# S32K3 FOR ZONAL AGGREGATOR

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SECURE CONNECTIONS
FOR A SMARTER WORLD

PUBLIC

# AGENDA

- Zonal Aggregator Typical Challenges
- S32K3 Overview
  - Power consumption
  - Communication interfaces
  - Freedom of interferences
- S32K Demo Overview
  - TSN Motor control demo
  - T-box demo
  - Multi-network synchronization
  - Door zone demo
- Summary

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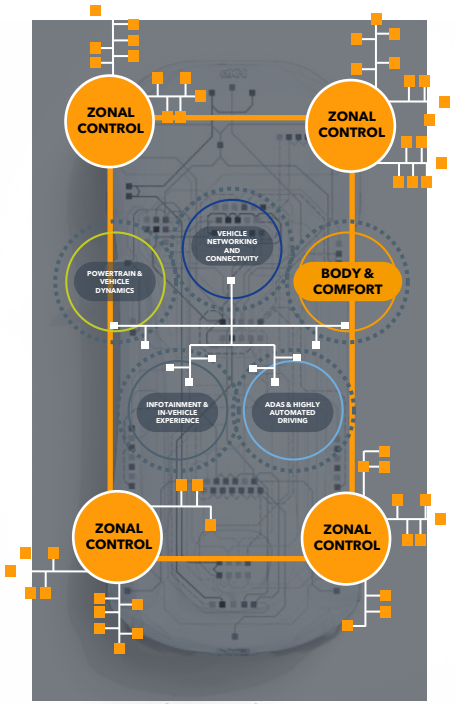
# ARCHITECTURAL CHANGES DRIVE GROWTH IN NODES AND PROCESSING PERFORMANCE

**TODAY**
Traditional
Flat Architecture

**2021+**
Domain and
Zonalization Transitions




**BODY DOMAIN AND ZONE EXAMPLE**

## Two parallel architectural evolutions

1

### Domain Focus

Scalable and centralized software development

1. Flexible & scalable software environment
2. Efficiently supports the user-defined vehicle
3. Centralized OTA, easily upgradable software

+

2

### Zonal Focus

Simplified wiring and connectivity

1. Dramatically reduced wire routing and cable costs
2. Flexible data monetization
3. Easy integration of new hardware

# ZONAL MODULES: MAIN CLUSTERS AS OF TODAY

## ZONAL AGGREGATOR

- TSN Switch ?
- OnRamp-100Mb
- Body I/O Control

## ZONAL CONTROLLER

- Gateway functions
- TSN Switch
- OnRamp-Gb
- Multi-domain I/O Control

## ZONAL PROCESSOR

- Applications processing
- Advanced Gateway functions
- TSN Switch
- OnRamp-Multi Gb

- Adv. Low Power Modes & Fast Wake-up
- Direct I/O Control (e.g. Body, Motors)
- Comms Acceleration (Gateway Offload)
- Multi-ECU Virtualization
- Adaptive AUTOSAR / Linux

**Key MCU/MPU Attributes**

# ZONAL AGGREGATOR TYPICAL CHALLENGES

- Low power and fast wakeup
- Low latency communication
- Communication protocol translation
- Freedom of interferences across different application tasks

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# S32K3:
# EXPANDING THE S32 PLATFORM

**NXP's S32 Automotive Platform enables software reuse across multiple applications,** reducing development complexity and easing the burden for Tier 1s and carmakers

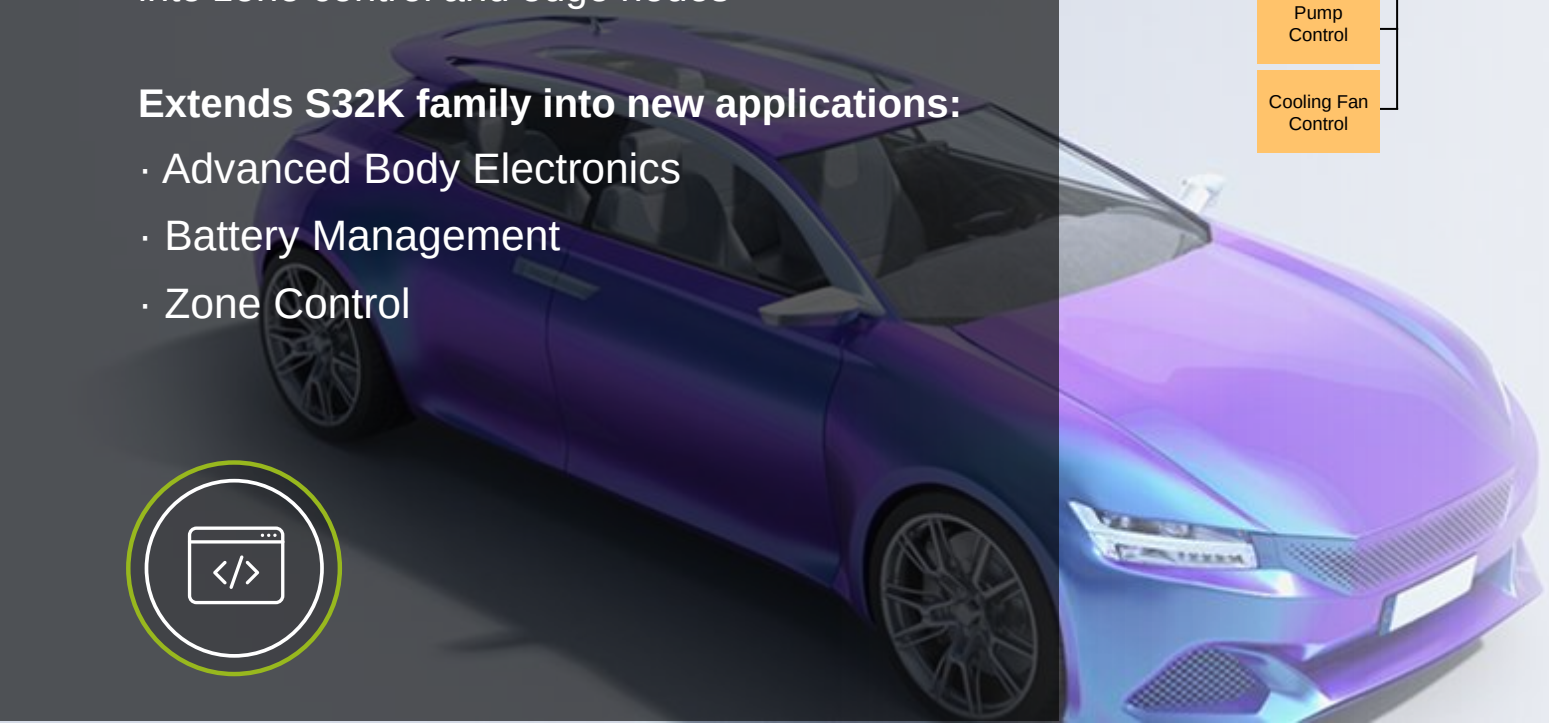
**S32K3 expands S32**
into zone control and edge nodes

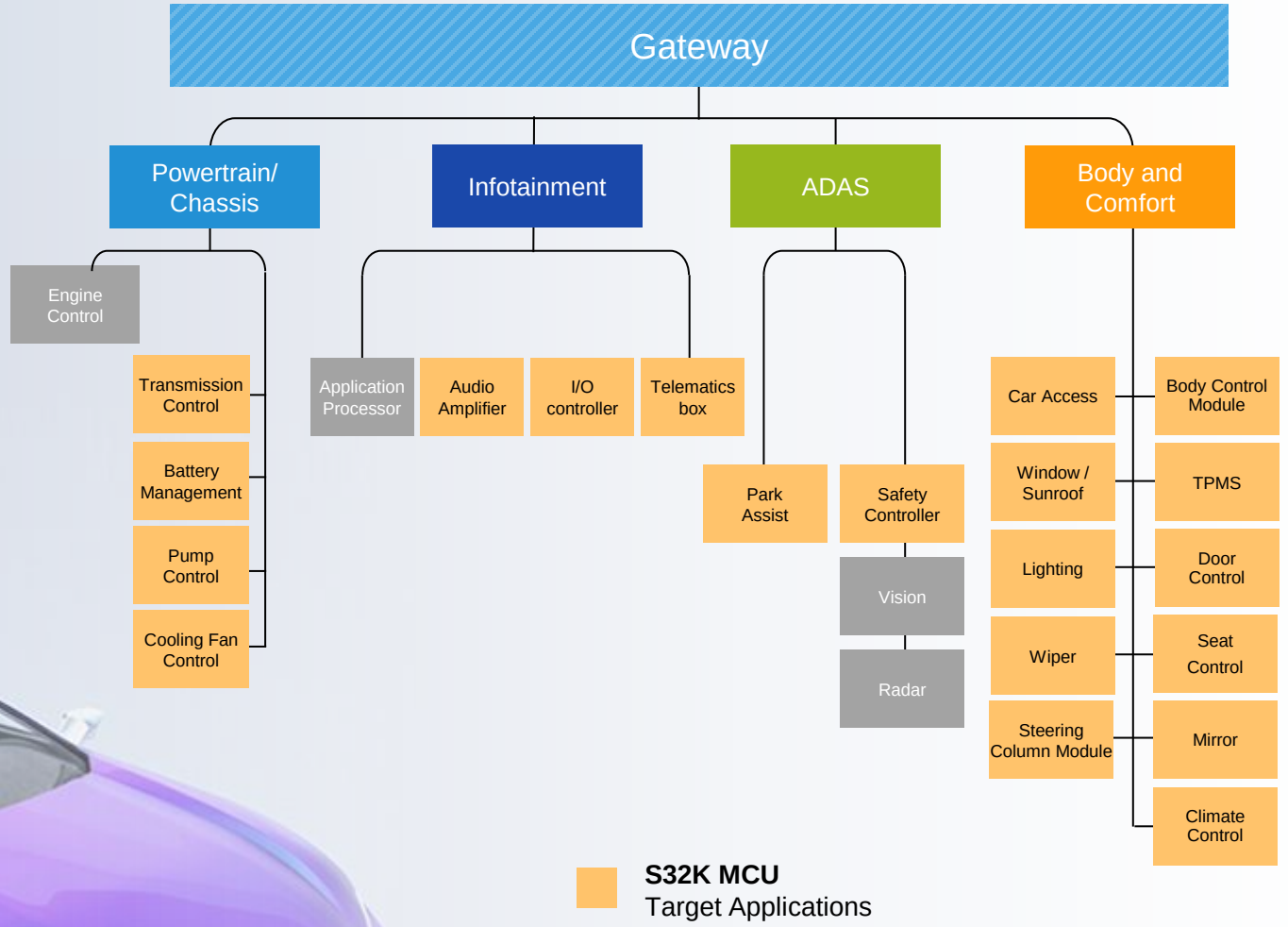
**Extends S32K family into new applications:**

· Advanced Body Electronics

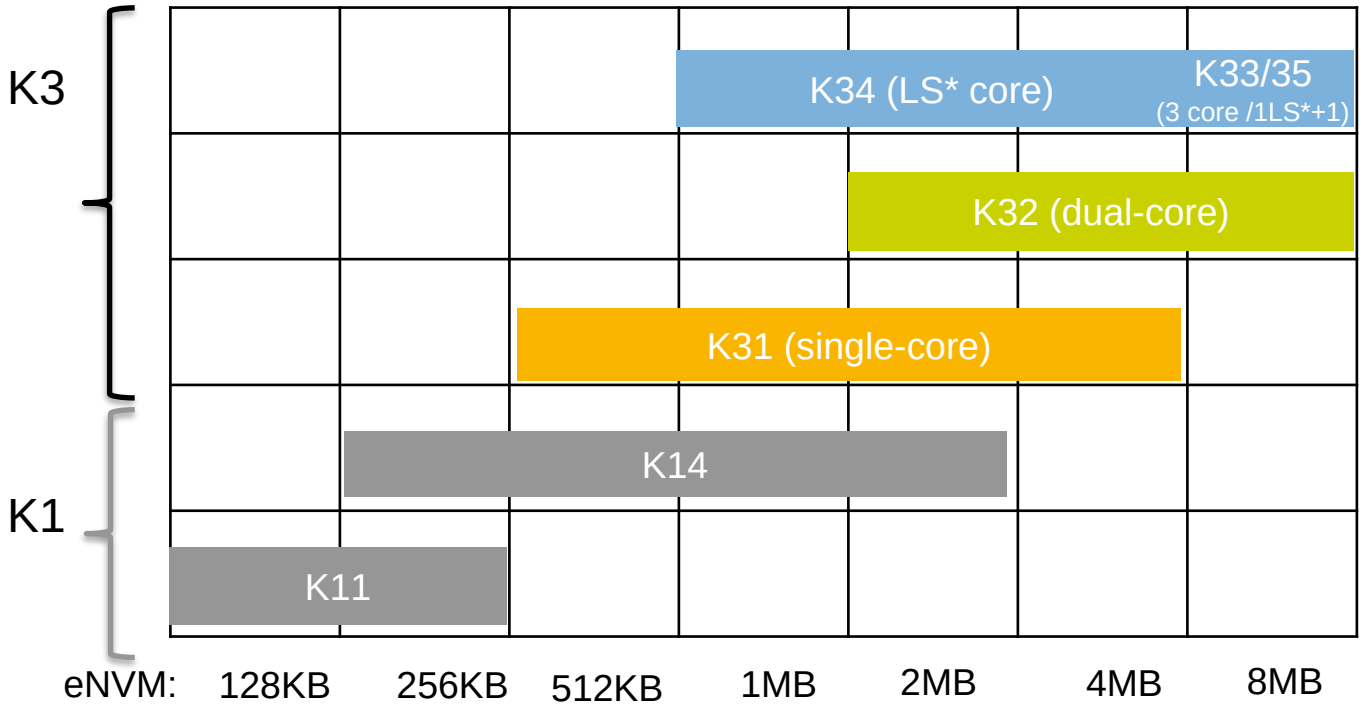
· Battery Management

· Zone Control





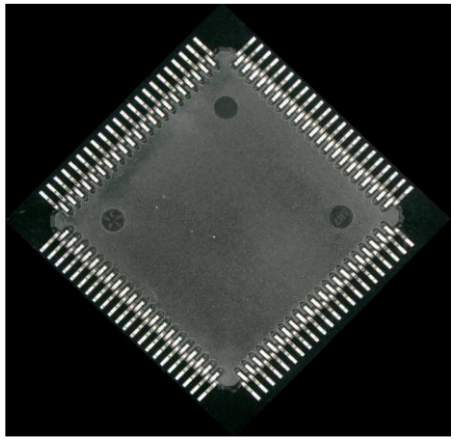
# S32K BROAD PORTFOLIO AND APPLICATIONS




| Typical Application | Arm® CPU Core | |
|---|---|---|
| **ASIL C/D –BMS, Electrification** | **2-3 x M7** | **240Mhz** |
| **ASIL A/B –High perf body, Zone & IO, Info/Audio** | **2 x M7** | **160Mhz** |
| **ASIL A/B – "K1 extension", Security 2022+, OTA** | **1 x M7** | **120Mhz** |
| **ASIL A/B – CAN FD and Ethernet nodes** | **1 x M4** | **112Mhz** |
| **ASIL A/B – Small CAN FD and LIN nodes** | **1 x M0+** | **48Mhz** |

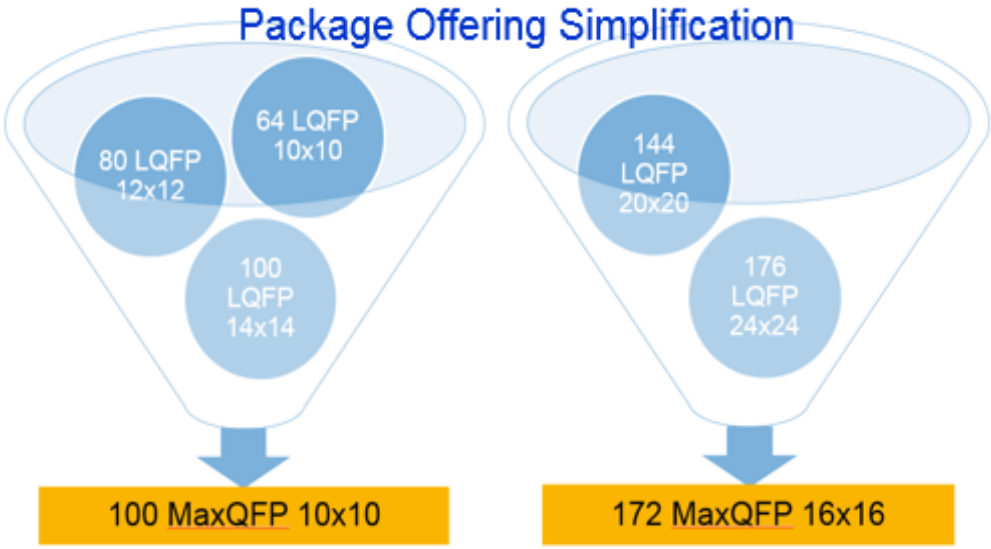
# S32K3 PLATFORM – UNMATCHED SCALABILITY

- Core & Platform: Same Arm Cortex®-M7 core across S32K3 family for software reuse
- Security: HSE B across S32K3 family
- Safety: ASIL D and ASIL B fully compatible in S32K3 family
- Memory: 512K-8MB in S32K3, scalable down to 128KB in S32K1
- Package: BGA / MaxQFP pin compatible in S32K3 family



| K3 Flash | K3 Package | | | | |
|---|---|---|---|---|---|
| | 48 LQFP | 100 MAXQFP | 172 MAXQFP | 257 BGA | 289 BGA |
| | 7 x 7 mm | 10 x 10 mm | 16 x 16 mm | 14 x 14 mm | 17 x 17 mm |
| 8M | | | K358/48/38/28 | | K358/48/38/28** |
| 6M | | | | | |
| 4M | | | K344/24/14 | K344/24/14 | |
| 2M | | K342/22/12 | K342/22/12 | | |
| 1M | K311 | K311 | K341 | | |
| 512K | K310 | K310 | | | |

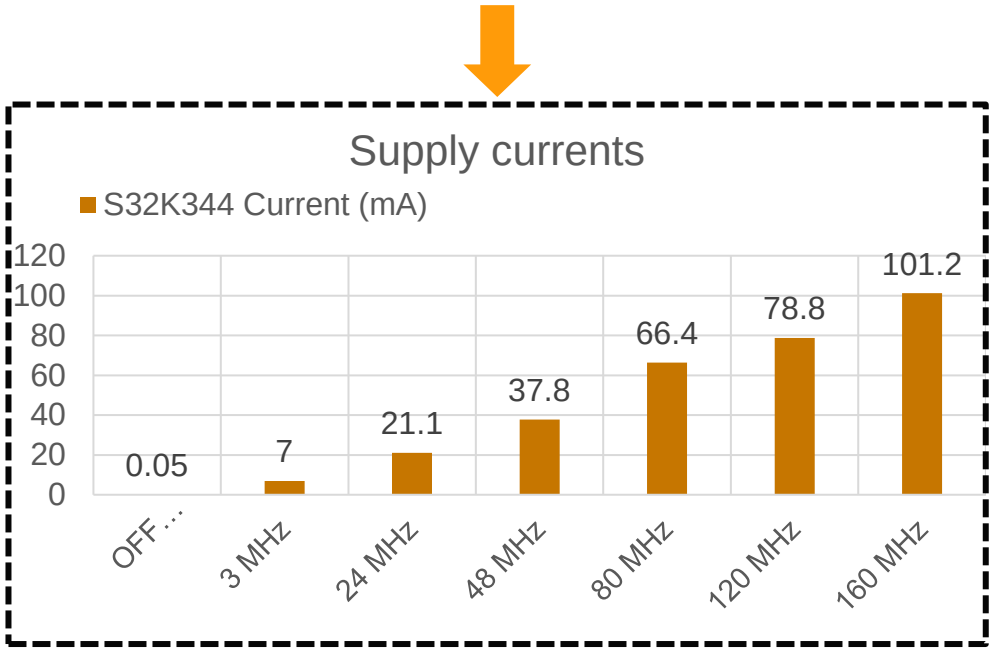
**BGA257 is subset of BGA289



# S32K3 OPTIMIZED FOR LOW CURRENT CONSUMPTION

## RUN mode

- Scalable current consumption based on the application requirements.
- All modules + FLASH are powered.
- All modules can be clock-gated to reduce power.
- Full support for max speed. Up to 160MHz.




## Standby mode

- Main cores / Platform / Flash / PLL are power gated off. Large parts of SoC inactive.
- STANDBY-RAM (32KB Content retention).
- WAKE-UP from up to **60** digital inputs.
- WAKE-UP from up to **24** analog inputs **(3 x LPCMP).**
- WAKE-UP from on-chip timers **(PIT0, SWT0, RTC).**
- Pad-keeping.
- Configurable secure and un-secure wake-up routes.

## Power estimation tool

- Help customers to obtain initial power / current consumption estimations based on their specific use case.

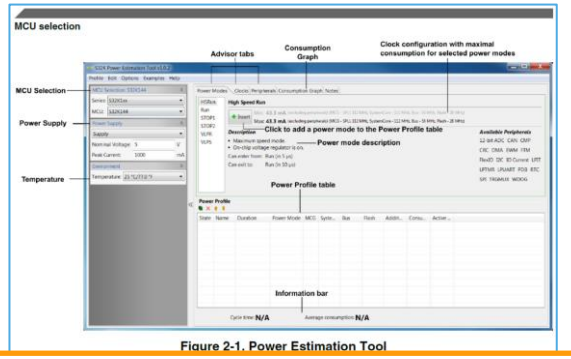


Figure 2-1. Power Estimation Tool

# S32K3 COMMUNICATION INTERFACES

- Ethernet MAC (10/100/1000Mbps): MII/RMII/RGMII interface, AVB and TSN support
  - TSN Enhancement to Scheduled Traffic  Standard 802.1Qbv-2015, Frame Preemption Standard 802.1Qbu-2016Standard 802.1br
  - Support IEEE 1722 Layer 2 Transport Protocol, IEEE 802.1AS Timing and Synchronization, IEEE 802.1Qav
  - Compliant with 3 Industrial Ethernet Protocols


- Ethernet 10BaseT1S
  - Supported by SPI + external MAC&PHY
- CAN FD
  - FlexCAN modules with ISOCAN-FD and DMA support
  - Support 5Mbps using 16 time quanta
- Enhanced FlexIO configurable as different communication peripherals
  - SENT, I2C, I2S, UART, SPI, entry level TFT LCD driver
- Synchronous Audio Interface (SAI)
  - Supports full duplex serial interfaces with frame synchronization such as I2S, AC97, TDM, and codec/DSP interfaces

# S32K3: ETHERNET IP

**S32K342/44**

- **Supports 10/100/200*/1000Mbps Ethernet**
- **Supports MII, MII-Lite, RMII, RGMII interfaces.**
  - Pinout mux ease PCB routing
  - TJA1100/1 compliant

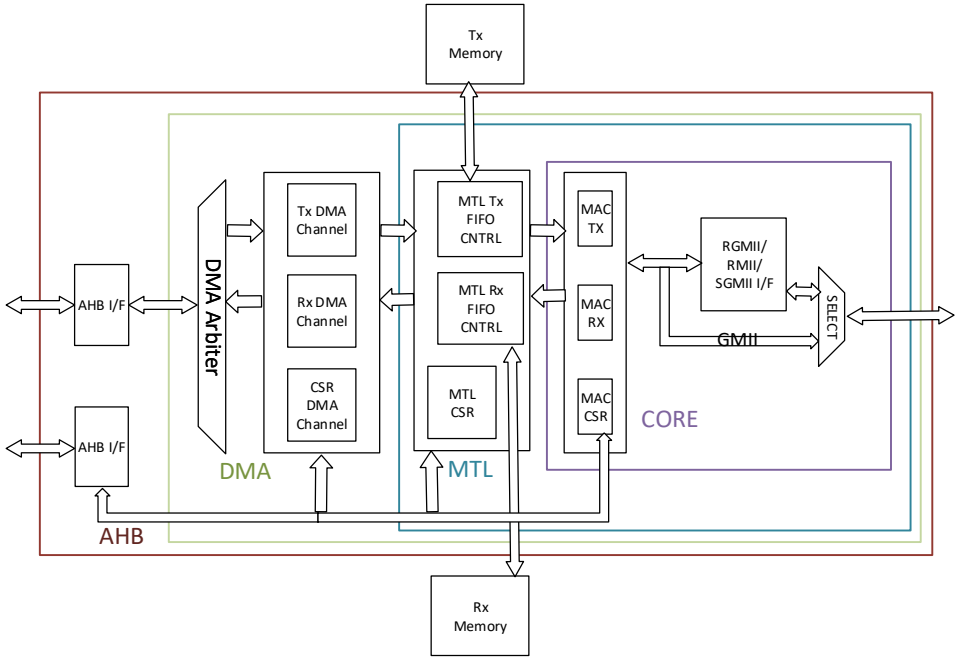
**General**

TCP/IP acceleration features

Single and Double VLAN support

RX Frame parser (Filtering by mask)

2 queues on Reception and Transmission of Traffic




**AVB features**

IEEE 1722 Layer 2 Transport Protocol

IEEE 802.1AS Timing and Synchronization

IEEE 802.1Qav: Forwarding and Queuing for Time-Sensitive Streams (FQTSS)

4-channel IEEE 1588 timer

Automatic time stamping

Media clock recovery support

| TSN Protocol Support | | |
|---|---|---|
| **Standard** | Description | S32K3 Family |
| **802.1Qbv** | Scheduled Traffic | Yes (Qbv 2015) |
| **802.1Qav** | Forwarding and Queuing Enhancements | Yes |
| **802.1Qbu, 802.3BR** | Frame Preemption | Yes (Qbu, QBR 2016) |
| **802.1AS** | Timing and synchronization for Time-Sensitive Applications | Yes |

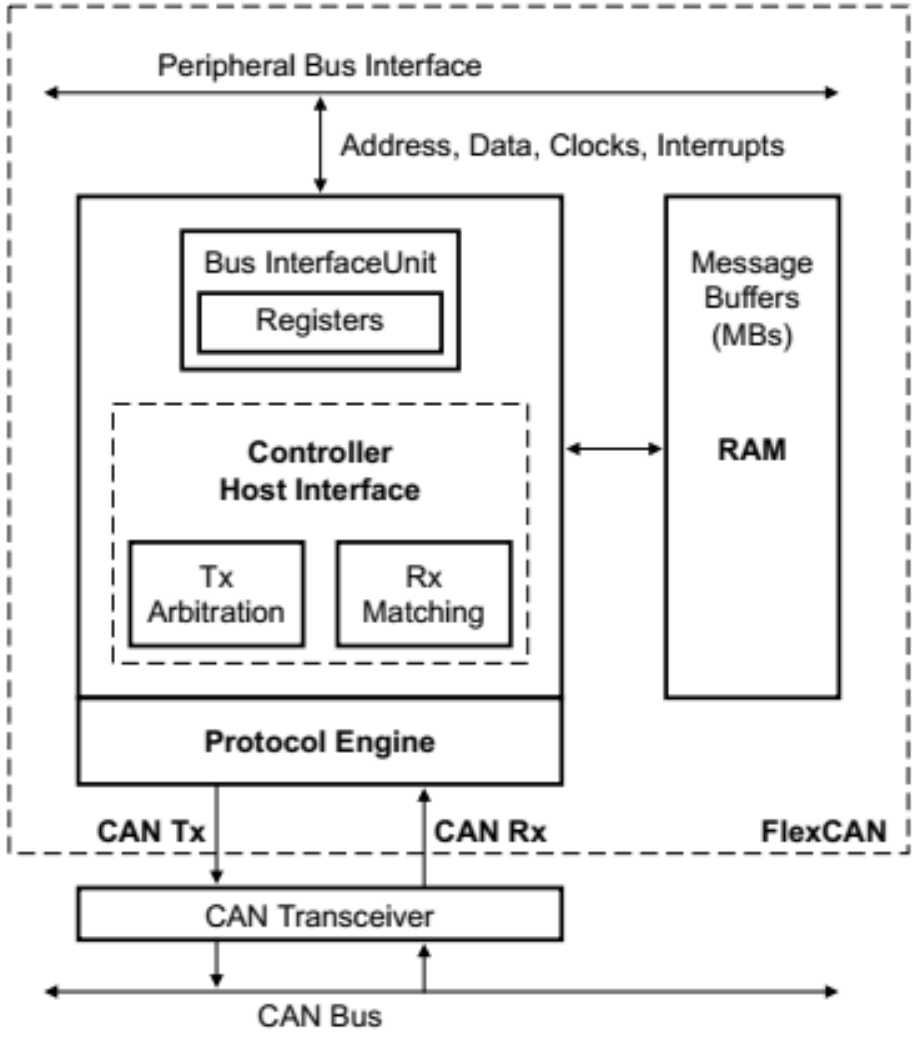
**TSN Features**

- TSN Enhancement to Scheduled Traffic Standard 802.1Qbv-2015
- TSN Frame Preemption Standard 802.1Qbu-2016Standard 802.1br

Enhancement vs S32K148

## FLEXCAN OVERVIEW

- Protocol Engine (PE):
  - Requesting RAM access for receiving and transmitting message frames
  - Validating received messages
  - Performing error handling
  - Detecting CAN FD messages
- Message Buffer RAM:
  - The message buffers are stored in an embedded RAM dedicated to the FlexCAN module
- Support of CAN 2.0 & CAN FD
- Support 3 to 8 FlexCAN instances across K3 family



# FLEXCAN FEATURES OVERVIEW - S32K344

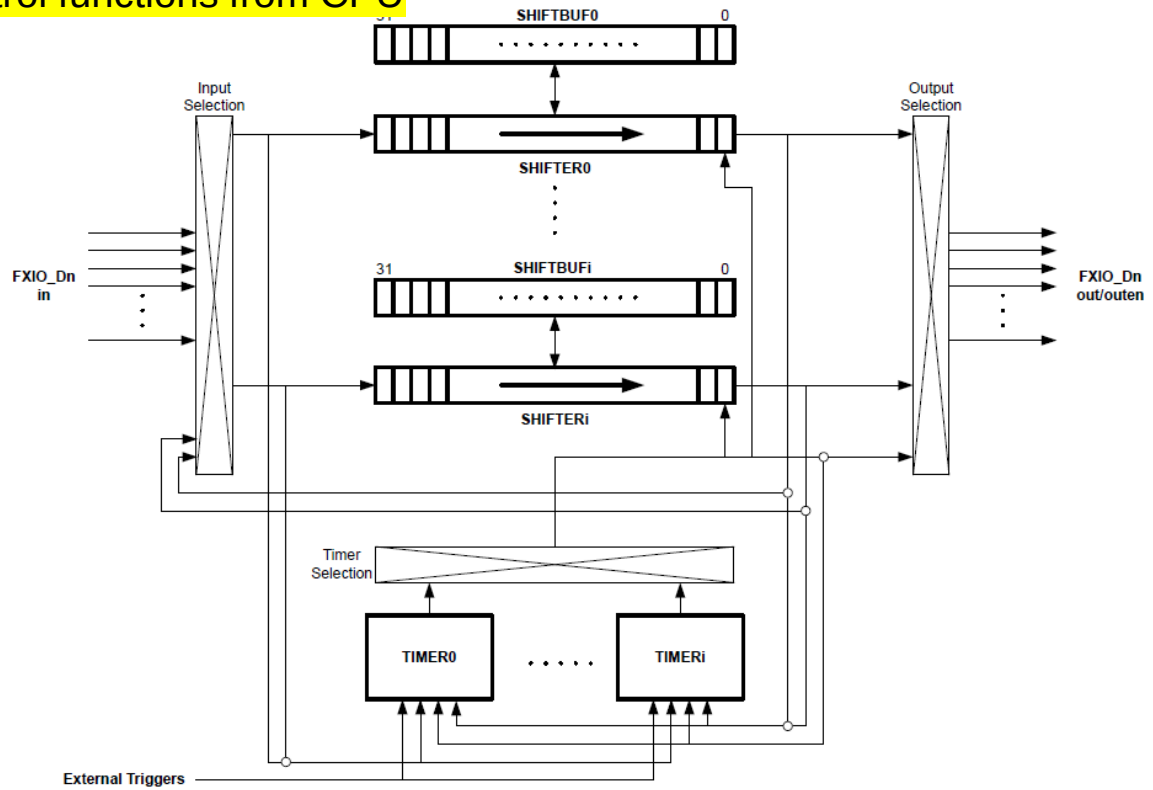
| Feature | FlexCAN0 | FlexCAN1 | FlexCAN2 | FlexCAN3 | FlexCAN4 | FlexCAN5 |
|---|---|---|---|---|---|---|
| CAN FD and CAN | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of CAN Classic Message buffers | 96 | 64 | 64 | 32 | 32 | 32 |
| Number of CANFD 64-byte Message Buffers | 21 | 14 | 14 | 7 | 7 | 7 |
| Rx FIFO Filtering (CAN Classic) | Yes | Yes | Yes | Yes | Yes | Yes |
| ECC | Yes | Yes | Yes | Yes | Yes | Yes |
| PNET | No | No | No | No | No | No |
| External Tick for timestamps | Yes, supported by PIT_RTI_2 Trigger[0] source | | | | | |
| DMA support for CANFD | Yes | Yes | Yes | Yes | Yes | Yes |
| Enhanced Rx FIFO (CANFD) | Yes | No | No | No | No | No |

# HIGHLIGHTS OF DIFFERENCES BETWEEN S32K1'S FLEXCAN

| Feature in K3 | In K1 |
|---|---|
| RAM ECC memory for Message buffers | Non-ECC memory |
| Enhanced RX FIFO with capability for CAN FD frames | Only legacy RX FIFO that supports CAN Classic frames |
| DMA trigger for reception of CANFD messages | DMA not available for CANFD |
| 32-bit wide timestamping timer | 16-bit wide timestamping timer |
| Pretended networking mode (CAN reception in low power modes) is no longer supported | PNET mode available |

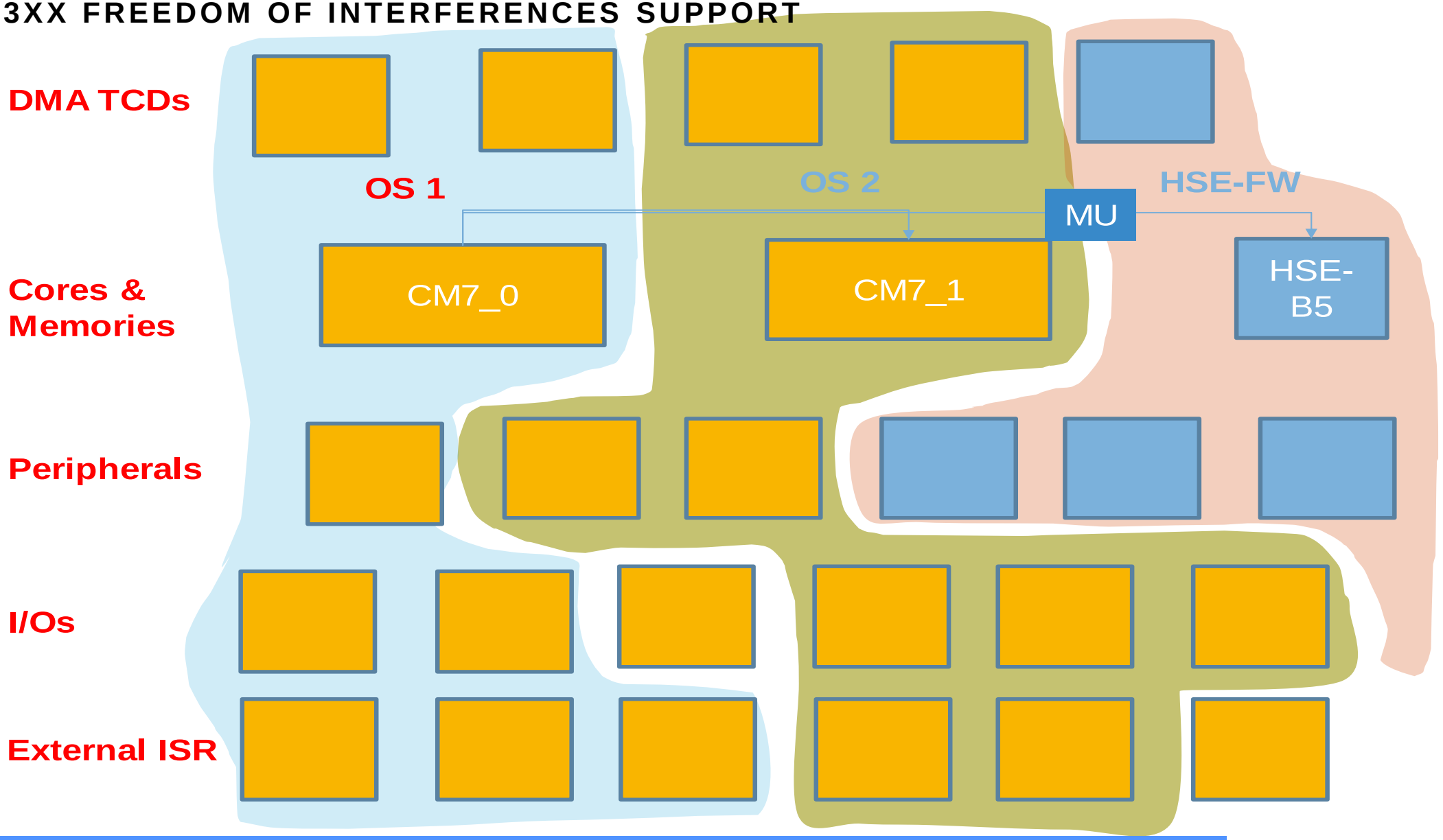
# FLEXIO OVERVIEW

- The FlexIO is a highly configurable module providing a wide range of functionality including
  - Emulation of a variety of serial communication protocols
  - Flexible 16-bit timers with support for a variety of trigger, reset, enable and disable conditions.
  - Programmable logic blocks allowing the implementation of digital logic functions on-chip and configurable interaction of internal and external modules
  - Programmable state machine for offloading basic system control functions from CPU
- Configurations on S32K3
  - 32 pins, 8 Timers (16-bit), 8 shifters
- FlexIO is able to emulate:
  - UART, I2C, SPI, I2S
  - Parallel shifting
    - TFT interface
    - Camera Interface
    - Intel8080/Motorola64k Protocol
  - Input-capture, pulse edge interval measurement.
    - SENT protocol support
  - PWM/Waveform generation




Enhancement vs S32K1

# S32K3XX FREEDOM OF INTERFERENCES SUPPORT




Pool of HW resources arranged around cores based on applications requirements!

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# TSN MOTOR CONTROL DEMO

Problem:

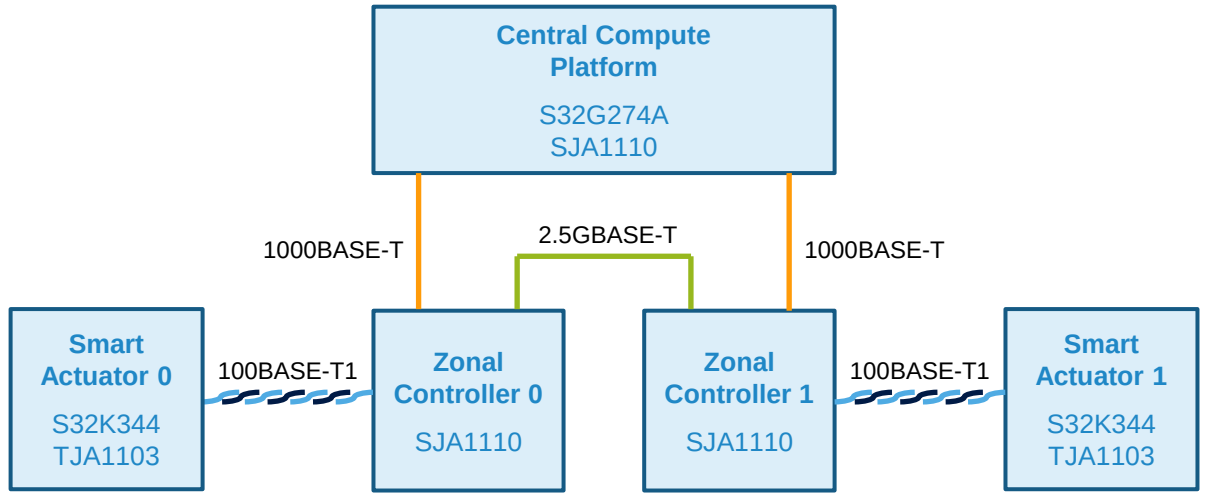
- Real time control via Ethernet from central compute platform– challenges of varying communication latency

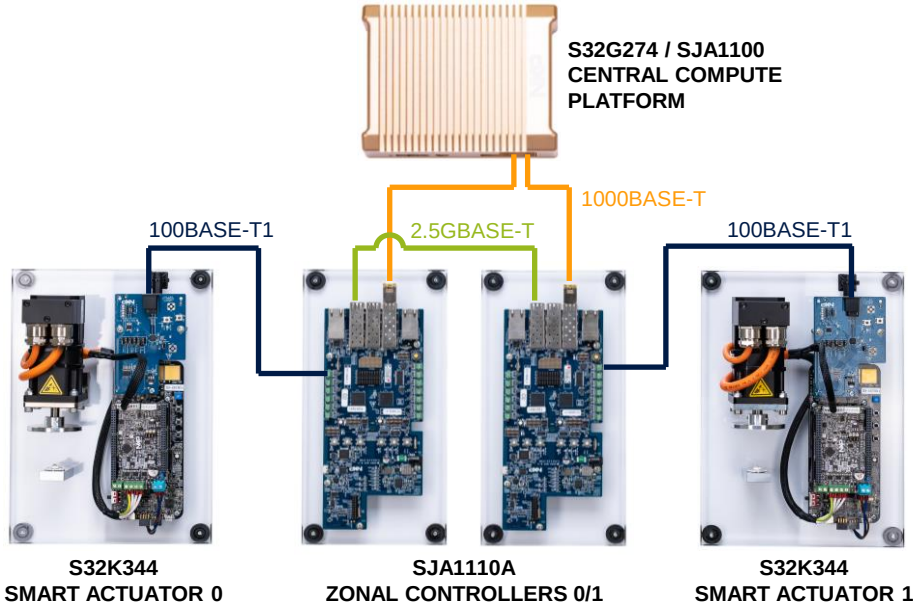
Goal:

- Remote speed controller implementation in the Central Compute Platform, decoupled from the Smart Actuator

Demo:

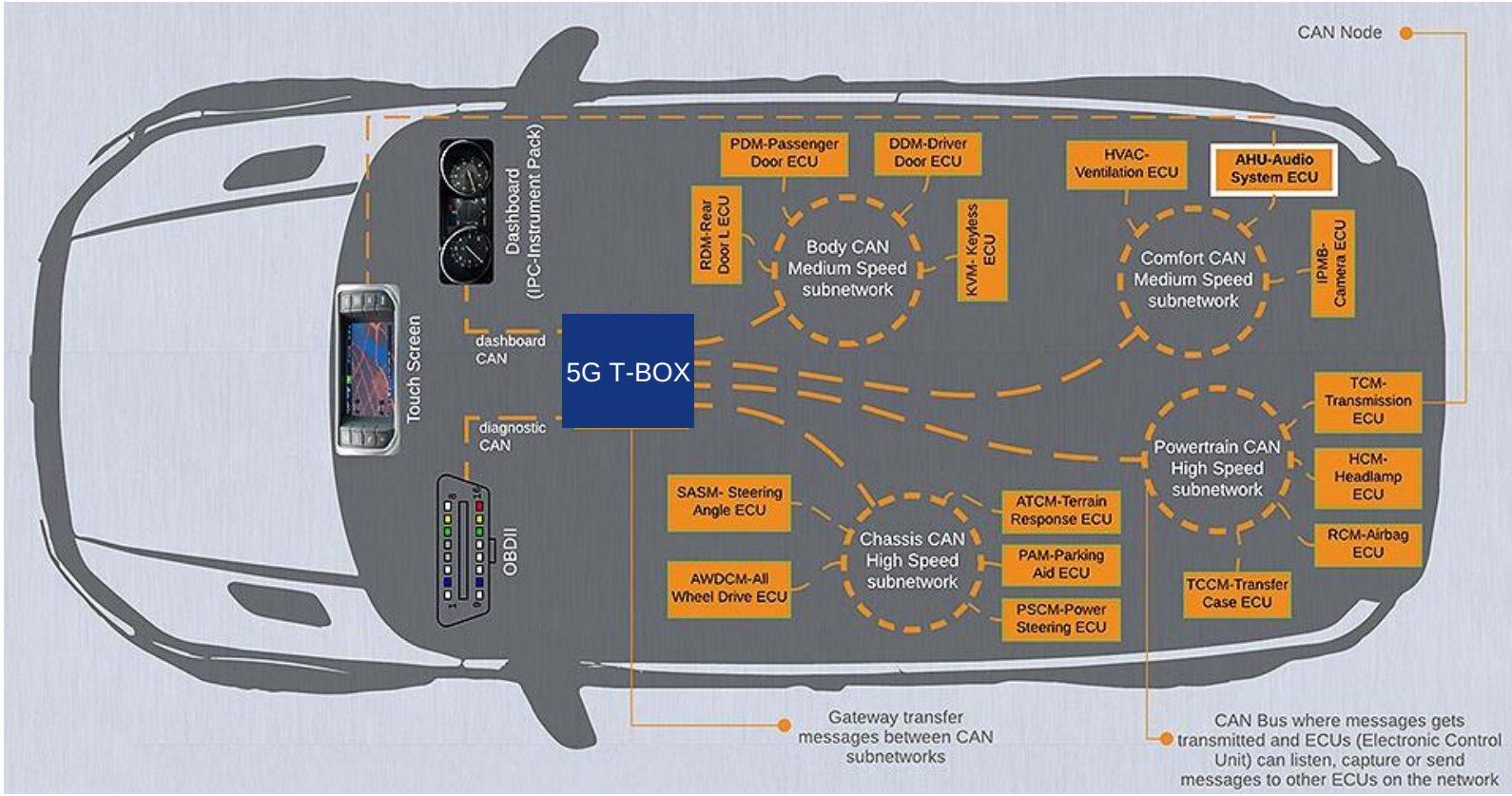
- Speed control loop latency kept within limits by time-aware traffic shaping (IEEE 802.1Qbv, IEEE 802.1as)
- Redundant control data paths enabled between Central Compute Platform and Zonal Controllers (IEEE 802.1cb)
- Multi-domain gPTP configuration for maintaining local clock synchronization in case of single link failure



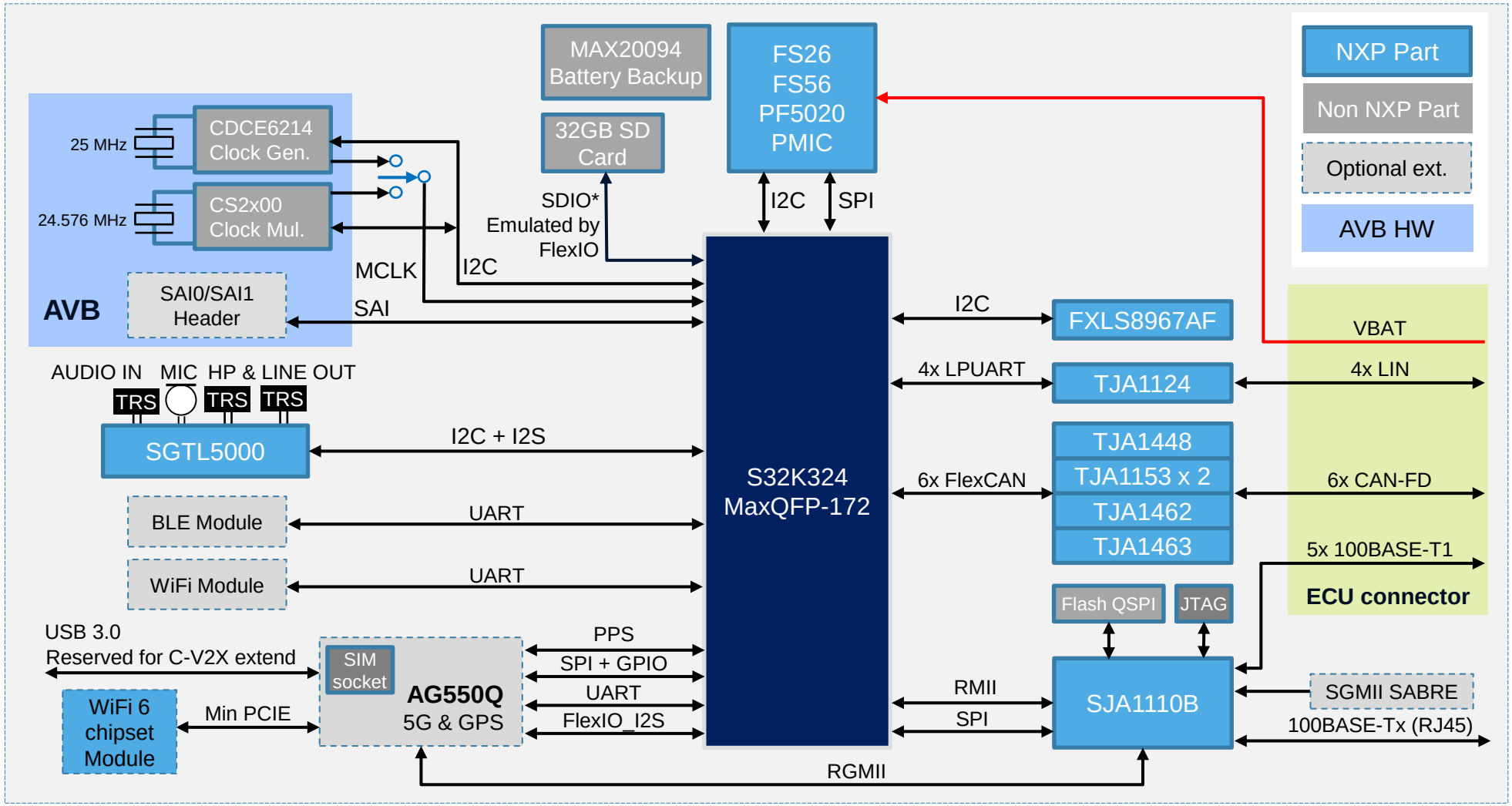



# WHERE IS THE 5G T-BOX IN A VEHICLE E/E ARCHITECTURE

- Benefits of 5G T-BOX with gateway integrated:
  - ✓ **Lower latency**: Able to get the critical vehicle data from CAN/LIN bus directly and timely in urgent case, such as high-way car collision occurrence
  - ✓ **V2X ability**
  - ✓ **Save system power consumption of low-power mode when IGN OFF**: can get important data without wakeup other ECU
  - ✓ **Save BOM cost**
  - ✓ **At least 4 CAN w/ FD required** for the new EV E/E architecture



# T-BOX BLOCK DIAGRAMS




**5G Support**

- Basic 5G T-BOX functionality with FOTA

**I/O aggregator support**

- 5x 100BASE-T1
- 1x 1000BASE-Tx
- 1x 1000BASE-T1 (ext.)
- 6x CAN-FD
- 4x LIN 2.x

**AVB Support**

- SJA1110 TSN switch with internal 802.1AS synchronization middleware
- Media clock generation supporting CS2x00 and CDCE6214
- Low-power stereo codec
- SAI header for TDF853x class-D amplifier connection or another codec

# S32K MULTI NETWORK SYNCHRONIZATION DEMO

- **Technical Challenges Addressed:**
  - Background: the adoption of zonal architecture
  - Protocol translation (ISELED, LIN, CAN, Ethernet) across different zones
  - Synchronization of lighting/sound effects across different zones
- **Demo Key Features:**
  - HW based on S32K1xx EVBs and ISELED strips
  - Middle-layer SW built on S32 EcoSystem (S32 DS, S32K1 SDK, ISELED driver)
  - Distributed time concept to have same time stamp across all nodes in network
- **Benefits:**
  - Scalable solution across communication interfaces with single S32K family
    - Demo supports ISELED, LIN, CAN (FD), Ethernet protocols
  - Smooth synchronization effects with fast response time/ low latency

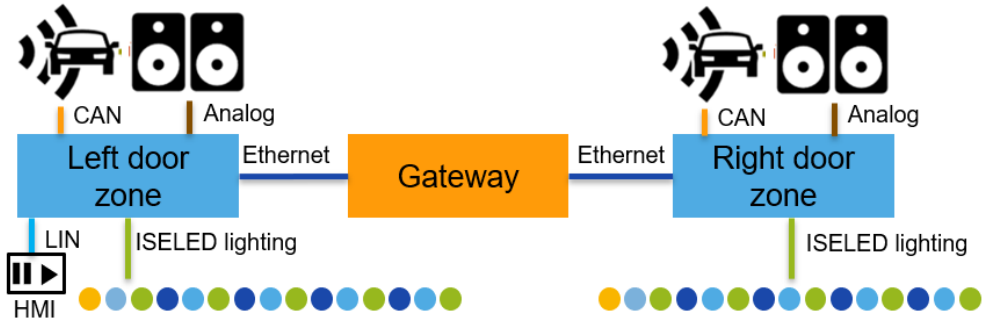



Fig 1. Use case example in zonal architecture

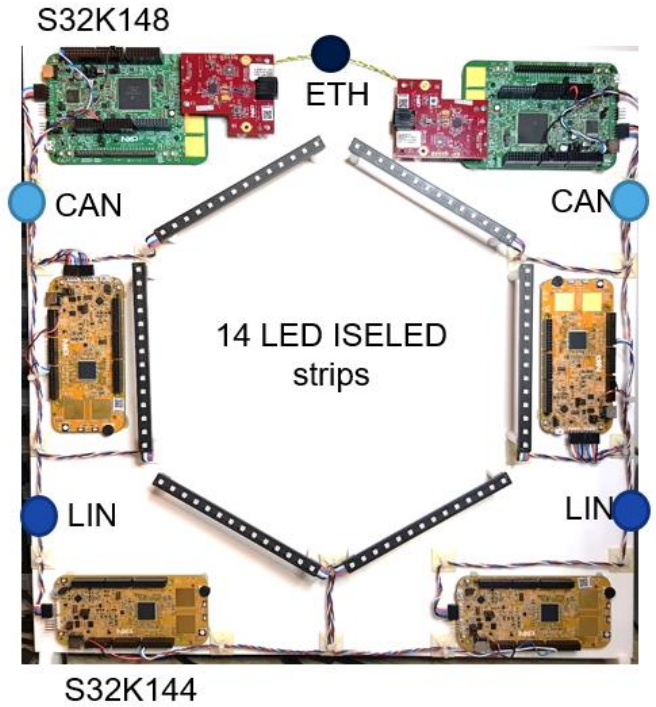
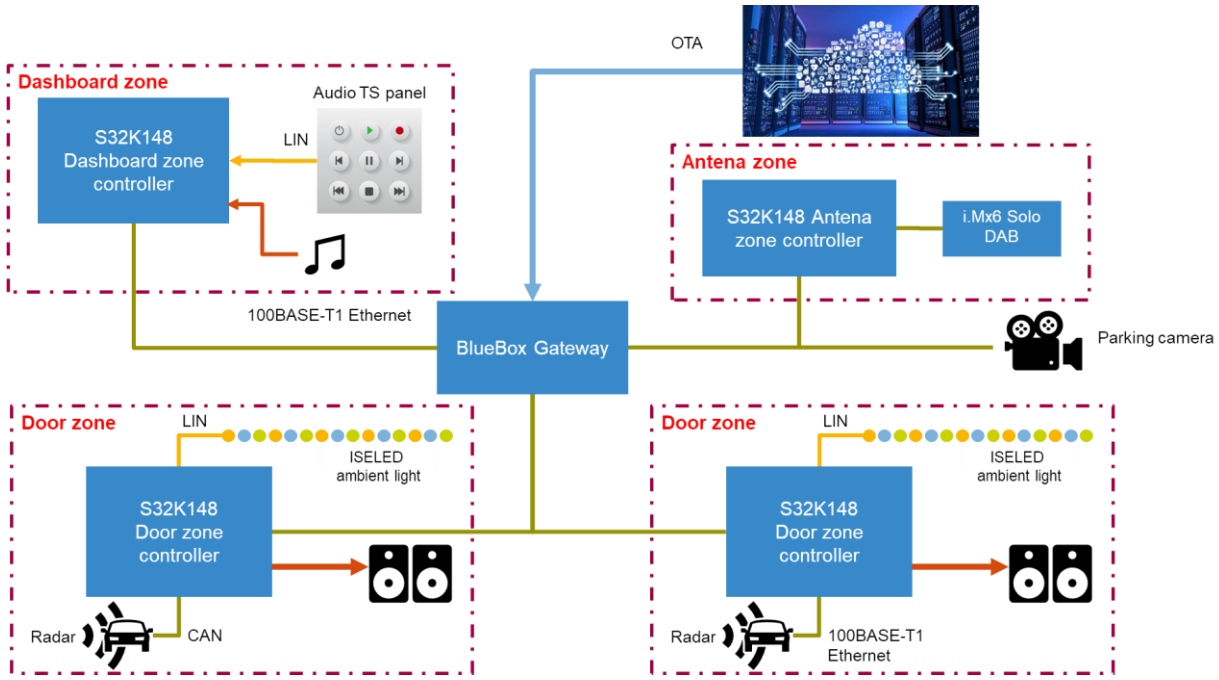



Fig 2. Demo Set Up Overview

# SMART DOOR ZONE SOLUTION WITH ISELED AND ETHERNET AVB

- **Problem:**
  - Traditional door solutions use dedicated modules with point to point wiring for lighting and audio. This requires extensive wiring, complicated OTA updates, and limits design flexibility. The addition of radar complicates the challenge.
  - Adopting a zonal architecture with an integrated Door Zone module reduces wiring, simplifies OTA, increases design flexibility, and enables the addition of radar, but introduces challenges in synchronization between door zones
- **Solution:**
  - Smart Door Zone module for lighting, audio, and radar
  - Lighting and audio synchronization supported by ISELED and Ethernet AVB




ISELED®

- ISELED is a digital LED Solution for dynamic lighting effects with synchronization
- ISELED has been developed by an open alliance to provide a complete eco-system to support market adoption
- NXP's S32K1xx family is the first and only production-ready HW and SW solution for ISELED on the market

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## SUMMARY

- S32K3 family solves the challenges in zonal aggregators with:
  - rich communication interfaces
  - low power performance
  - freedom of interferences support
- Various demos available to further demonstrate use cases

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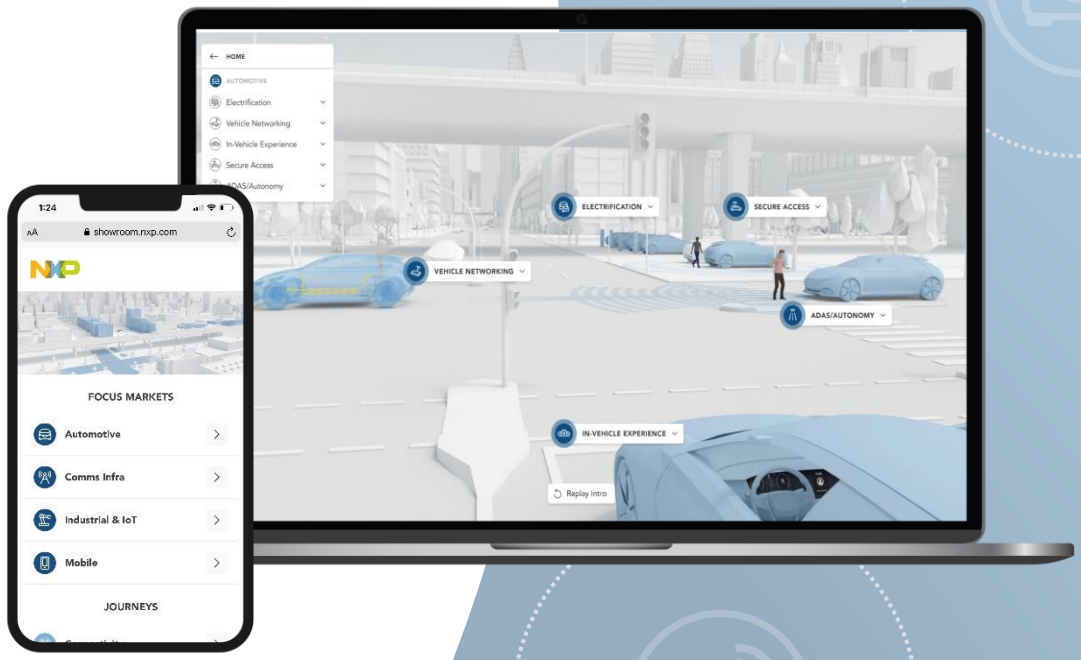
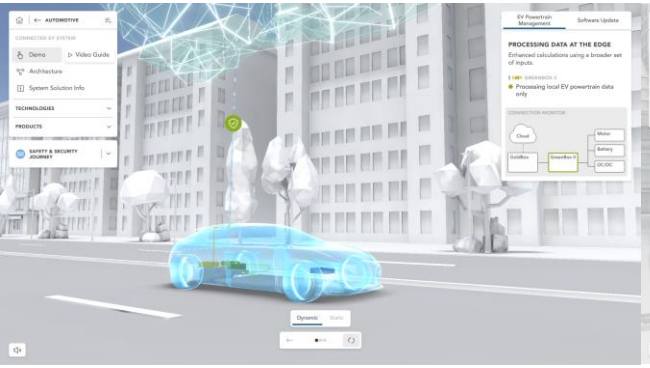
## 60+ VIRTUAL DEMOS

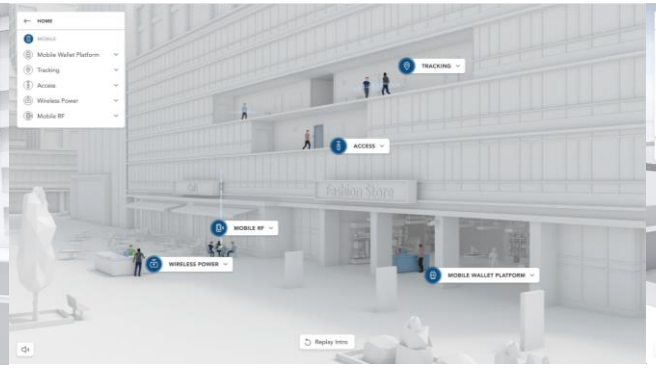
Focus on system solutions
Set up along NXP verticals

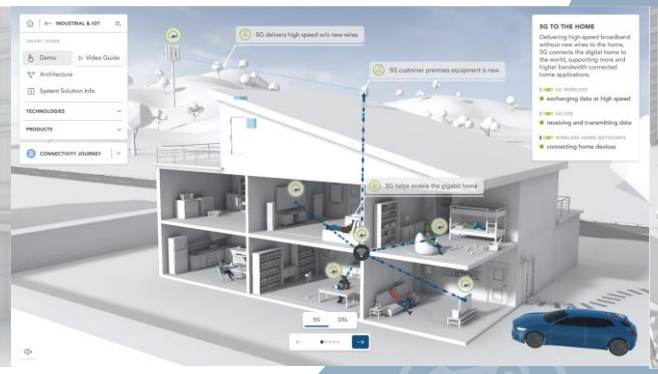
## JOURNEYS BY DESIRED FOCUS

Low Power Innovations
Advanced Analog
Connectivity
Edge & AI/ML
Safety & Security







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