Safety Power Management for Automotive Radar and ADAS Applications

Yasuomi Sakyu

Product Marketing

Safety and Power Management Group

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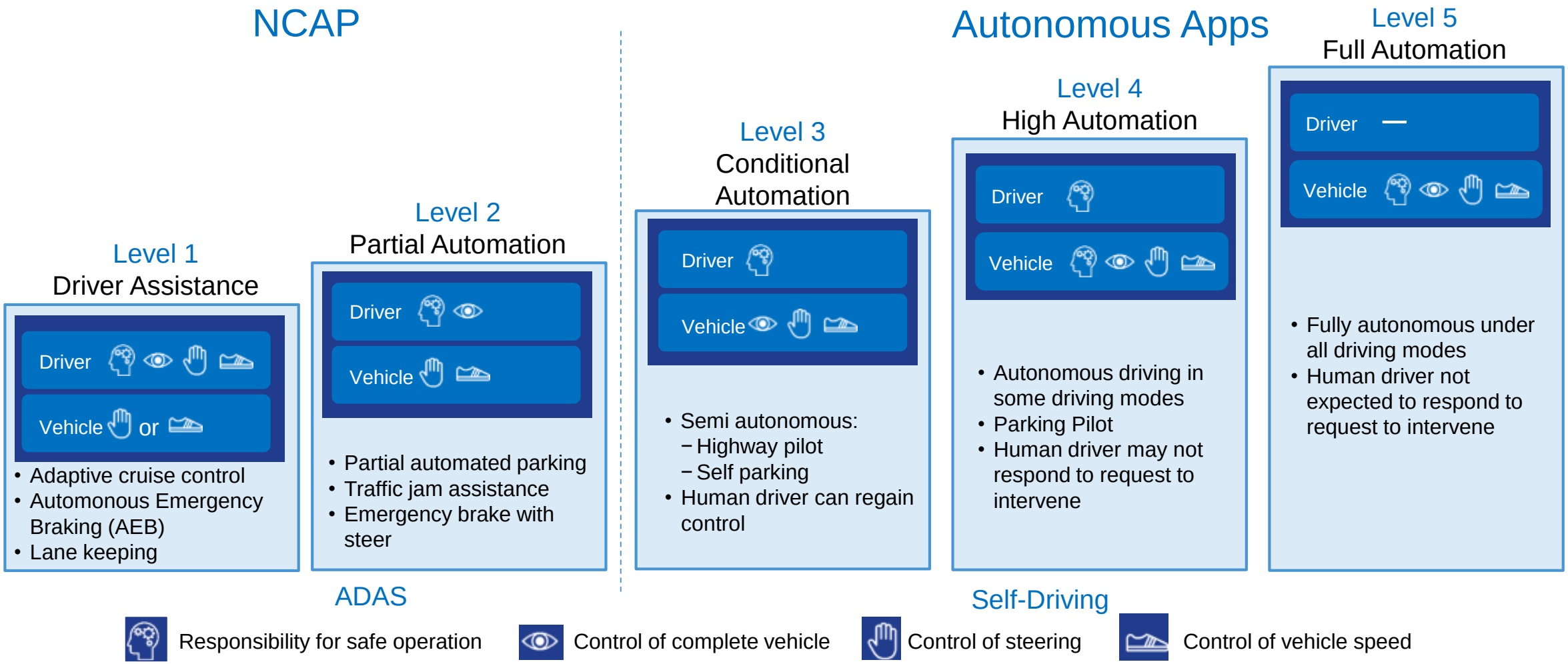
SECURE CONNECTIONS FOR A SMARTER WORLD

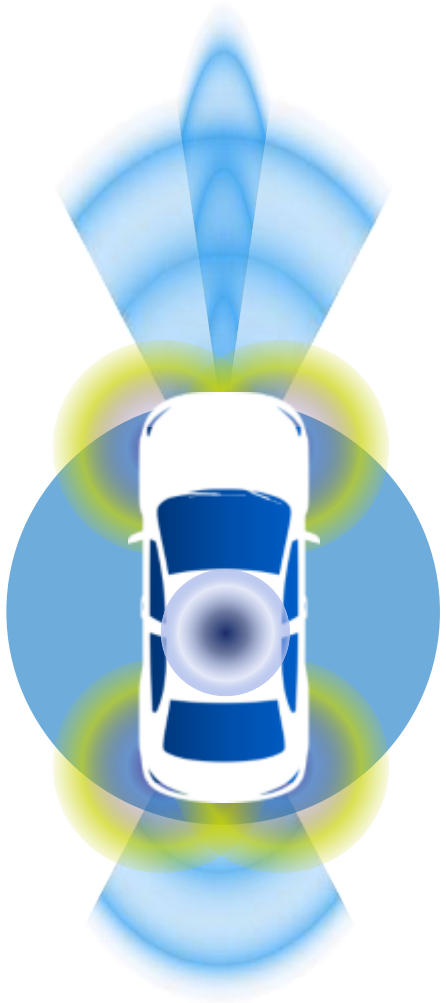
Agenda

- ADAS Market Trend
- NXP Safety Power Management Strategy and Device Portfolio
- Functional Safety Implementation
- Application Example
- Summary

Autonomous Driving Category



ADAS System Solutions



RADAR : S32R + TEF810X

Front L/M Range

Corner Radar

Imaging Radar

VISION : NCAP & Open Standards : S32V

Front View

Surround View

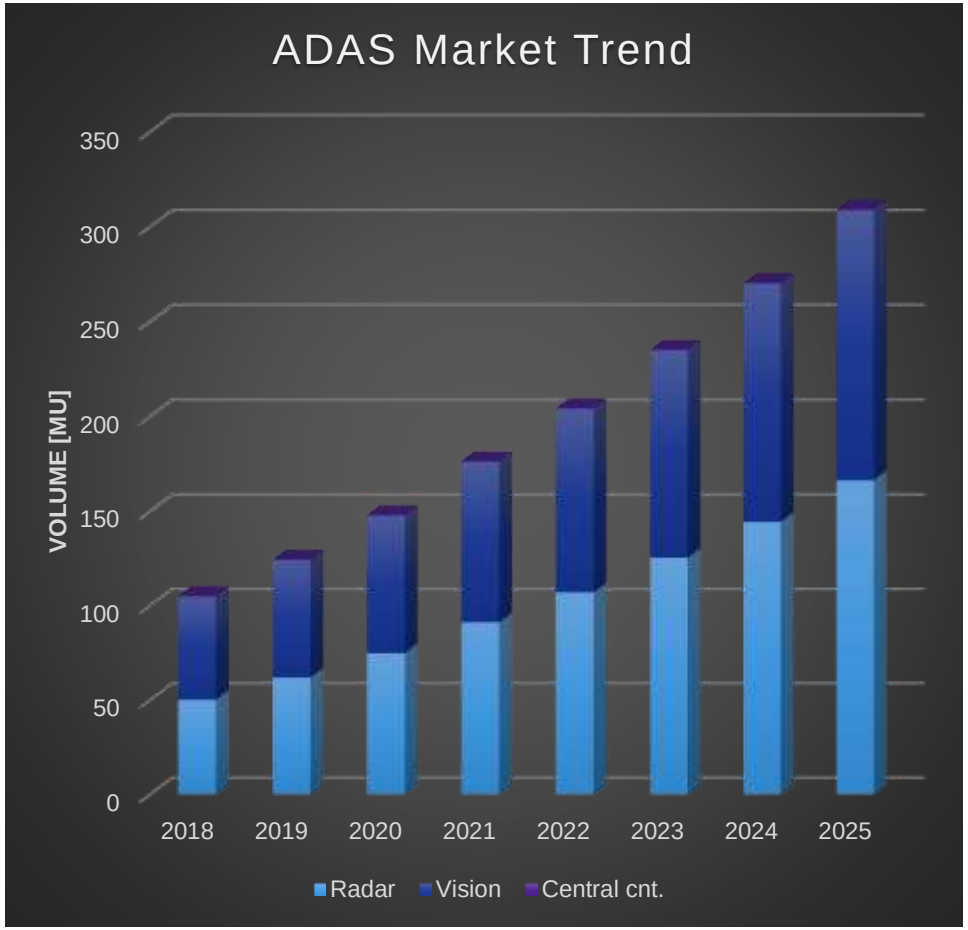
Driver Monitor

SAFE Central Processing for L3-L5

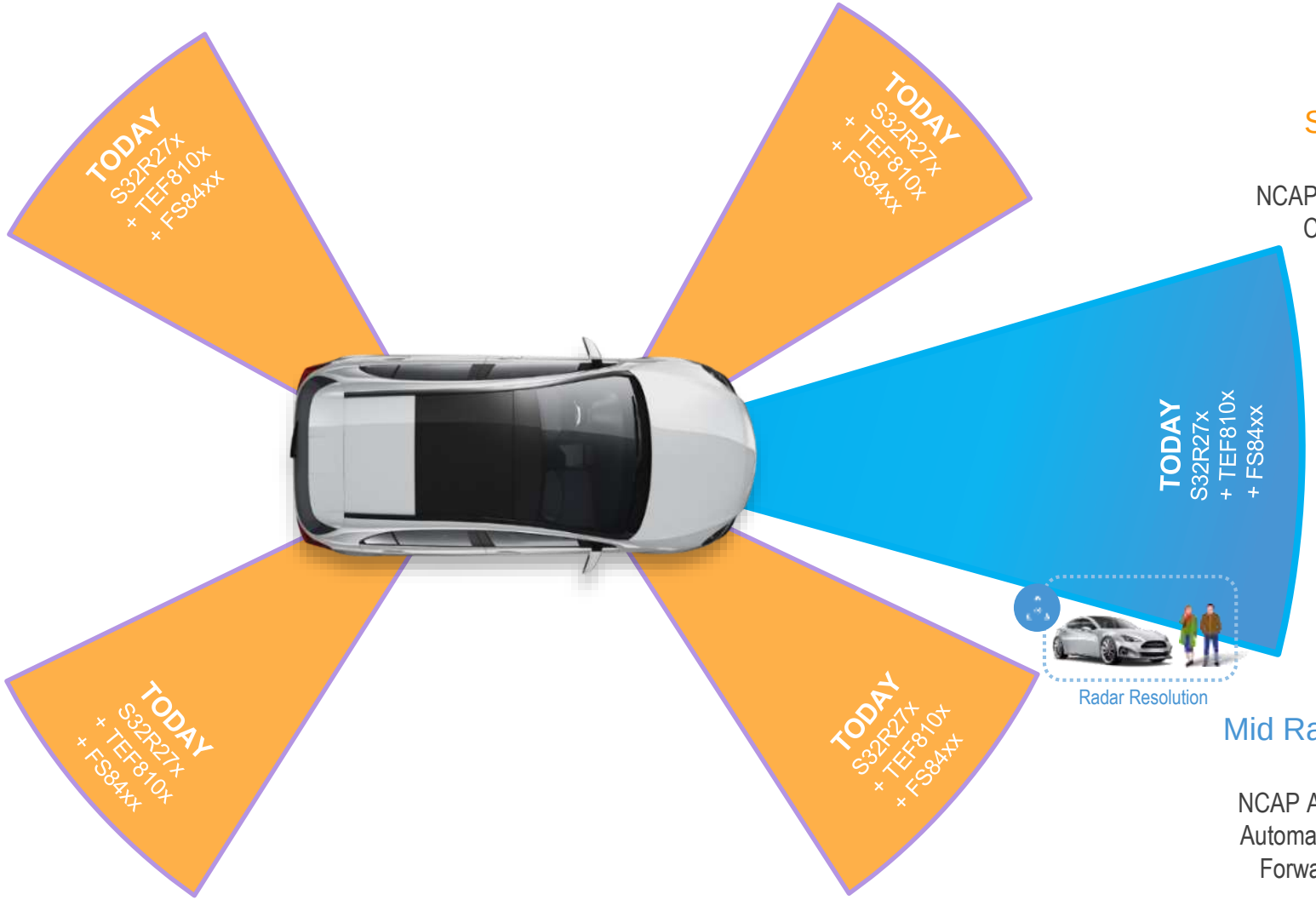
Aut. Driving AI

Perception

Planning



Radar application : Today

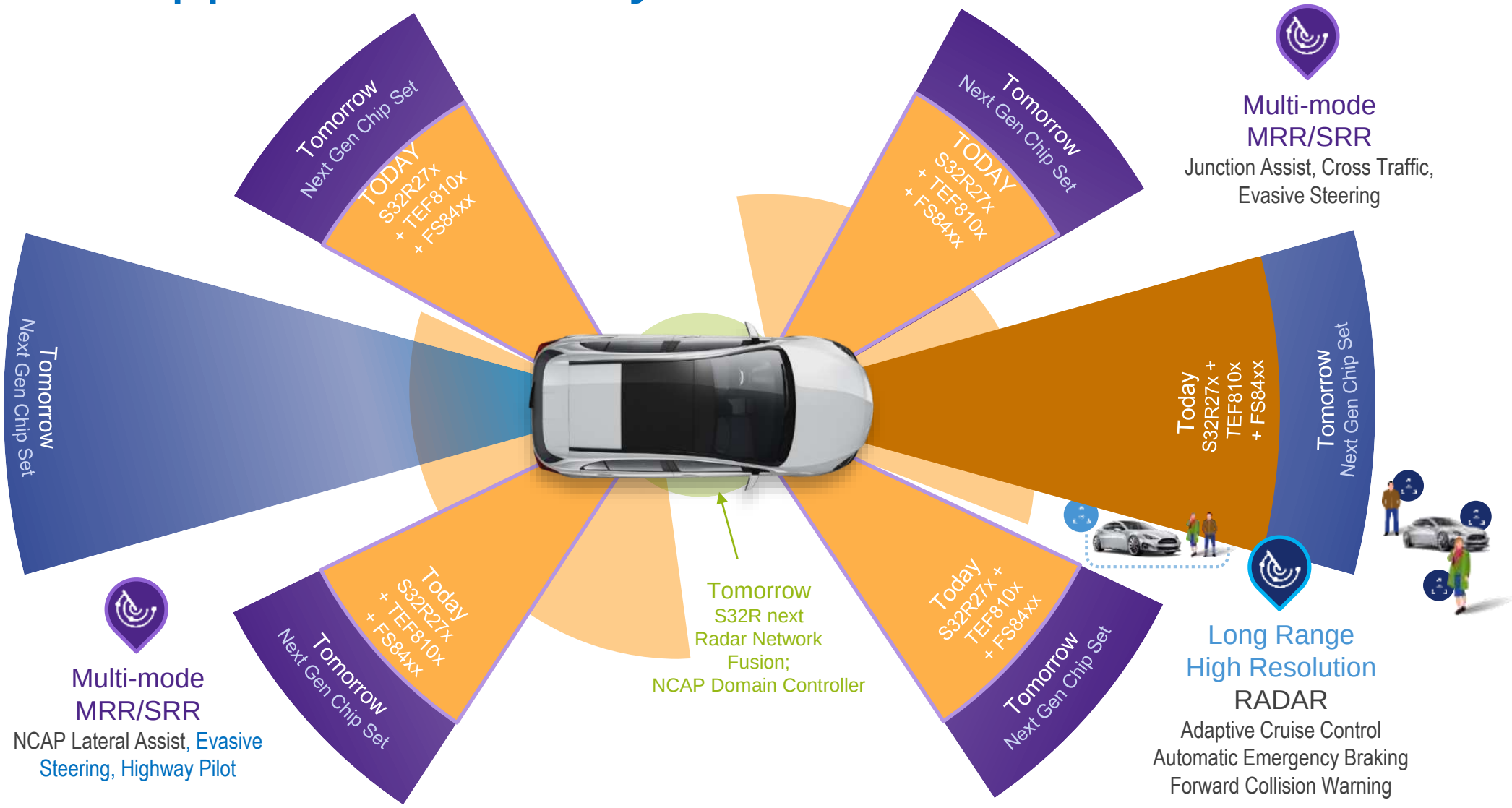


Short Range
RADAR
NCAP 2020 Junction Assist
Cross-Traffic Alert

Short Range
RADAR
NCAP Lateral Assist

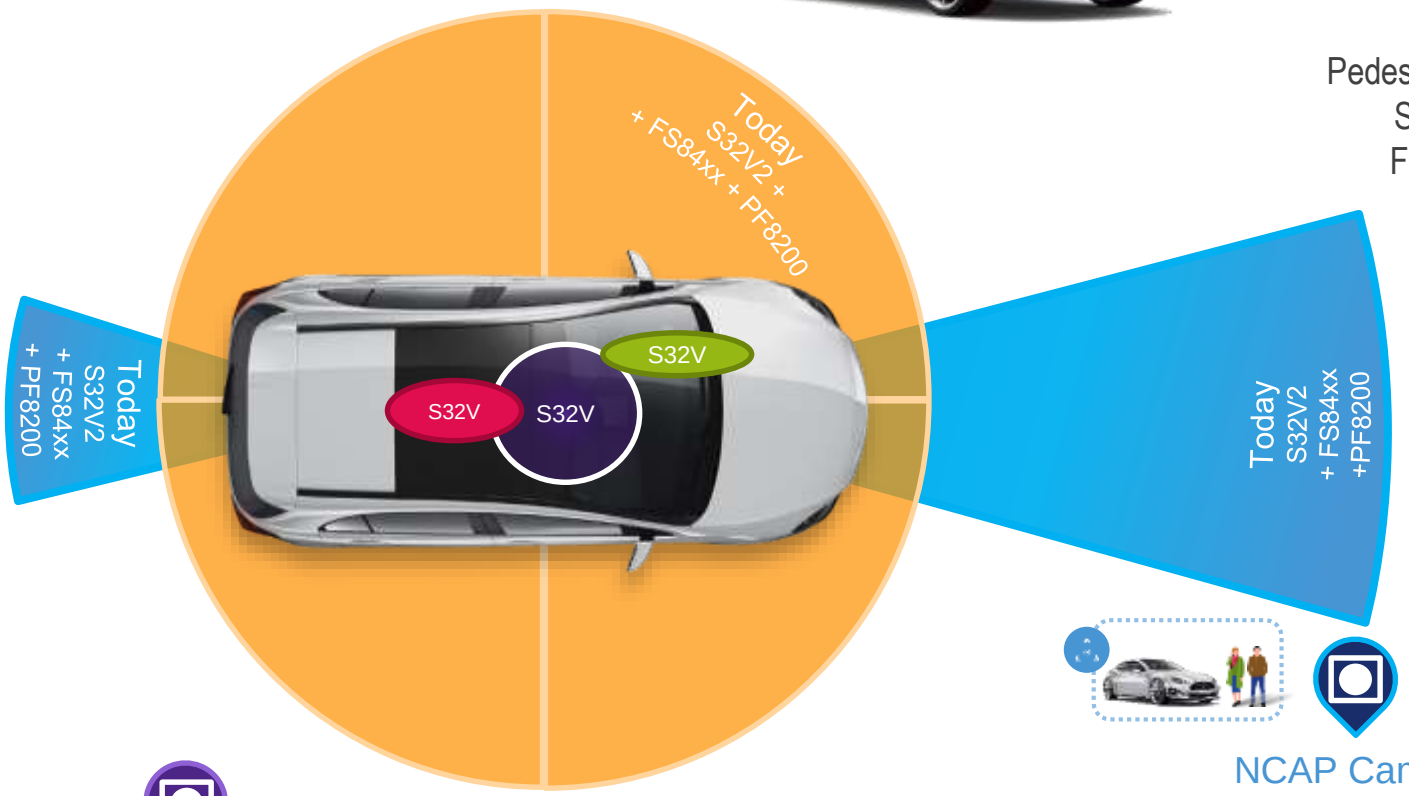
Mid Range/Long Range
RADAR
NCAP Adaptive Cruise Control
Automatic Emergency Braking
Forward Collision Warning

Radar application : Today & Tomorrow



Vision/Lidar application : Today

Lidar
LIDAR
Pedestrian Detection
Scene Seg
Free Space



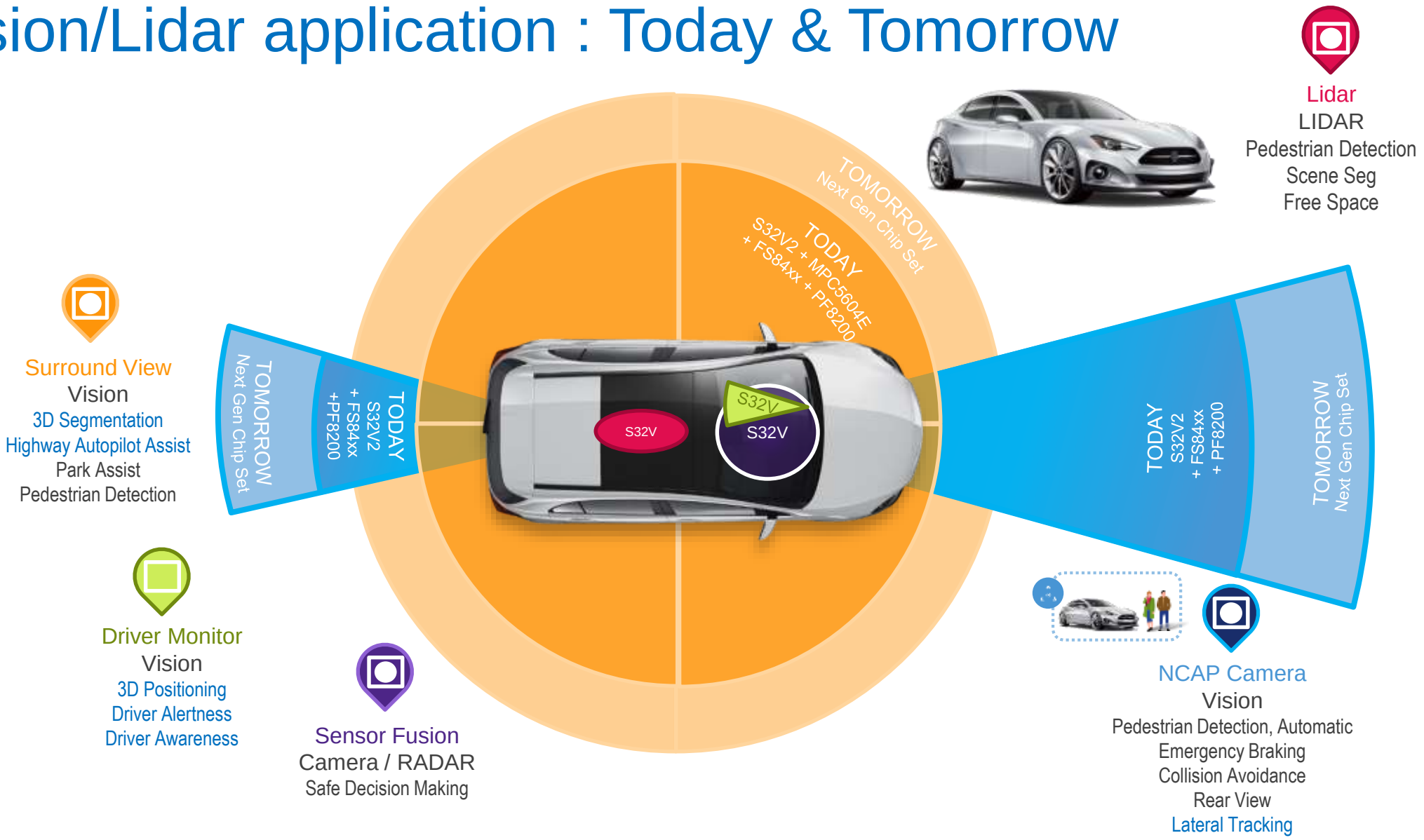
Surround View
Vision
Park Assist
Pedestrian Detection

Driver Monitor
Vision
Face Tracking
Drowsiness monitor

Sensor Fusion
VISION / RADAR
Safe Decision Making

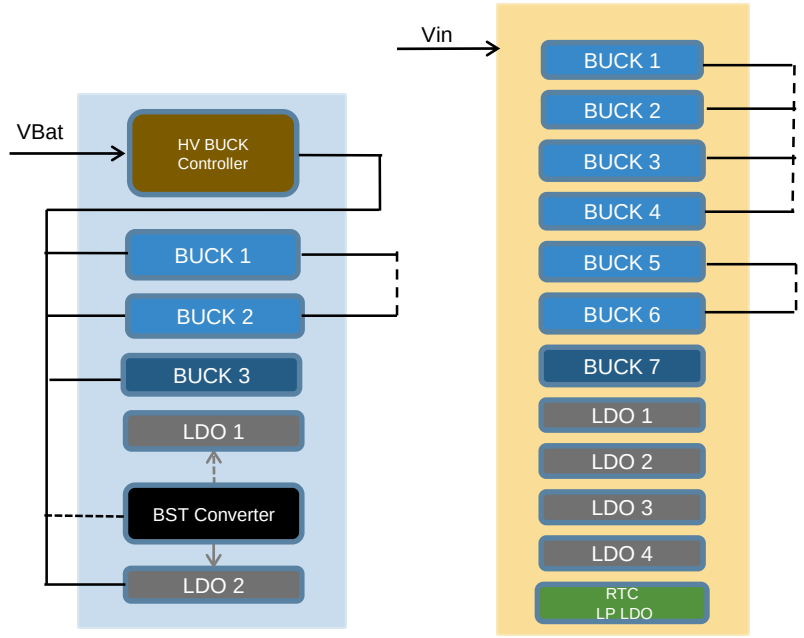
NCAP Camera
Vision
Pedestrian Detection
Automatic Emergency Braking
Forward Collision Warning
Rear View

Vision/Lidar application : Today & Tomorrow



Addressing Advanced Automotive System Power Challenges

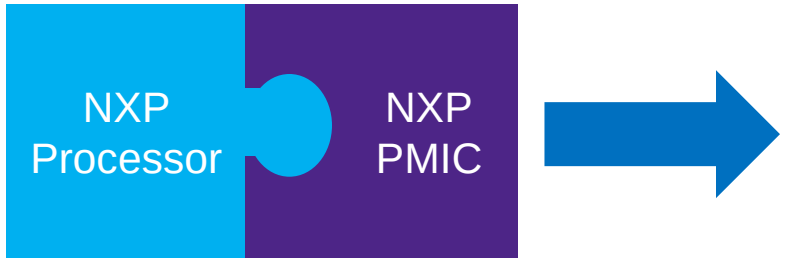
Heat Dissipation Hot Spots, Extended Temperature	Higher Power Efficiency, Scalable Architecture (e.g. Multi-Phase SMPS, Master-Slave Architecture
Deep Submicron Process Technology	Lower Voltage Ripple Transient & Static
Optimized SoC Power within Safe Operation range	Voltage Scaling and Higher Monitoring Accuracy
Noise reduction & Interference	Lower Emission w/ Frequency Tuning, Synchronization & Spread Spectrum
New Low Power Modes e.g. DDR Refresh/ Retention Mode	Low Power Design & Modes Short Wake Up Time
System Scalability and Performance	Scalable Architecture Power Management & Functional Safety
Safety and System Availability	Configurable Fault Recovery and Fail-Safe Architecture

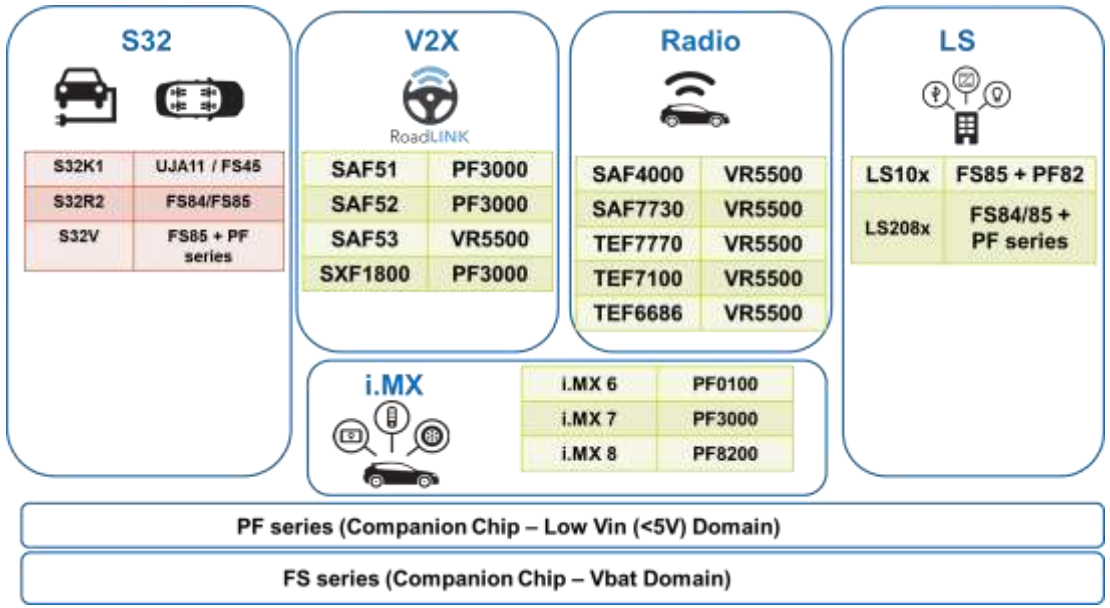


Optimized Embedded System

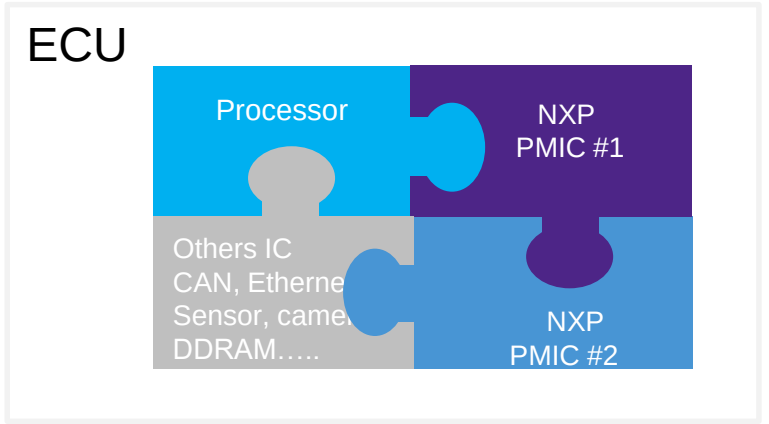
NXP Safety PMIC Strategy

1 100% Processor Attach



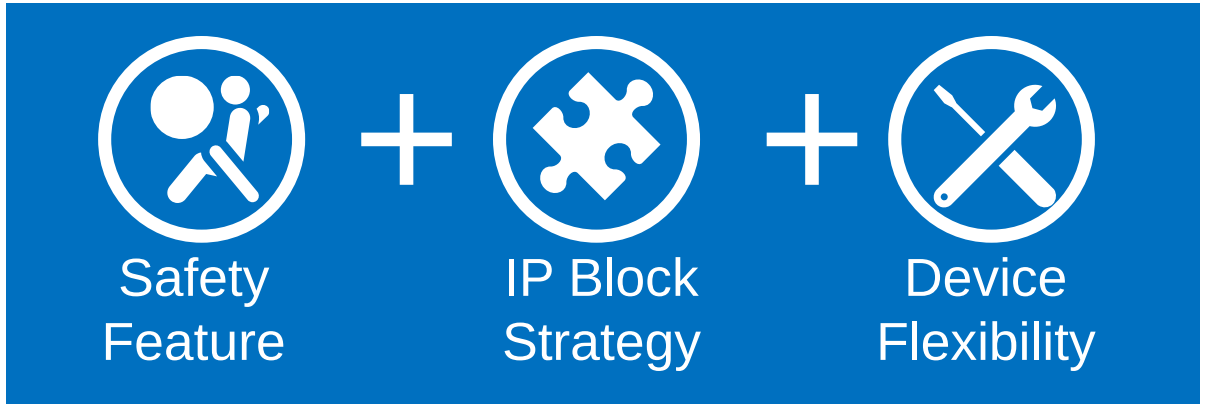


2 System Power Solutions



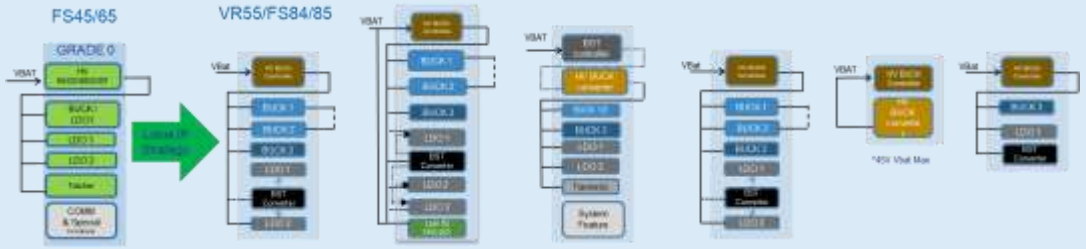
Safety PMIC “building blocks” Portfolio

NXP Safety PMIC Concepts



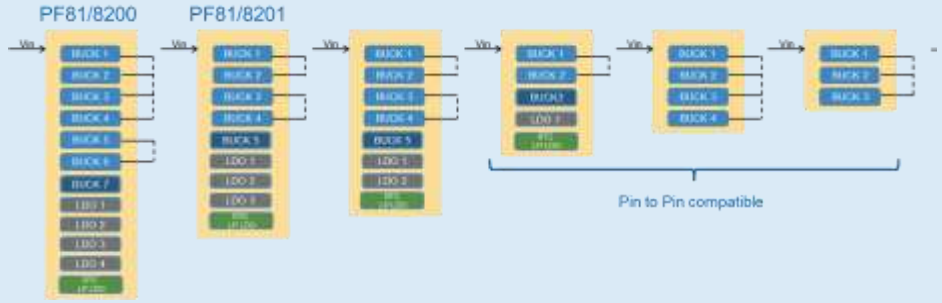
Automotive PMIC 12V/24V Battery Connected

FS series

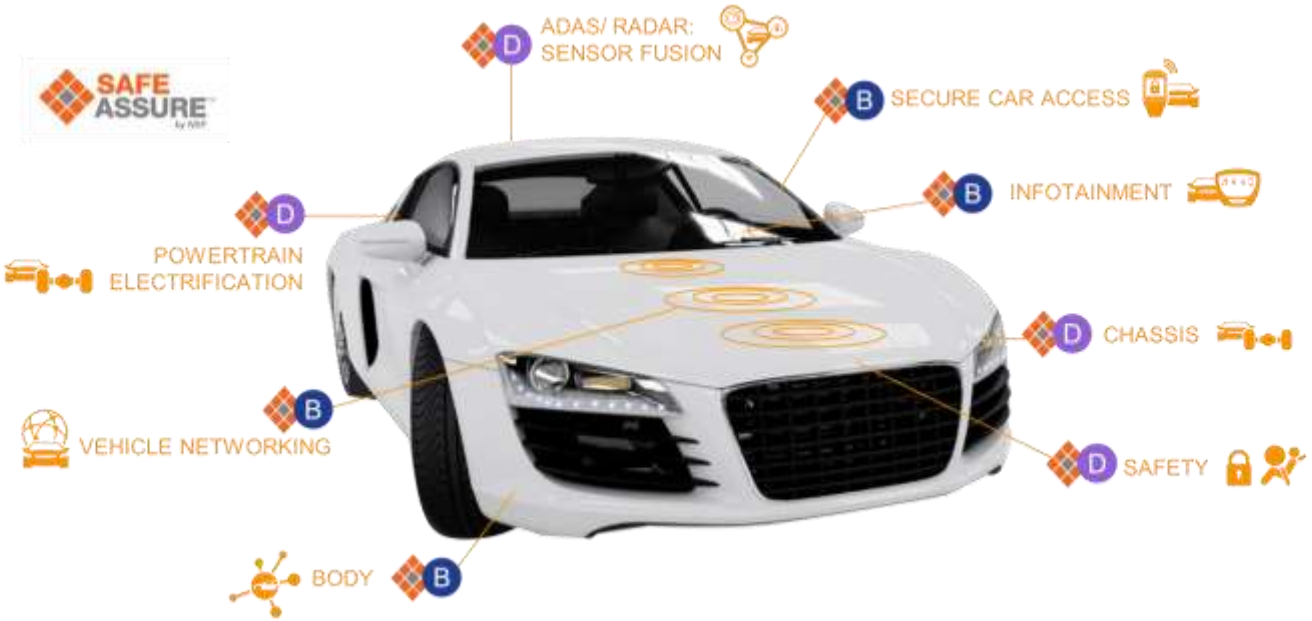


Automotive PMIC <5V Low Vin Connected

PF series



Safety Feature

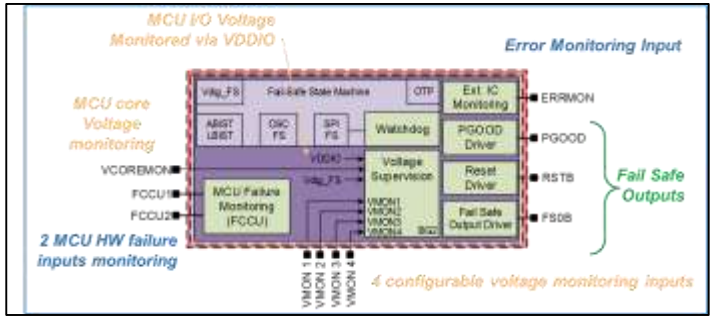


3rd Generation of SAFETY PMIC

Process

ISO 26262

Safety Architecture



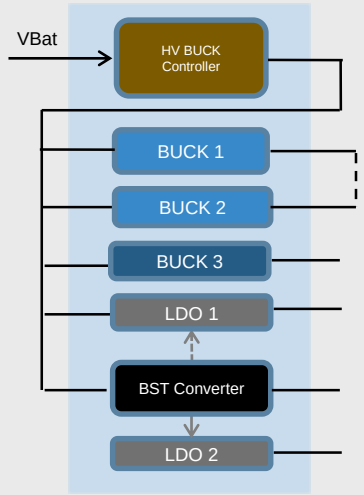
IP “Building Blocks” Strategy

Automotive PMIC Modular/ Scalable IP Building Blocks

HV buck controller		3.3V to 5V – 10A (depending on external FET)
HV buck converter		3.3V to 5V – 3A
Boost converter		5.0V to 5.74V – 800mA – after buck
LV buck type A		0.4 to 1.8V – 2.5A multiphase
LV buck type B		1V to 4.1V – 2.5A
LDO		1V to 5V – 400mA
LDO LP HV		10mA with 60V input voltage. Stay ON in Standby mode to keep processor supplied

NEW PMIC

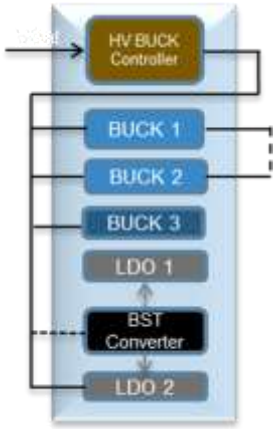
FS8530

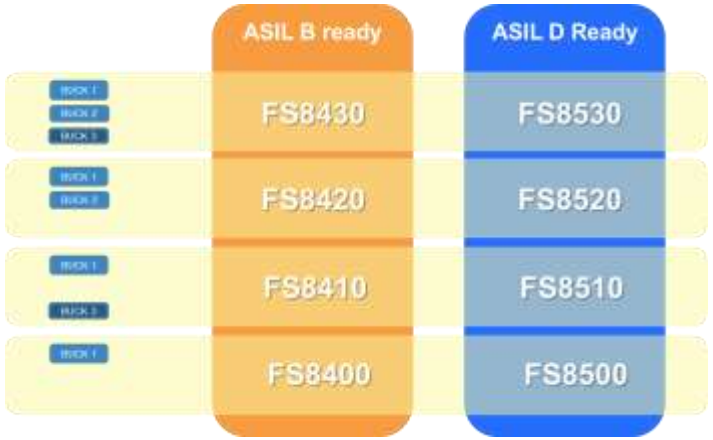


You know one, you know them all!!

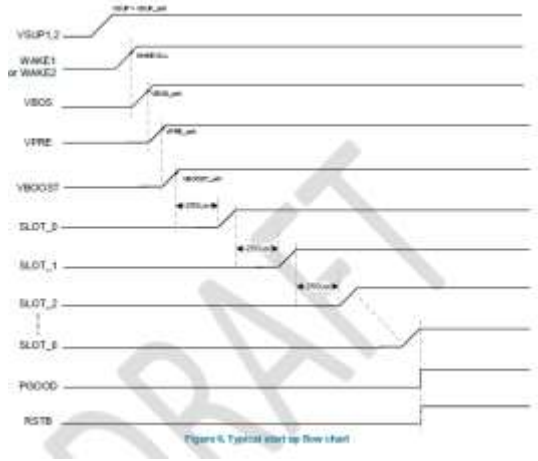
Device Flexibility

- Flexible product through OTP configuration
  - Buck / LDO/ Boost value
  - Power up /down sequencer
  - Safety reaction
  - Some functionality
- Scalable product
- Board thermal performance & size with multiphase Smart Point of Load Approach
- Multi-PMIC ONE BOX system
- FS device + PF Device
- PF Device + PF Device

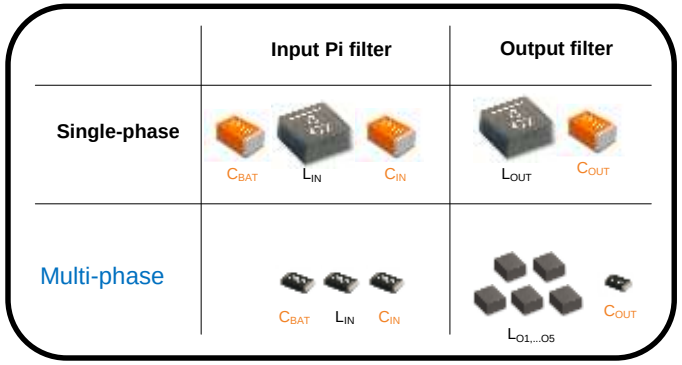




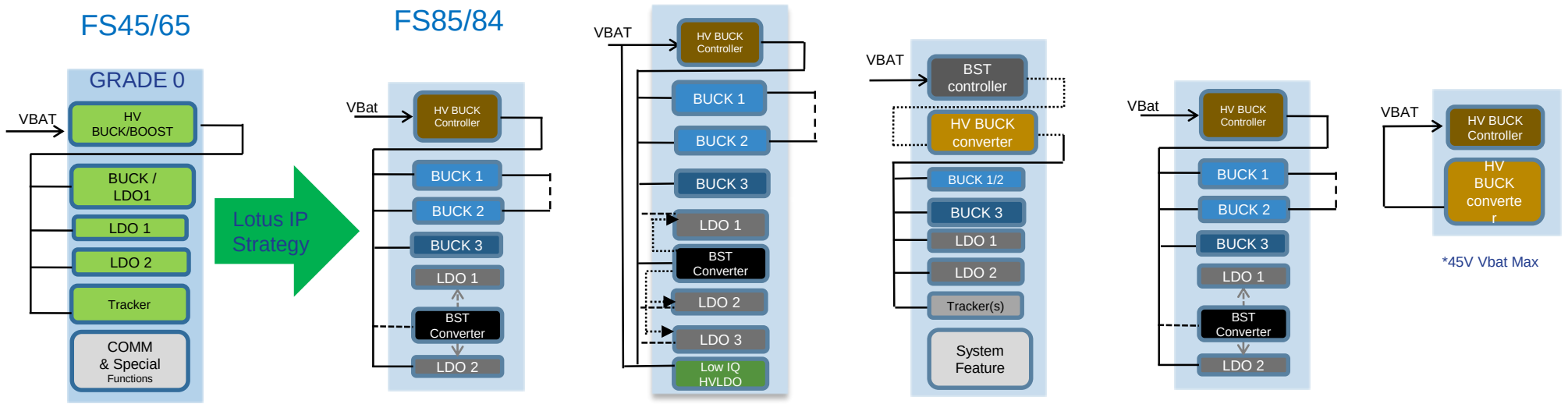
Power Up Sequencing



Board Performance & Size



12V/24V High Voltage Input - FS series



Under Development

Vin = 2.7V to 36V
SMOS8MV

Vin = 2.7V up to 60V
SMOS10HV

SAF4000
S32Rx
TEF810X, MR3003
S32V247

Next Gen Veh Net Processor
V2X (SAF5x)
SAF4000
i.MX

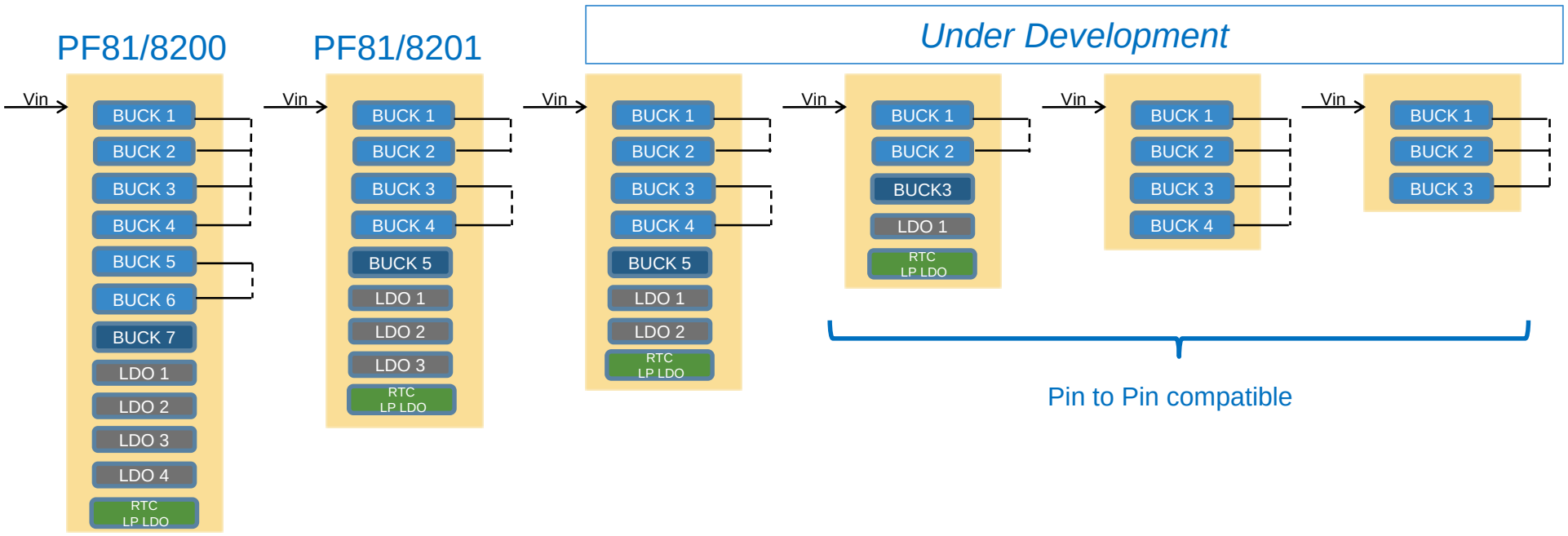
S32KX/S1

Next Gen
Powertrain MCUs

Processor Attach

Companion

3.3V/5V Low Voltage Input - PF series



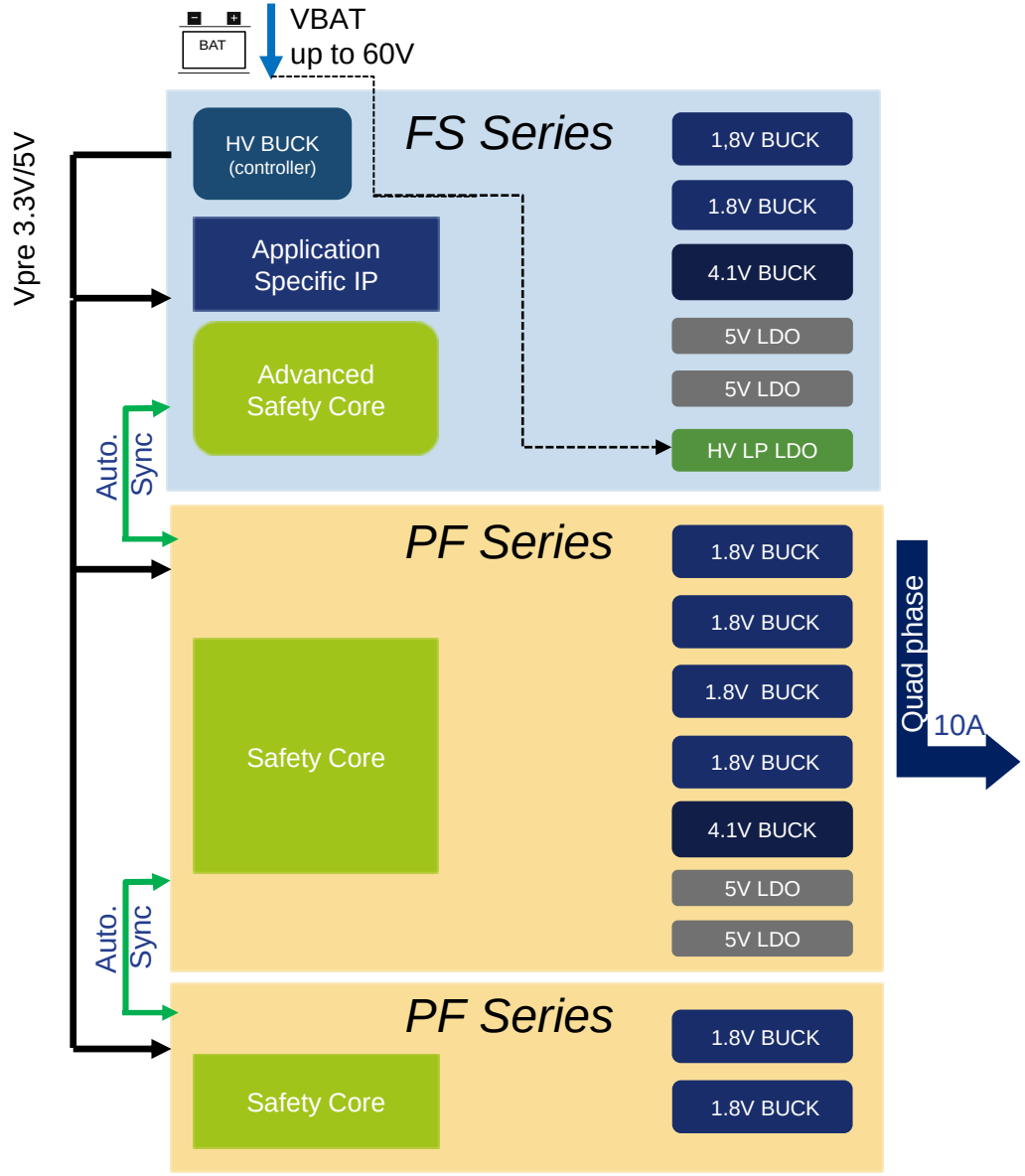
Vin = 2.7V to 5.5V
SMOS10HV

Processor Attach
i. MX8 / S32V

Companion / SMART Point of Load

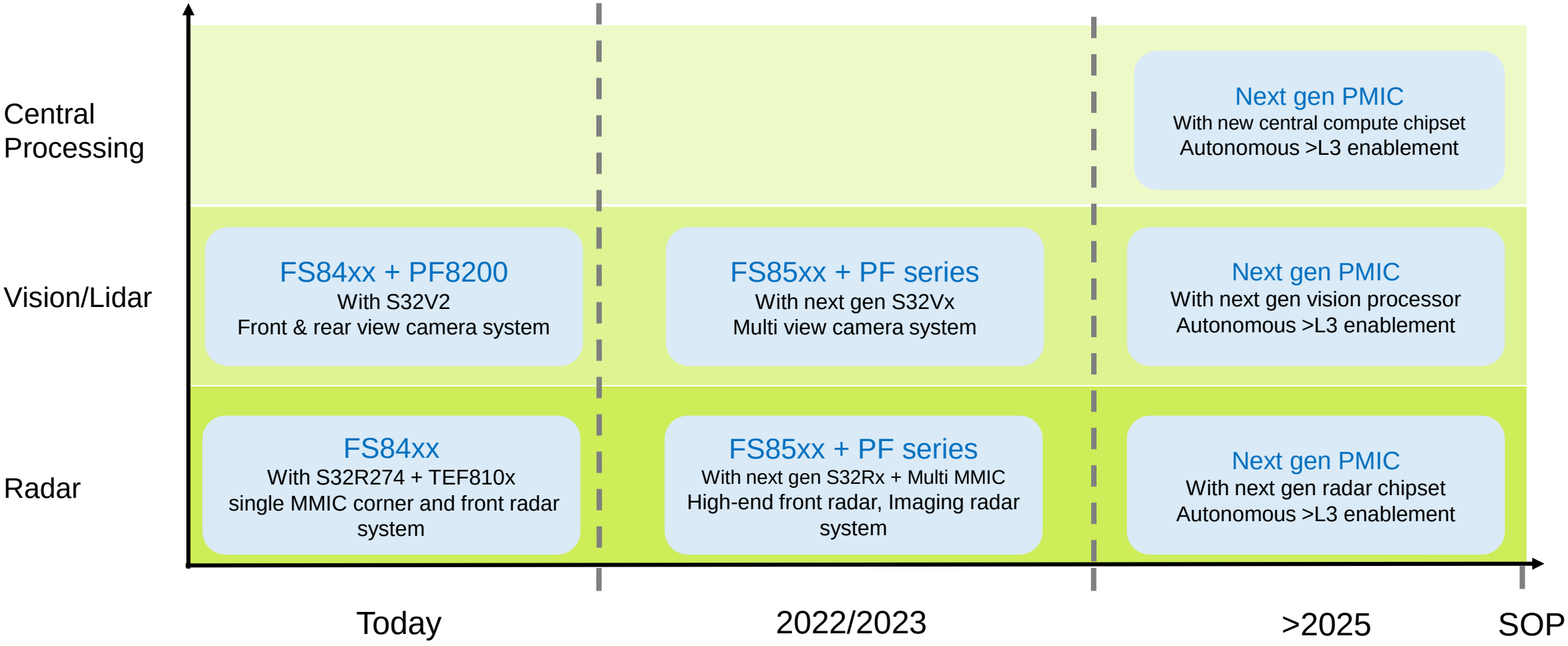
Safety System Power Solutions

- Higher power for higher performance
- Advanced functional safety Proven robustness with NXP processors for less development risk and time
- Scalable and expandable portfolio
  - Advanced power and safety management concepts
  - Common architecture platform
  - Unified IP reusable for unlimited combinations



System Power Concept

Safety Power Management Roadmap for ADAS Application



FS8530 – 12/24 V & ASIL B/D Safety SBC

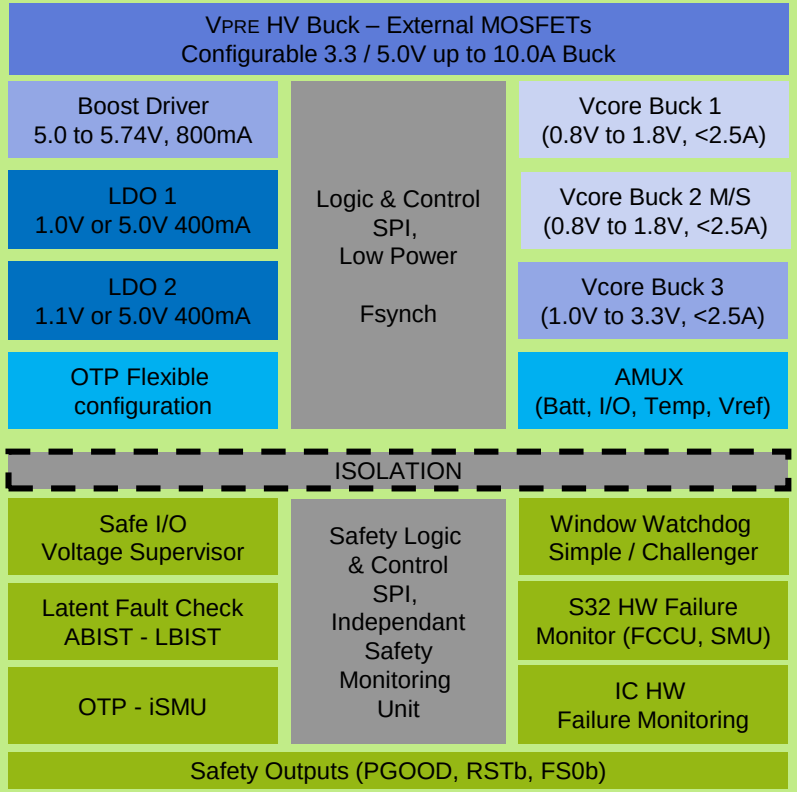
Power Management

- Input supply up to 60V – 12V and 24V systems
- HVBUCK , adjustable 3.3V to 5V, scalable output current up to 10A
  - Synchronous Buck, 455kHz or 2.22MHz, ext. MOS
- BUCK1/2, adjustable 0.8V to 1.8V, up to 2.5A DC – 3.6A peak
  - Synchronous Buck, up to 3MHz, int. MOS
  - Can operate in multi-phase delivering 5A
  - SVS capability on Buck1
- BUCK3, adjustable 1.0V to 3.3V, up to 2.5A DC – 3.6A peak
  - Synchronous Buck, up to 3MHz, int. MOS
- BOOST 5V or 5.74V, up to 800mA DC- 1.5A peak, int. MOS
- LDO1/2, configurable 1.1V to 5V, up to 400mA
- Synchronization signal for dual device operation / Power GOOD output
- Frequency Synchronization Fin/Fout.

System Features

- Independent Safety Monitoring Unit fit for ASIL D (FS85x) and fit for ASIL B (FS84x) architecture
- Control via 32 bits SPI and I2C (including CRC).
- Low Power Mode : 10µA in LPOFF, wake up via WAKE1/2 pins
- AMUX: Battery, Internal Safety critical voltages, Vref and Temperature
- Emulation and Programming capability offered in Engineering mode only : Voltage, Frequency, Phase shift, Power sequencing.
- EMC: Spread Spectrum, Freq. Synch., Vpre Slew Rate control, Freq. Tuning

FS8530 Functional Block Diagram



FS84/FS85 Scalable Safety & Power

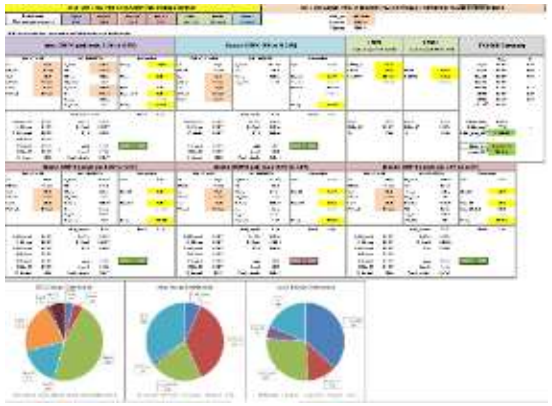
	VR55/FS55 – Quality Mgt (QM)	FS84 – ASIL A/B	FS85 – ASIL C/D
VPRE Controller (ext FETs)	12/24 V HV BUCK – 10 A	12/24 V HV BUCK – 10 A	12/24 V HV BUCK – 10 A
Buck1 + Buck2 + Buck3	VR5500 (multi phase option)	FS8430 (multi phase option)	FS8530 (multi phase option)
Buck1 + Buck2		FS8420 (multi phase option)	FS8520 (multi phase option)
Buck1 + Buck3	FS5502	FS8410	FS8510
Buck1		FS8400	FS8500
BOOST	YES (VR5500)	YES	YES
LDO	YES	YES	YES
System Solutions	Fsynch, Pgood, AMUX, SPI/I2C, LPOFF (10 µA), Wake Up	Fsynch, Pgood, AMUX, SPI/I2C, LPOFF (10 µA), Wake Up	Fsynch, Pgood, AMUX, SPI/I2C, LPOFF (10 µA), Wake Up
Safety & Monitoring	QM	Fit for ASIL B (see next table) SafeAssure	Fit for ASIL D (see next table) SafeAssure

Documentation, Tools & Application Support – FS85 Example

✓ Data Sheet

✓ Quick Starter Guide

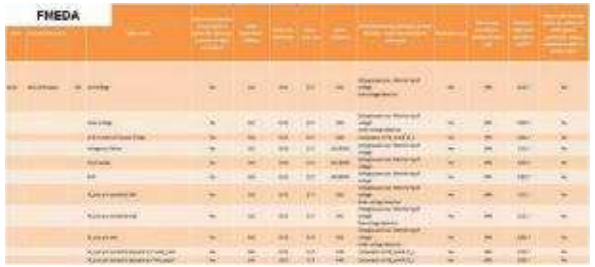
✓ Thermal Tool



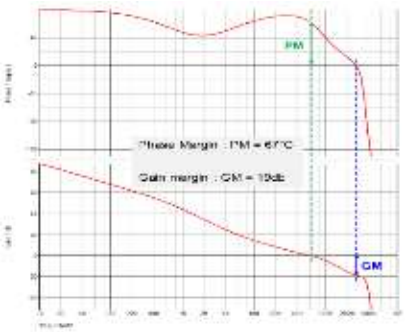
✓ OTP Programming Tool

✓ Safety Manual

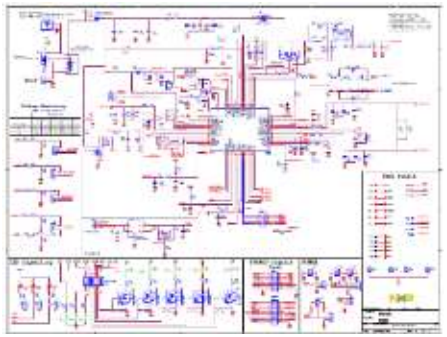
✓ SafeAssure – FMEDA



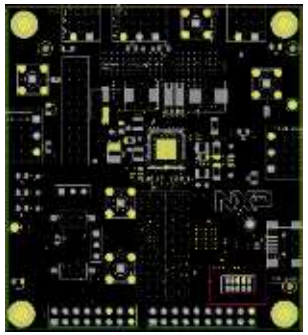
✓ Models - SIMPLIS



✓ PCB Schematic



✓ PCB Layout Recommendations



HW Evaluation Tool – FS85 Example

3 boards developed to support application validation, CTM support and EMC measurements + GUI

Socketed

Description / Purpose:

- Functional Validation
  (Not for performance due to socket)
- OTP Programming
- Highly flexible thanks to many jumpers
- Easy access to all signals

Soldered

Description / Purpose:

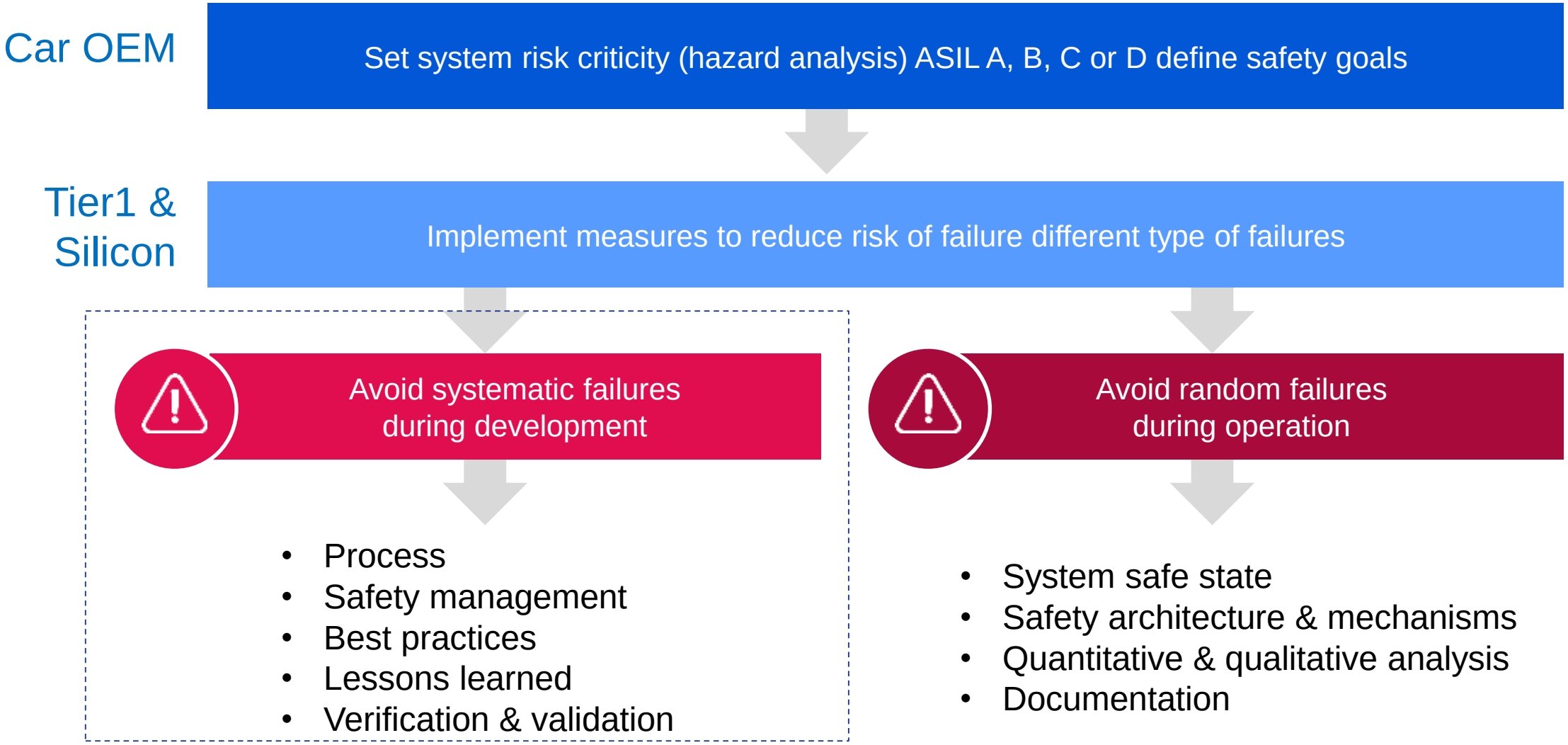
- Performance Validation
- OTP Programming (Populated part)
- Highly flexible thanks to many jumpers
- Easy access to all signals

EMC / Demo

Description / Purpose:

- EMC Performance Level
- Optimized layout
- OTP Programming (Populated part)
- Availability: Now (Rev.A)
- Vpre current: 6 Amps
- VMON Fixed

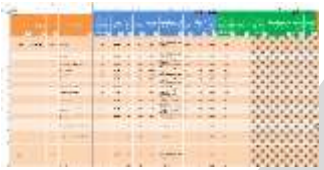
Functional Safety Management



NXP ISO 26262 Innovations

Lessons Learned and Continuous Improvement

Product Requirement Mgt
- OEM workshops
- Lessons learned
- System Safety Goal Translation
- Fail Operational analysis and solutions



Customer Support
- Documentation (FMEDA, SM)
- Reference Design & AN
- SW Production ready
- System Solutions (RADAR, …)

Product Definition
- Doors (SoC & IP)
- Standardized Fail Safe State Machine
- Common chassis safety platform
- Safety Behavioral Model

System Validation
- eFAST : OEM Non ISO Pulse
- HW Fault Injection Test
- FIT verification through Model

Product Architectures
- Fail Safe (qualified, certified)
- Fail Silent (qualified, certified)
- Fault Tolerant Systems

Verification
- Automated Traceability Matrix (NPI360)
- Virtual Test
- Fault Injection Simulation

Available
Planned

Functional Safety Management

Car OEM

Set system risk criticity (hazard analysis) ASIL A, B, C or D define safety goals

Tier1 & Silicon

Implement measures to reduce risk of failure different type of failures

Avoid systematic failures during development

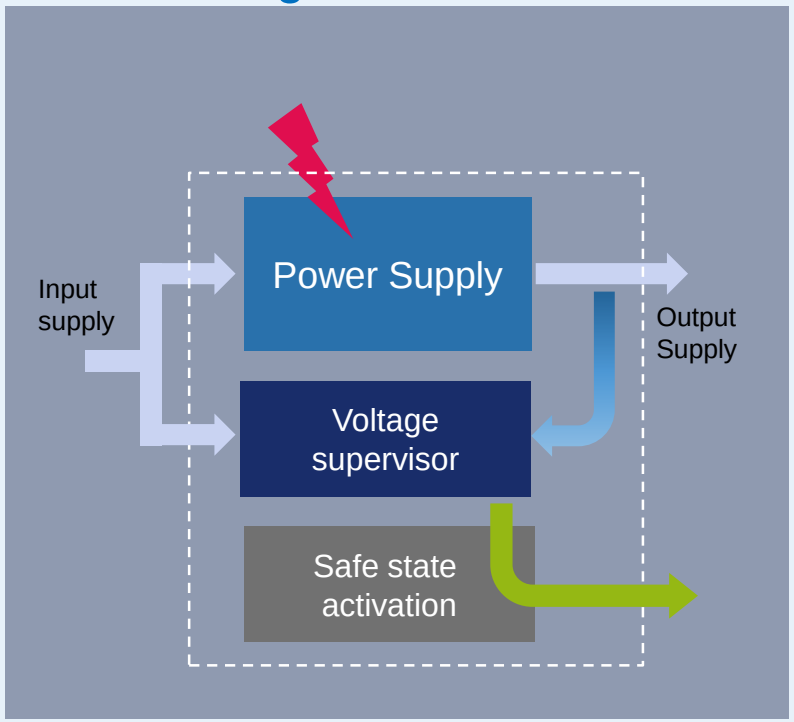
- Process
- Safety management
- Best practices
- Lessons learned
- Verification & validation

Avoid random failures during operation

- System safe state
- Safety architecture & mechanisms
- Quantitative & qualitative analysis
- Documentation

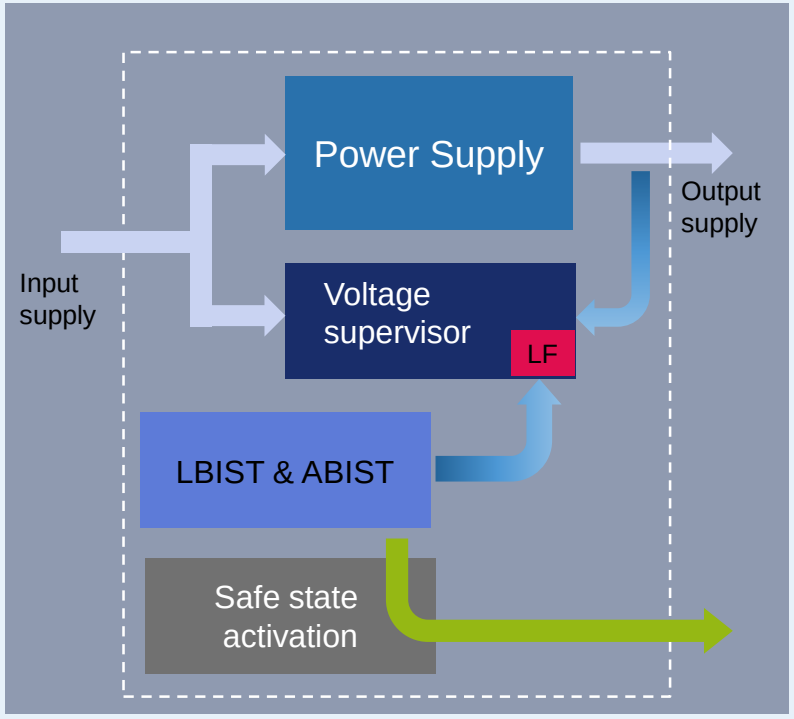
Fault Management & ASIL Power Supply Quantitative Analysis

Single Point Fault



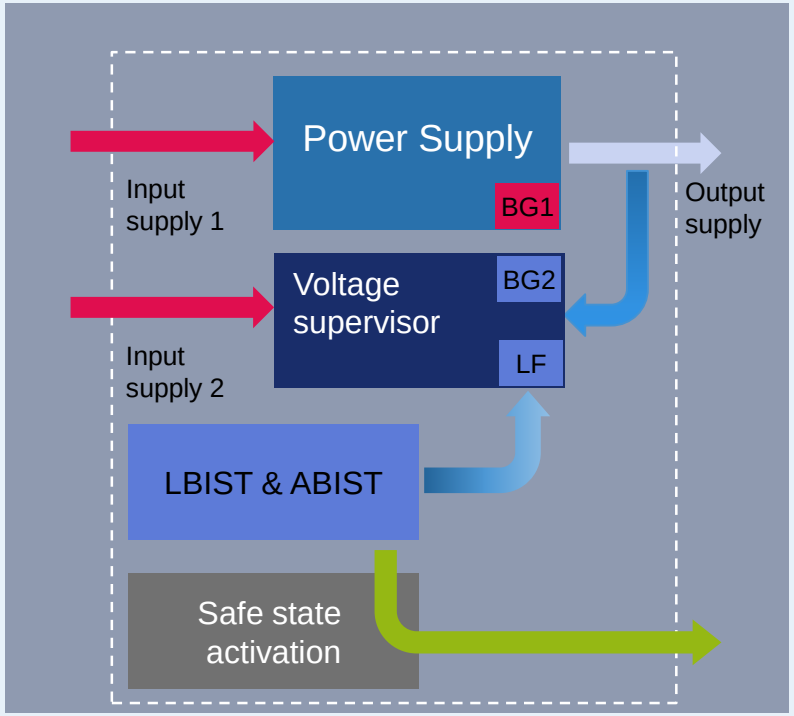
ISO 26262 ASIL level	ASIL B	ASIL D
SPFM Single Point Failure Metric	> 90%	> 99%

Latent Fault



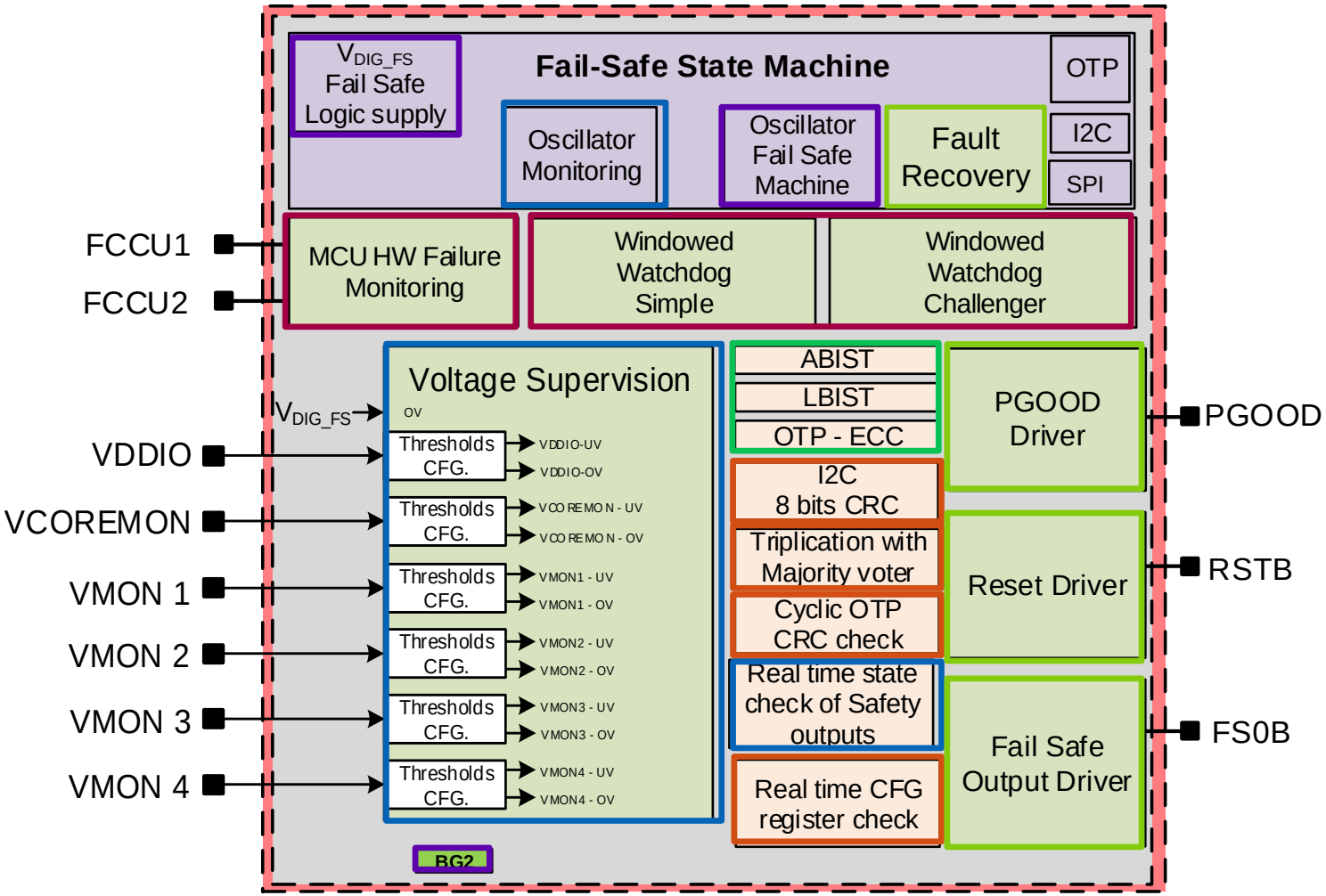
ISO 26262 ASIL level	ASIL B	ASIL D
LFM Latent Point Failure Metric	> 60%	> 90%

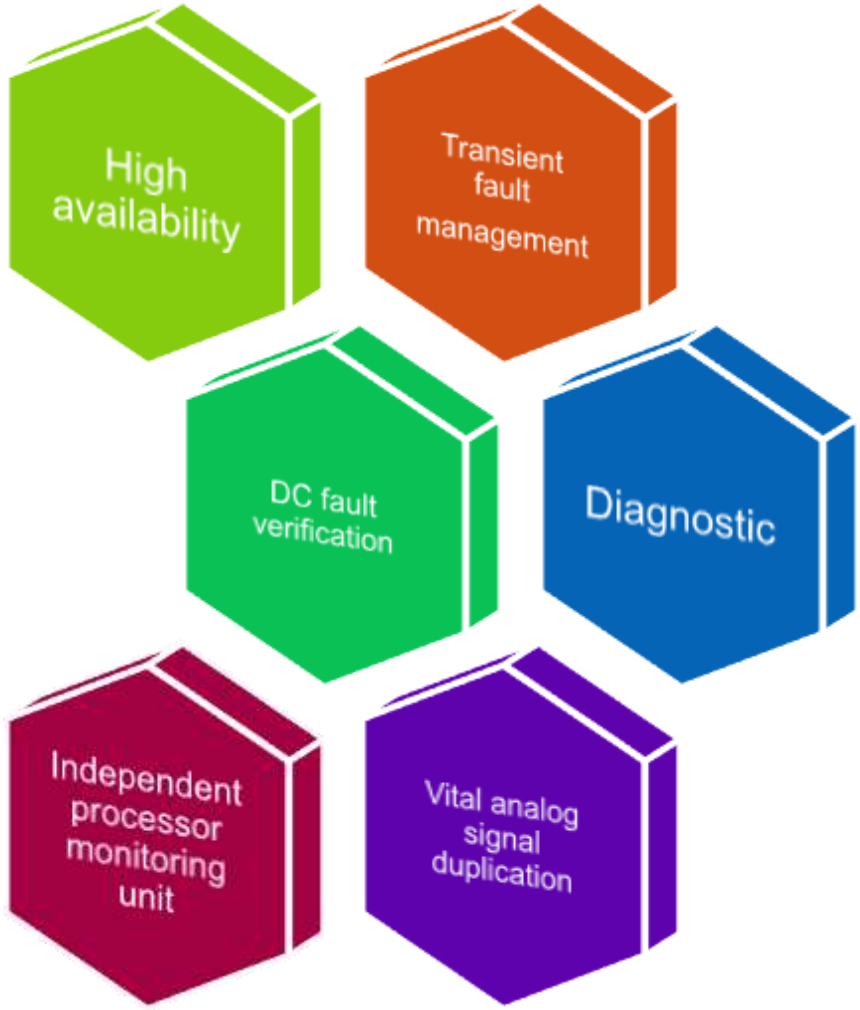
Common Cause Fault



ISO 26262 ASIL level	ASIL B	ASIL D
PMHF -Probability Metric of HW Failure	< 10E-7	< 10E-8

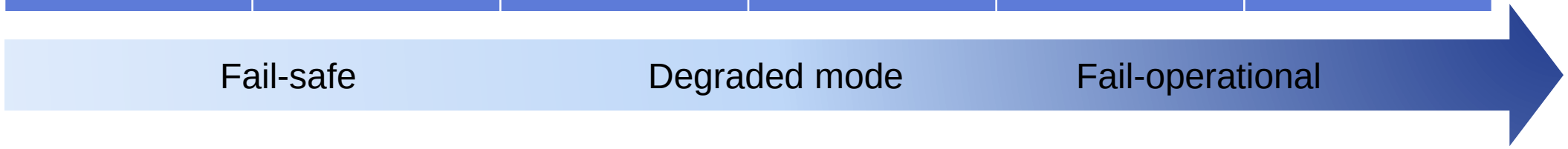
Independent Safety Monitoring Unit





Safety Concept Evolution

Previous Gen	Current Gen	Next Gen
Fail Safe	Safety & Availability	Fail Operational
Detect Fault Indicate fault to Safe State System	Detect Fault Indicate fault to Safe State System and recover	Detect Fault Indicate fault to Safe State the System
Stop operation	Continue operation Continue degraded Stop operation	Sufficient vehicle level redundancy to continue full operation
Rely on driver	Partially rely on driver	No reliance on driver
SAE Level 0 / 1	SAE Level 2 / 3	SAE Level 4 / 5



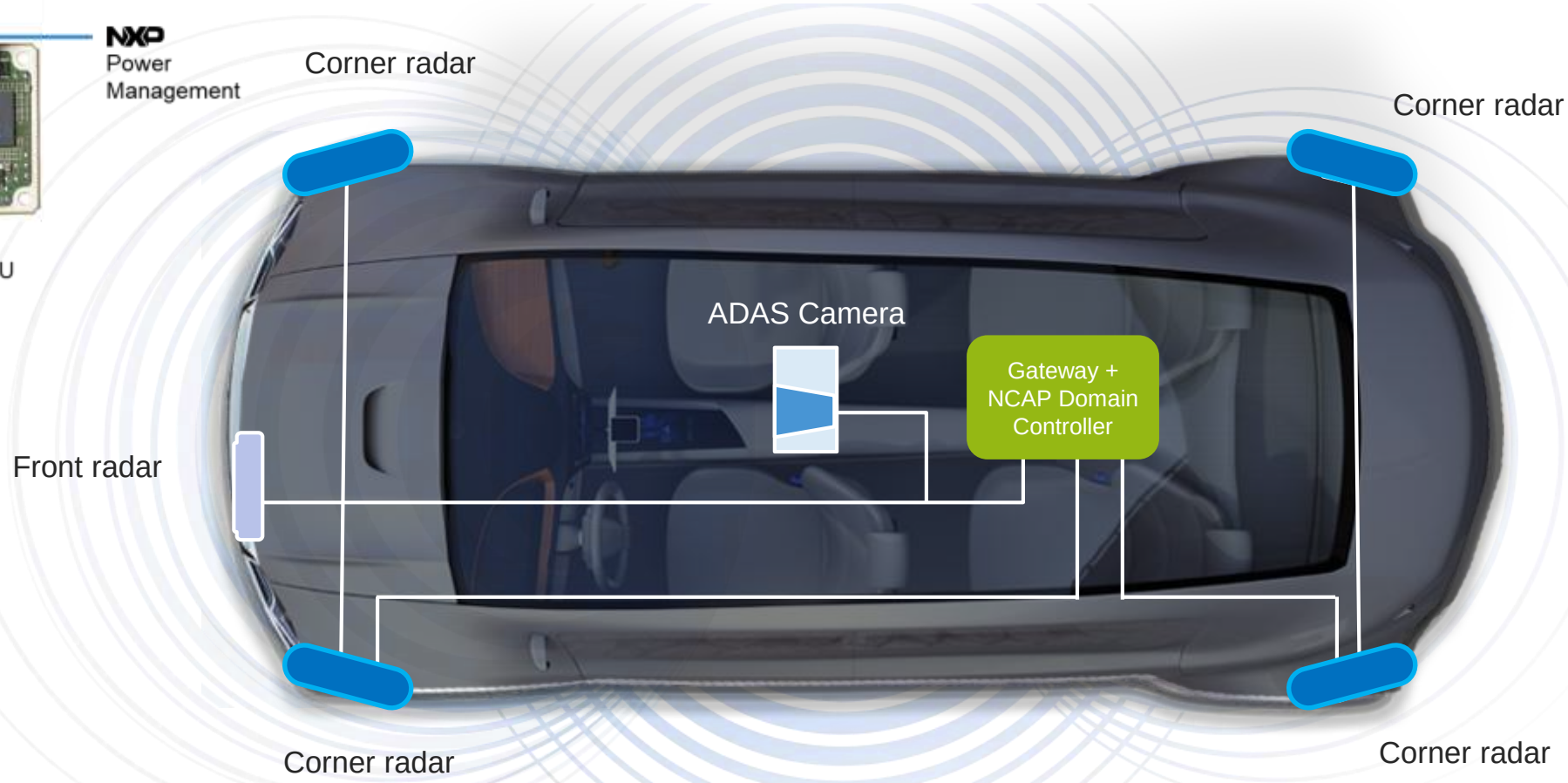
System Availability

ADAS Radar Application

NXP
Radar Transceiver

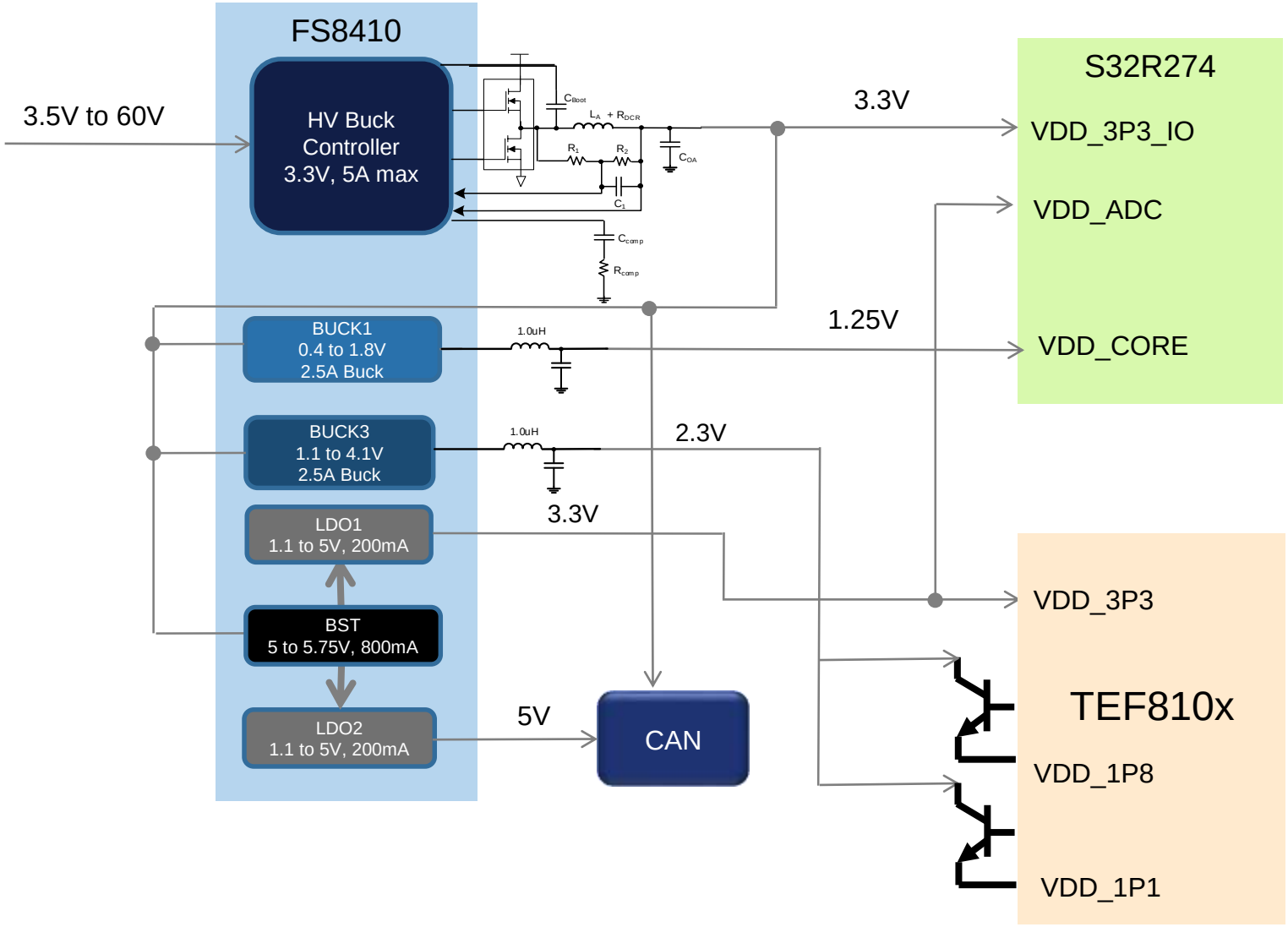
NXP
Radar MCU

NXP
Power
Management

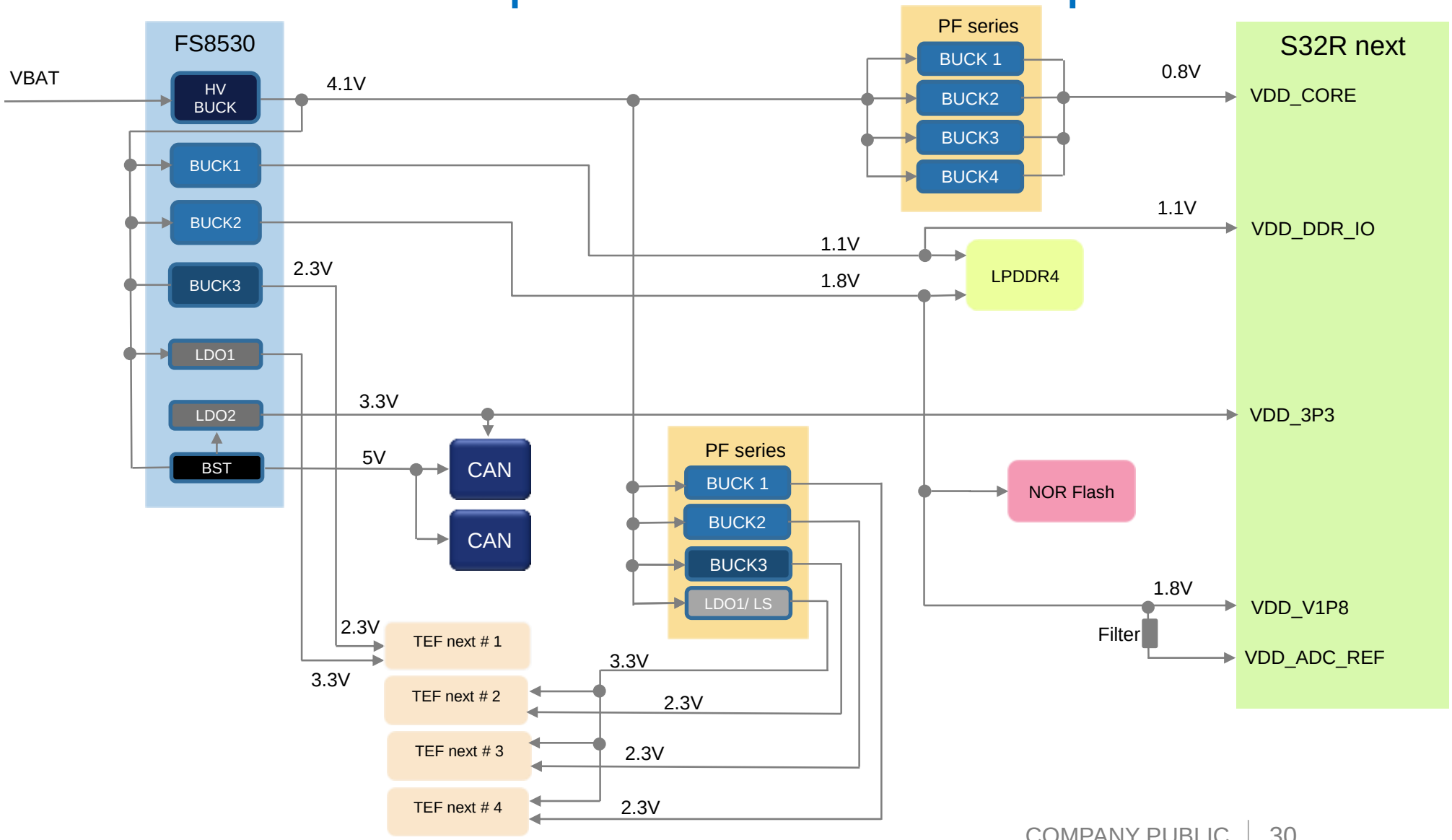


CAN-FD

Single Radar Chip Power Tree Example



Cascaded Radar Chip Power Tree Example



Summary

- ADAS market is significantly growing led by NCAP and Autonomous demands
- NXP is offering system solution for ADAS application including processor, sensor and power management IC
- NXP PMIC is flexible to fit in various application
- NXP PMIC offers scalable functional safety solution which can save cost and development time

Q & A

SECURE CONNECTIONS
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