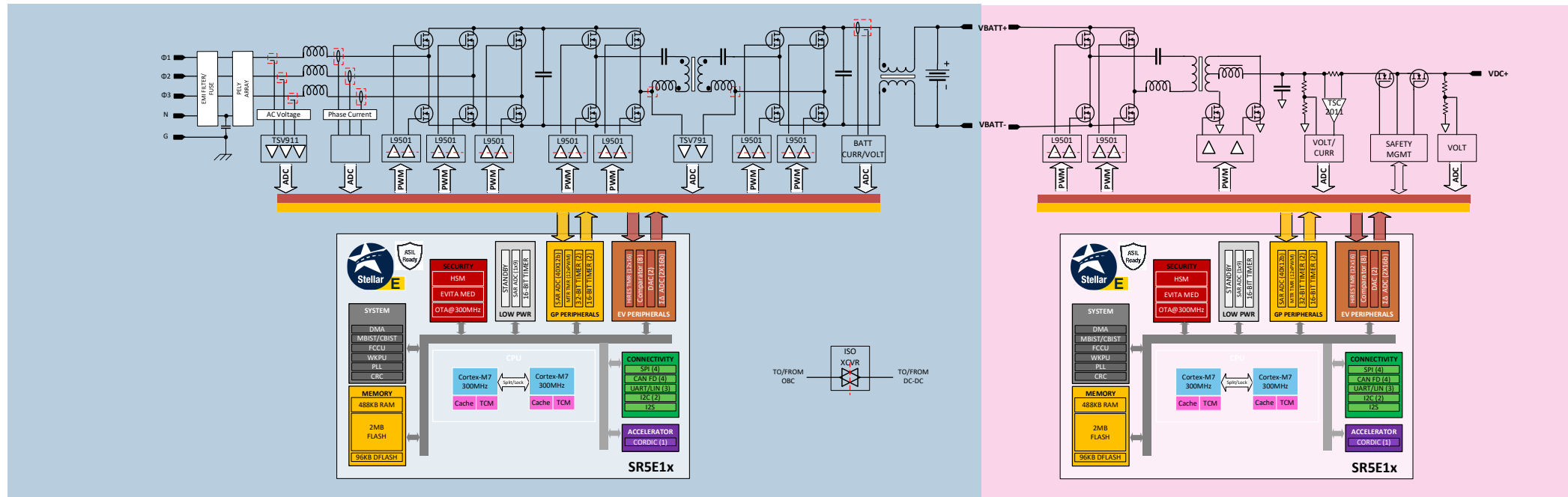
Combo solution
Software development flow

Stellar E

PFC, CLLC, DC/DC | **Loop Control**

State machine | **Fault detection**

ADC | **HRTIM** | **CAN/CANFD**

Core1/2

Boot | **HAL** | **LL**

HW

- Model-Based Design
- V model process
- PFC, CLLC, and DC/DC applications
- Multicore
- Docs & Quality

Application
- MIL Test
- Loop control design
- State machine
- Code generation

MATLAB SIMULINK

Peripheral drive
- ADC sampling
- HRTIM PWM
- CANFD communication

Stellar Studio / SDK
- Code integration and compilation

GUI
- Status monitor
- System configuration

GUI & monitor

CAN / CAN FD

debugger

LAUTERBACH
DEVELOPMENT TOOLS

Program Download

ST Confidential

ST Confidential

E

Integrate dual traction inverter and DCDC converter management

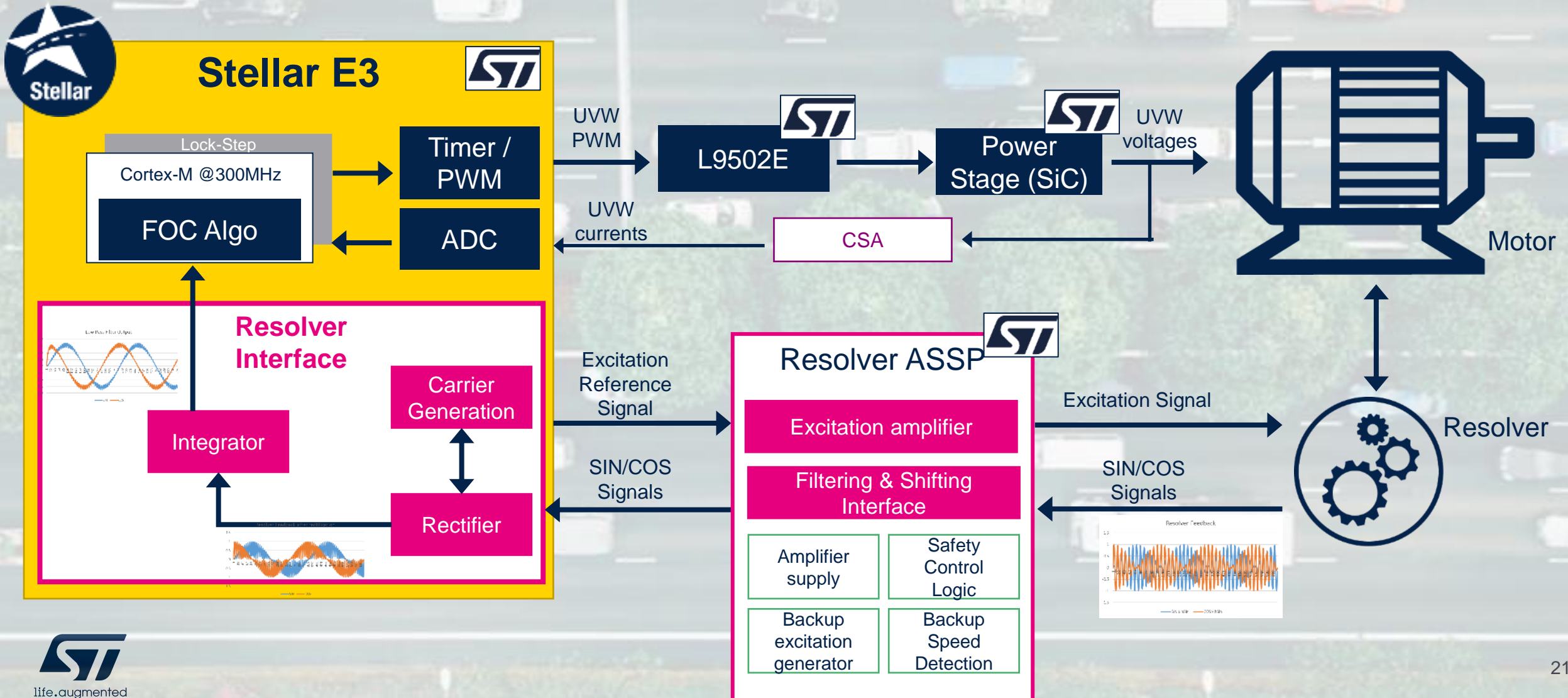### All system control in ONE MCU

Standard Approach for Power Control Unit
Traction Inverter + Traction Boost DC/DC + Auxiliary DC/DC

MCU

Resolver → Traction Inverter

DSP — Control Loop

DSP — Control Loop

Traction Boost DC/DC → Auxiliary DC/DC

Stellar E

Stellar E3

2x Resolver

Control Loop

RSC IC → Traction Inverter

Traction Boost DC/DC → Auxiliary DC/DC
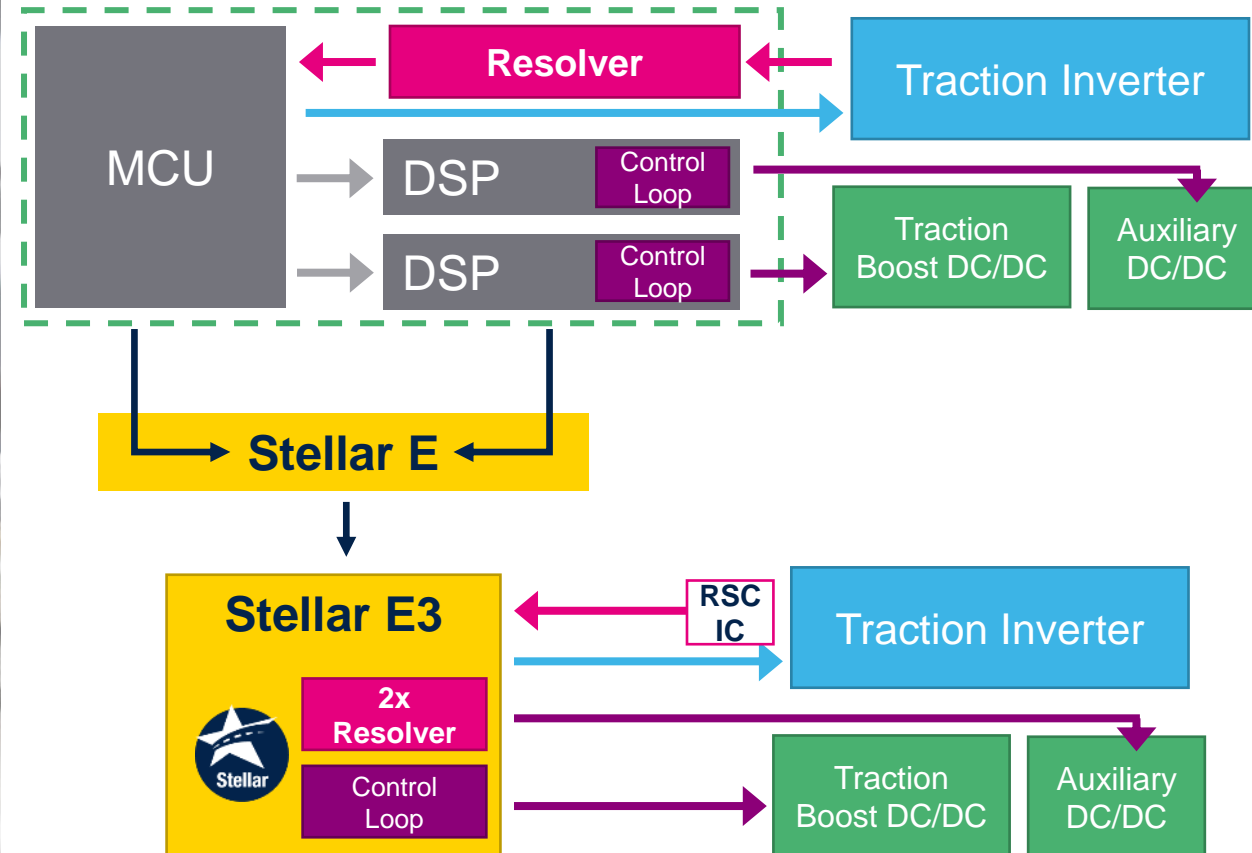
Battery management solutions

L9963E-T – 14 channel stackable battery monitoring / balancing chipset

STBMIC

Accurate, real-time measurement of battery cell voltage, current and temperature

TQFP64 10x10
exposed pad down

L9963E

SO16N

Battery pack monitoring , balancing and protection up to 14 cells

14 independent ADCs for cell voltage measurement

Synchronized acquisition of cell voltage and pack current

High accuracy current measurement with Coulomb counter

Fully programmable via SPI interface

High-speed and robust transformers and capacitive isolation

Main Applications

- Automotive: 48 V and high-voltage battery packs
- Backup energy storage systems and UPS
- E-bikes, e-scooters

L9963E-T – 14 channel stackable battery monitoring / balancing chipset

STBMIC

L9963E: 14-cell, high-accuracy voltage monitoring and balancing, with temperature, stack voltage and current monitoring with Coulomb counting

L9963T: High-speed Vertical InterFace (VIF) for isolated SPI communication, single- and dual-channel versions supporting transf and capacitive isolation
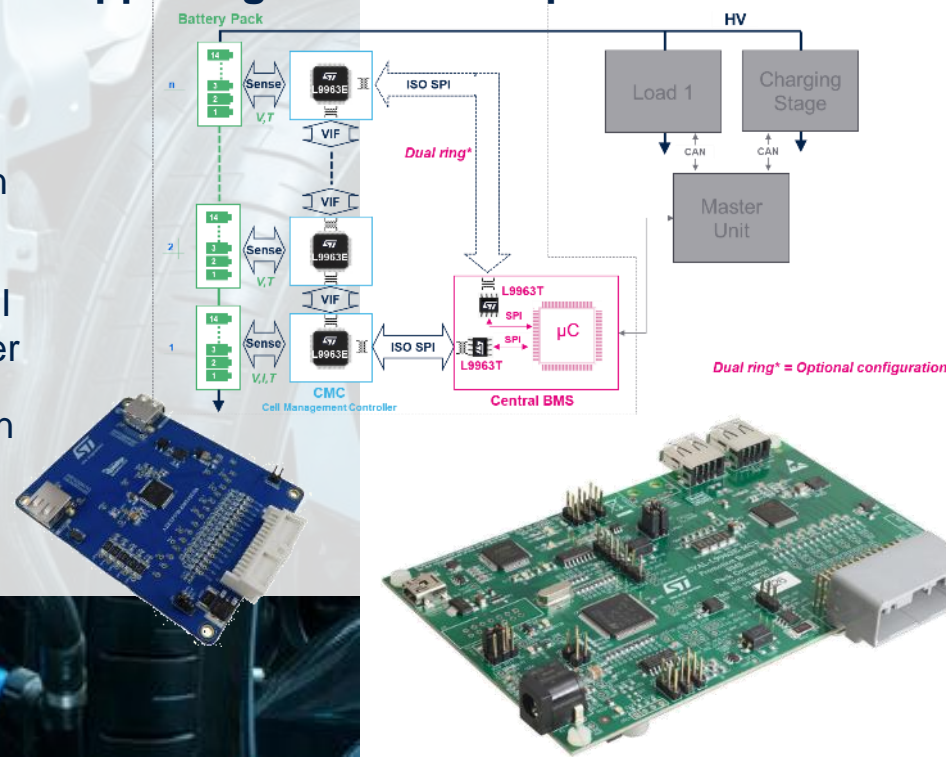
Status: in production

AEK-POW-BMS63EN Battery Management System solution based on L9963E with AutoDevKit support
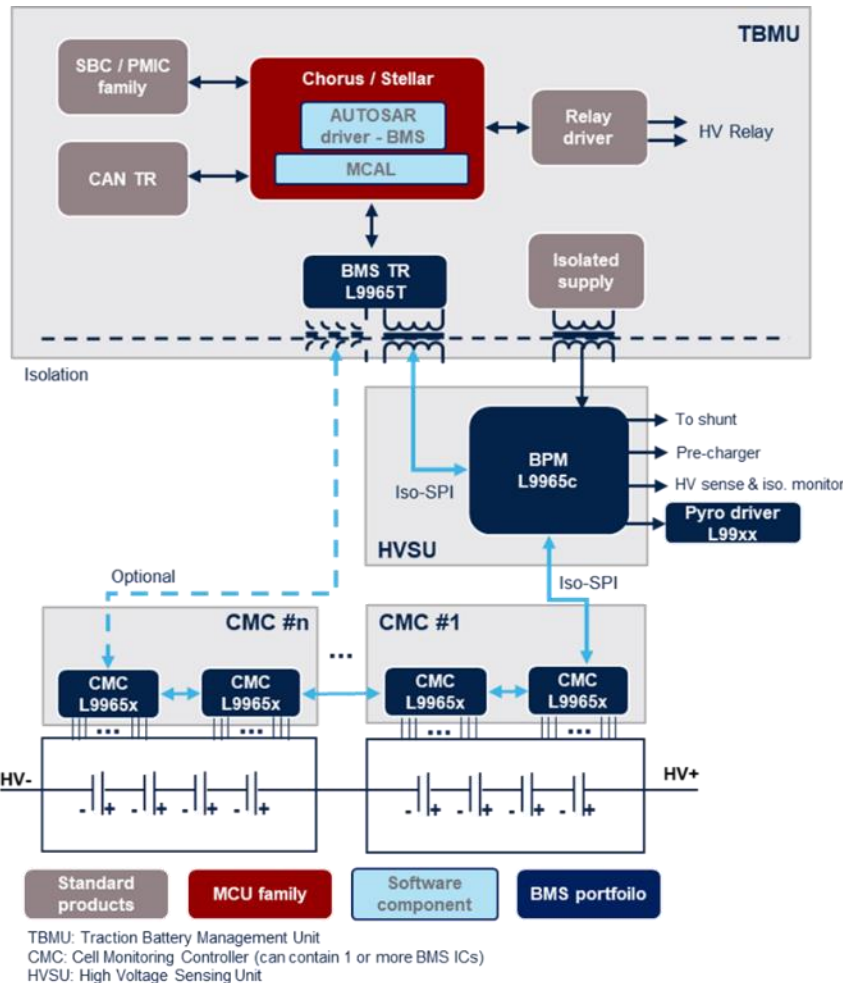
AEK-COM-ISOSPI1 SPI to isolated SPI dongle based on the L9963T transceiver

EVAL-L9963E-MCU L9963E Evaluation Board with on board MCU

SPC5 Studio plugin device drivers

L9965x – 16-18 channel stackable battery monitoring / balancing system

L9965x — Next-generation, 16 to 18 cell, high-accuracy voltage monitoring and balancing, with temperature, stack voltage measurement

L9965C — Battery Pack Monitoring IC with precise I/V/T sense & fast overcurrent detection, daisy chain compatible with L9965x

L9965T — High-speed Vertical InterFace (VIF) for isolated SPI communication, single- and dual-channel versions supporting transf and capacitive isolation

TBMU: Traction Battery Management Unit
CMC: Cell Monitoring Controller (can contain 1 or more BMS ICs)
HVSU: High Voltage Sensing Unit

Engineering sample 2023   **Final samples 2024**   **PPAP 2025**

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Automotive system solution catalog

20+ system solution campaigns already launched… new solutions launched every quarter…
…and a short/medium term plan defined

12V Heating Systems	**High-integration chipset** for EFI small engine applications	**48V Electric Traction**	**USB Type-C Power Delivery**	**Head-Up display Stepper Motor**
Infotainment Power supply L5963 - Multi-channel SMPS	**H-Bridge DC Motor Driver** for Automotive Application	**12V Heating Systems Renew Campaign**	**Auto LED Lighting**	**Window Lift**
Trunk Control System	**Automotive Pumps**	**TESEO-LIV3F Module**	**Seat Positioning**	**Adaptive front Lighting**

… and much more!!!

Our technology starts with You

🌐 Find out more at www.st.com/automotive

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