TSN AND INDUSTRIAL ENET SOLUTION

RT1170 OVERVIEW

Richy Ye
MCU Sys & Apps Engineering Manager, BL EP
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SECURE CONNECTIONS
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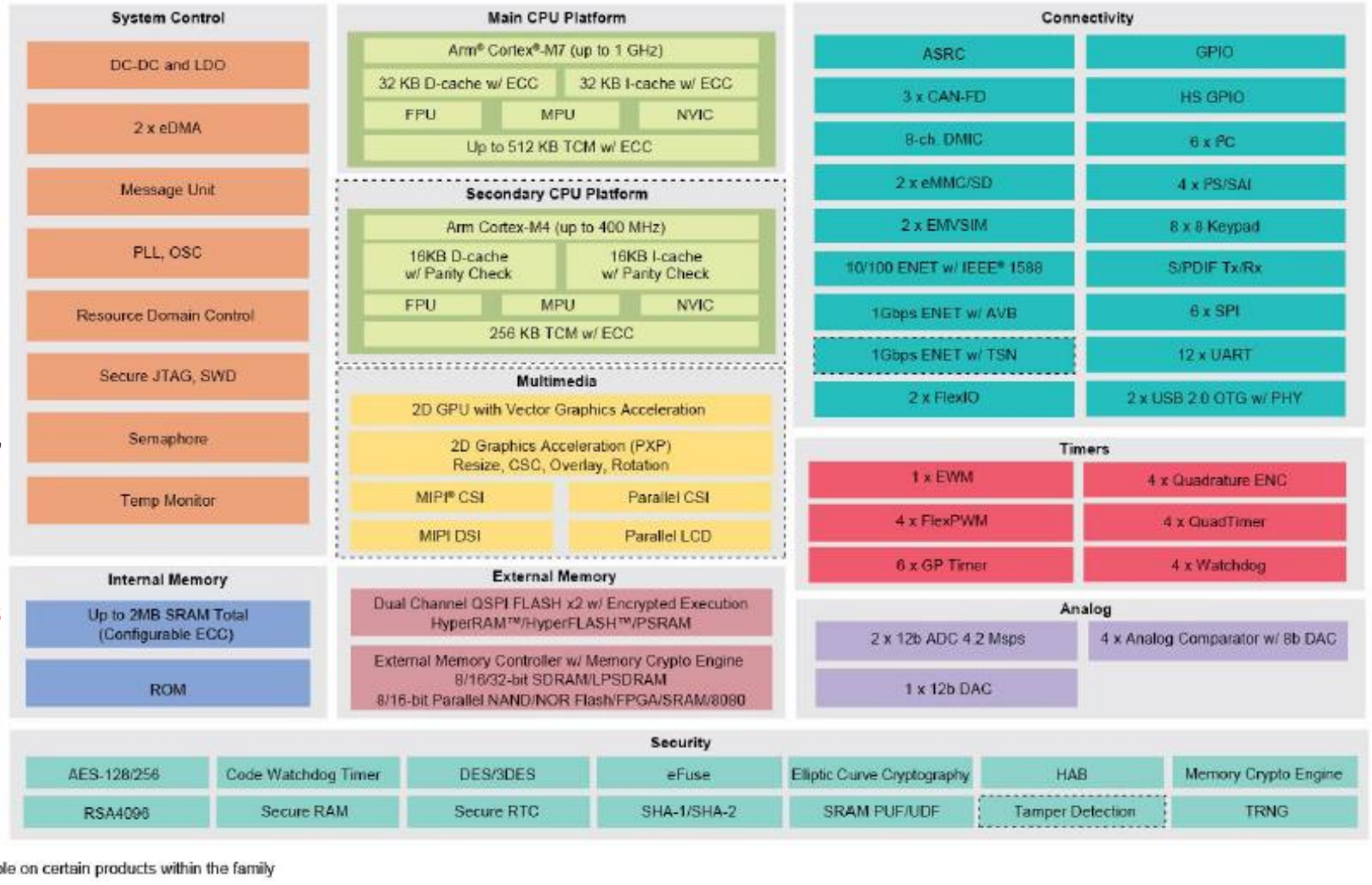
Agenda

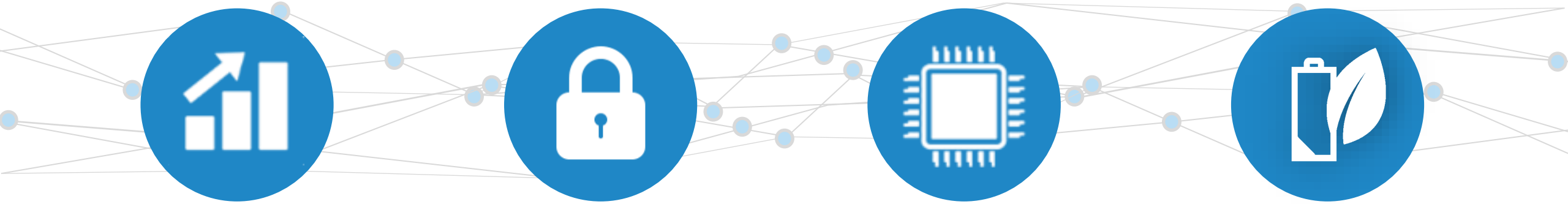
- **RT1170 Features Overview**
- **Industrial ENET Interface Overview**
- **Motor Control Resource Overview**
- **HMI Multimedia Resource Overview**
- **Motion Control Use Case**

RT1170 CROSSOVER MCU FAMILY

- Specifications
  - Process: SEC 28FD-SOI
  - Core Voltage: 1.0V
  - Package: MAPBGA289, 14x14mm, 0.8mm pitch
  - Temperature: -40C to 125C (Tj)
- Key Features and Advantages
  - Arm Cortex-M7 processor, 1 GHz, 32KB/32KB L1 Cache, 512KB TCM
  - Arm Cortex-M4 processor, 400MHz, 16KB/16KB L1 Cache, 256KB TCM
  - 2MB on-chip SRAM (including TCM for CPU core)
  - Parallel LCD Display up to WXGA @60fps
  - 8/16/24-bit Parallel Camera Sensor Interface
  - 2-lane MIPI CSI and 2-lane MIPI DSI with 1.5GHz bit clock
  - 2D GPU & Graphics Acceleration PXP
  - 8/16/32-bit SDRAM controller with up to 200MHz
  - 8/16-bit Parallel NOR FLASH/NAND FLASH/SRAM
  - 2x dual-channel FlexSPI Interfaces, w/ On-The-Fly decryption, which support serial NOR FLASH/serial NAND flash/PSRM /HyperBus devices
  - 2x eMMC 5.0/SD 3.0/SDIO Port
  - 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
  - Audio: 4x I2S/SAI, 1x S/PDIF Tx/Rx, ASRC, digital microphone input
  - 3x ENET: 1Gbps ENET w/ AVB + 10/100 ENET w/ IEEE 1588 + 1Gbps ENET w/ TSN
  - 2x 12-bit ADC, 4.2Msps, up to 20 input channels total
  - 4x Analog comparator, 1x 12-bit DAC
  - Full PMU Integration, DCDC+LDOs
  - Supports up to 4 servo motors control
  - Secure Boot, TRNG, RSA4096, Tamper Detection, Secure Key Storage
- Enablement
  - MCUXpresso, FreeRTOS with SDK
  - Autosar



RT1170 KEY DIFFERENTIATION



1GHz Cortex-M7
400MHz Cortex-M4
Over **6468** Coremark

High Performance

High-Performance Crypto
Tamper Detection
On-The-Fly Memory Encryption & Decryption
Secure Boot

Advanced Security

Up to **2MB** SRAM
High-speed ADC, DAC
Gbps Ethernet
2D GPU
MIPI CSI / DSI

Rich Feature Set

28nm FD-SOI Process
Optimized for both active power & leakage power

Low Power

Target applications on industrial automation:

- Motion controller
- Servo motor controller
- Industrial HMI
- PLC

RT1170 ETHERNET INTERFACES

10/100M Ethernet

- Ethernet MAC interface
- Supports both MII and RMII interfaces to external PHY
- Integrated time-stamping module to support IEEE 1588 standard, provides accurate clock synchronization for distributed control nodes for industrial automation applications.

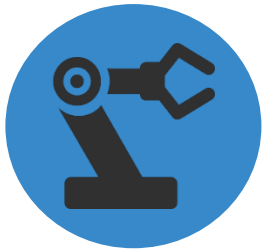
1G Ethernet

- Ethernet MAC interface
- Supports both MII/RMII/RGMII interfaces to external PHY
- Integrated time-stamping module to support IEEE 1588 standard, provides accurate clock synchronization for distributed control nodes for industrial automation applications.
- Supports Ethernet AVB

1G Ethernet QOS

- Ethernet MAC interface
- Supports both MII/RMII/RGMII interfaces to external PHY
- Supports 802.1AS, 802.1Qbu, 802.1Qbv, 802.1Qav standards
- Supports media clock recovery and generation
- Supports both TSN and AVB
- Programmable safety watchdog timeout limits

TSN FEATURES FOR INDUSTRIAL APPLICATIONS



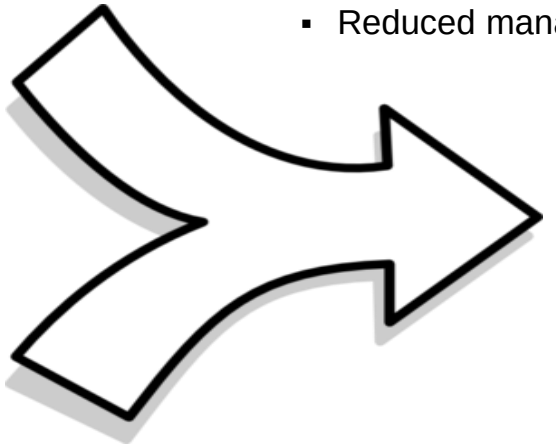
Industrial automation application requirements:

- Very Low Latency
- Time Sync
- High Bandwidth
- Redundancy
- Network Convergence

Extend use cases from audio/video applications to control systems

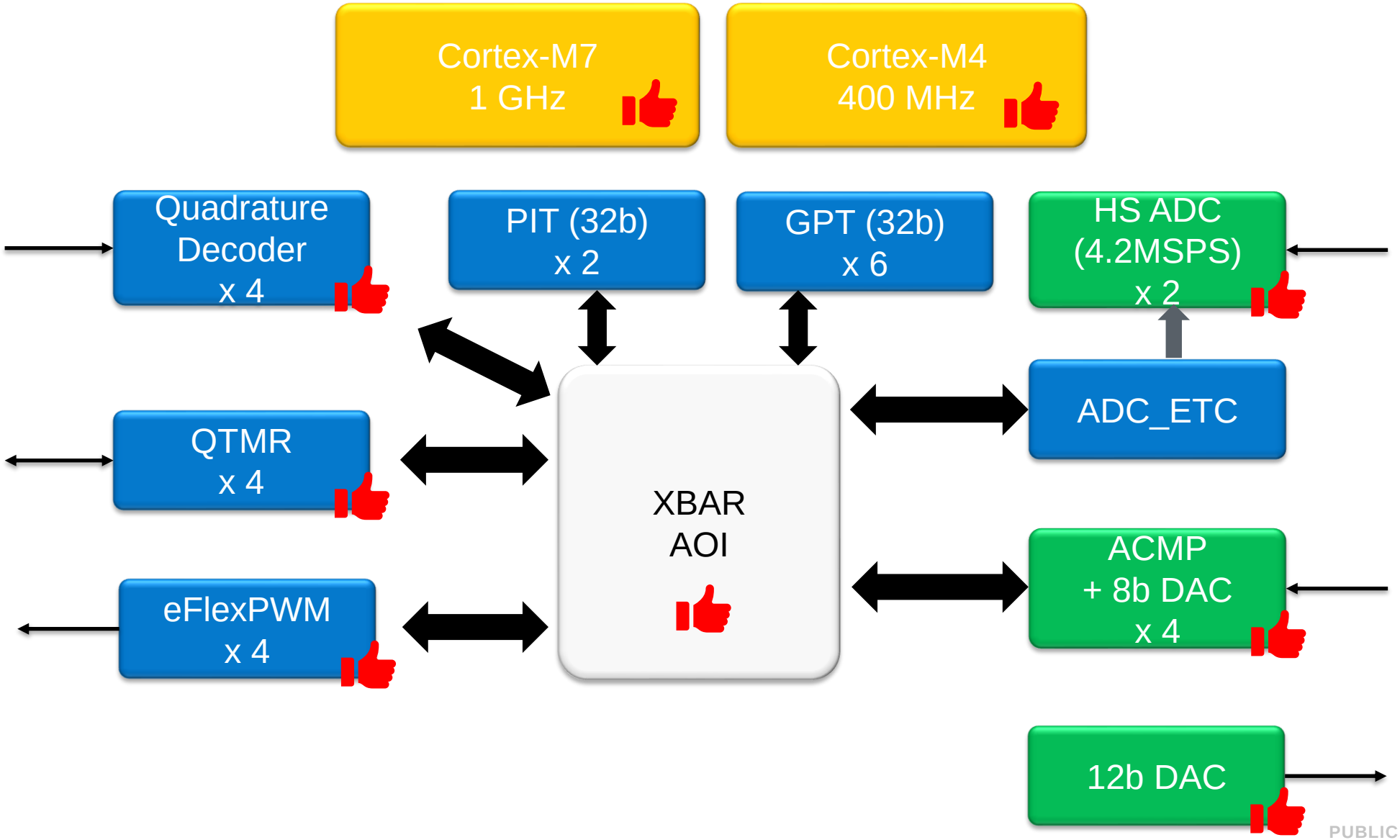
- **Reduced worst-case delays**
  - 4 µs or less per hop @ 1 Gbps for short messages (plus cable delays)
  - Guaranteed end-to-end latency
- **Time synchronization**
  - Precision Time Protocol, all devices in gPTP network are synchronized
- **Improved robustness:**
  - Alternative paths with “instant” switchover
  - Seamless redundancy using multiple simultaneous streams
  - Multiple clock sources with “instant” switchover
- **Scalability**
  - Reduced management traffic for resource reservations and configuration

PROFINET
EtherNet/IP
Modbus
ETHERNET POWERLINK
EtherCAT
DeviceNet
ControlNet
sercos the automation bus
ASHRAE BACnet

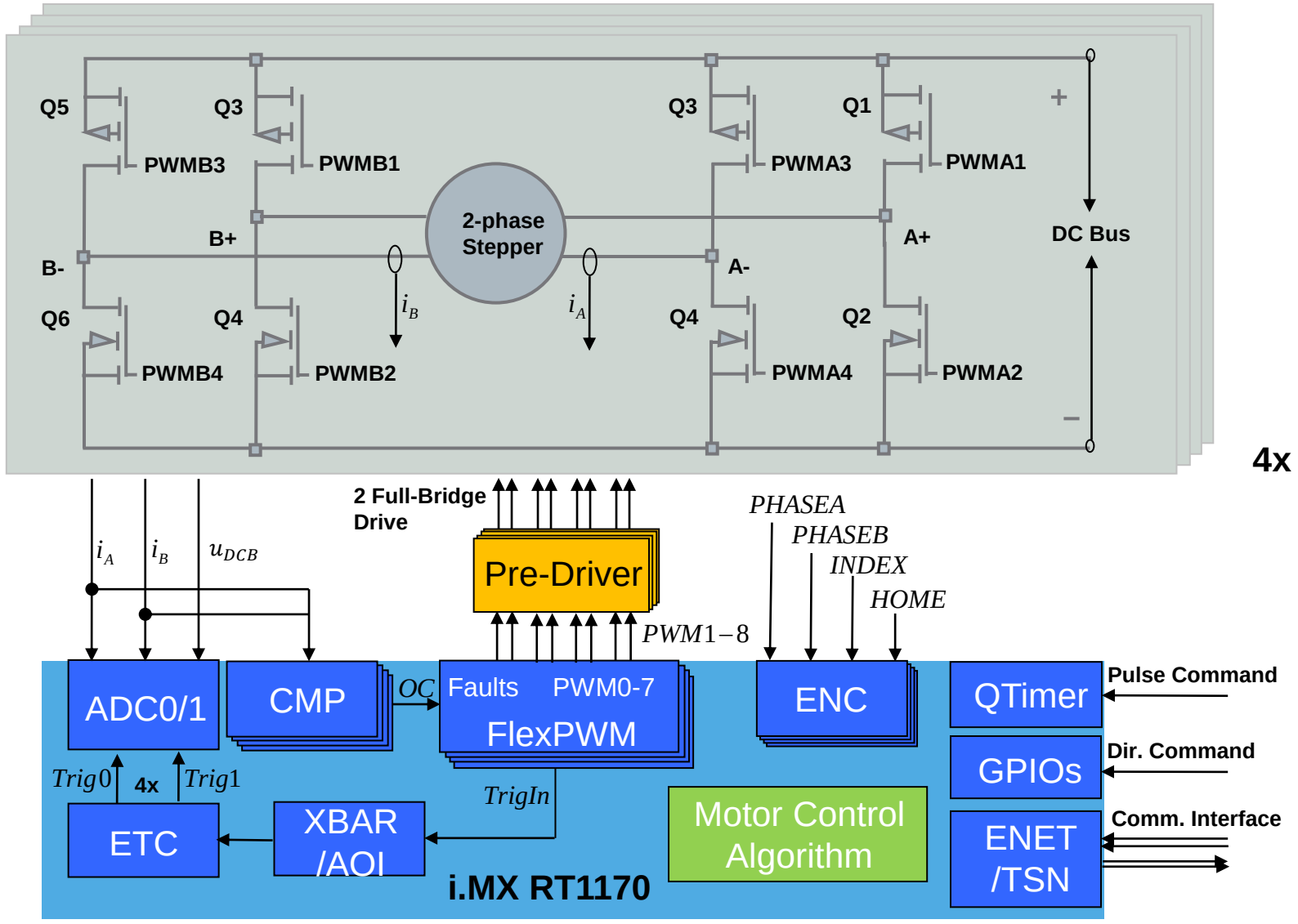


TSN

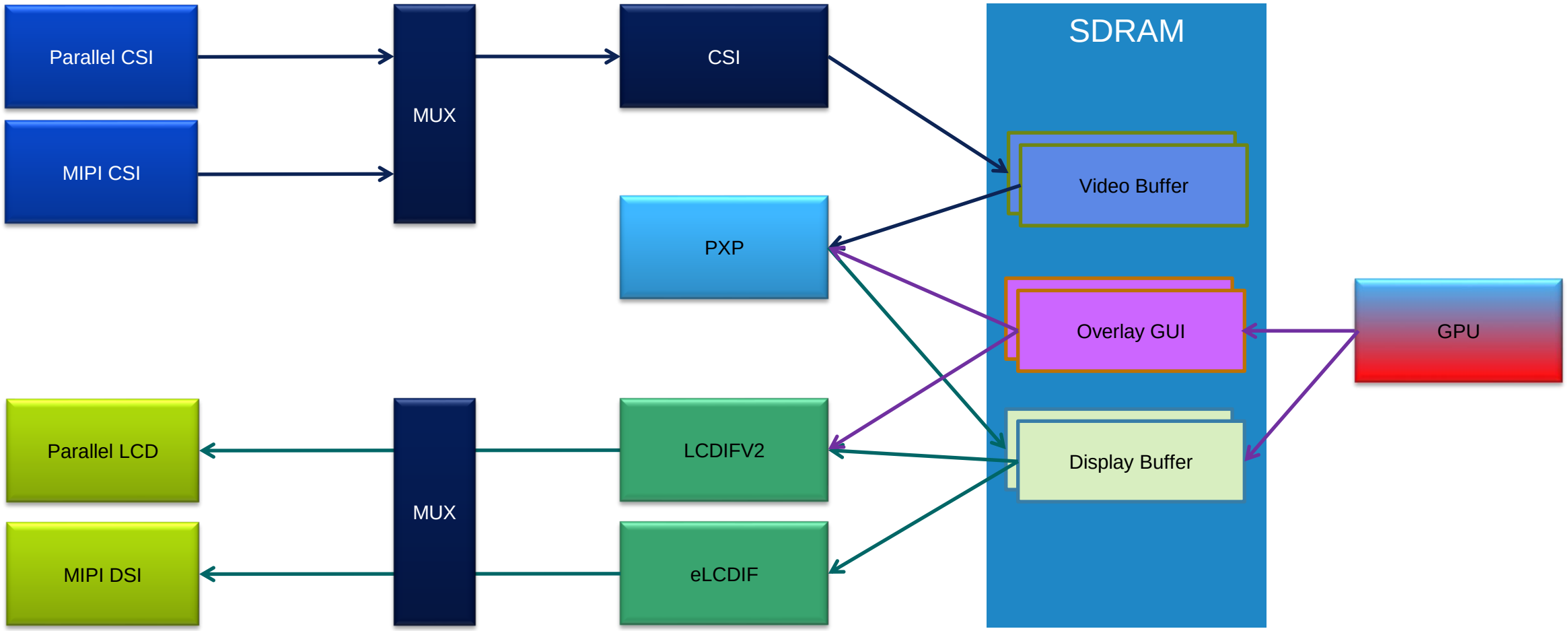
RT1170 MOTOR CONTROL PERIPHERALS



USE CASE -- QUAD STEPPER SERVO MOTORS CONTROL



RT1170 GRAPHIC SYSTEM



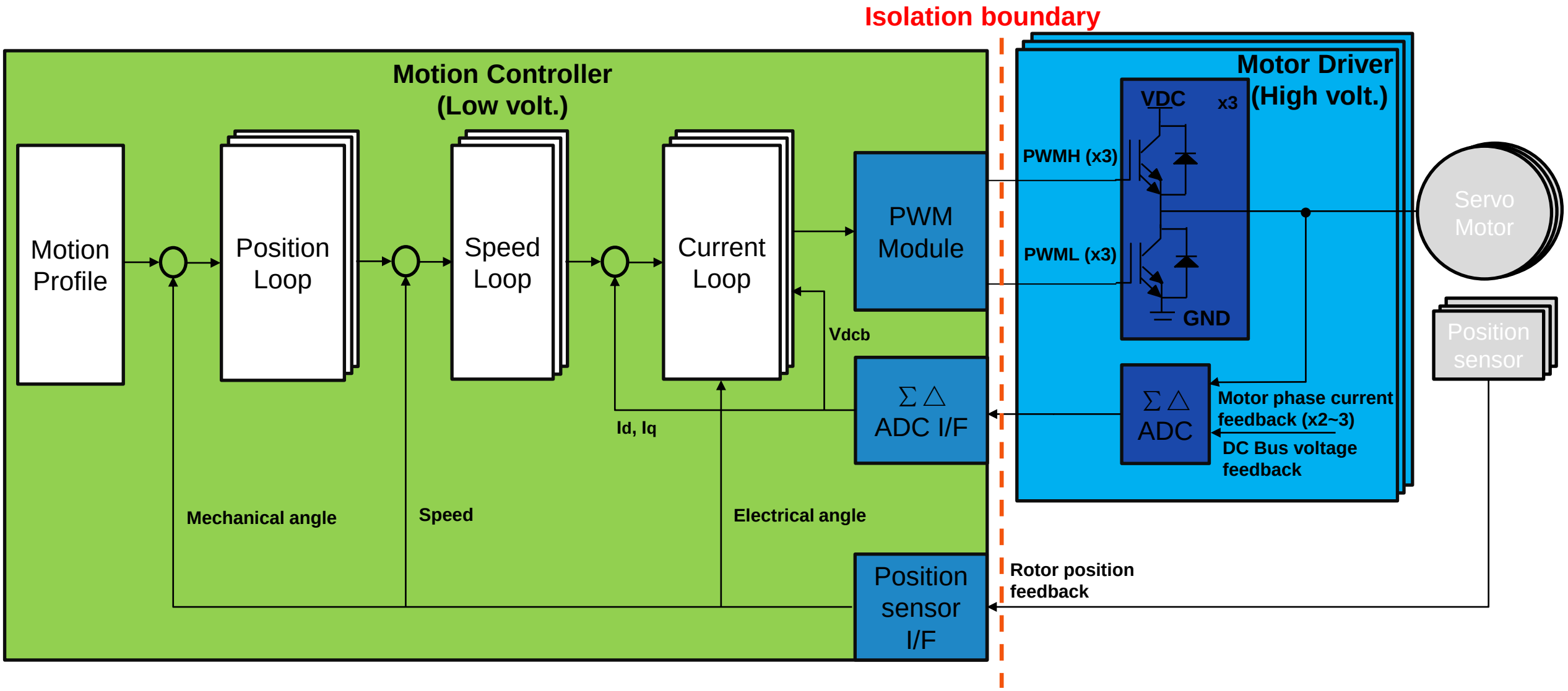
RT1170 AUDIO SYSTEM

- Functional Modules:
  - SAI-1: support up to 4-TX lanes & 4-RX lanes
  - SAI-2/3/4: support 1-TX lane & 1-RX lane for each block
  - 1x SPDIF TX & RX
  - 1x MQS
  - ASRC
  - 1x Digital Microphone Interface (up to 8-ch input)

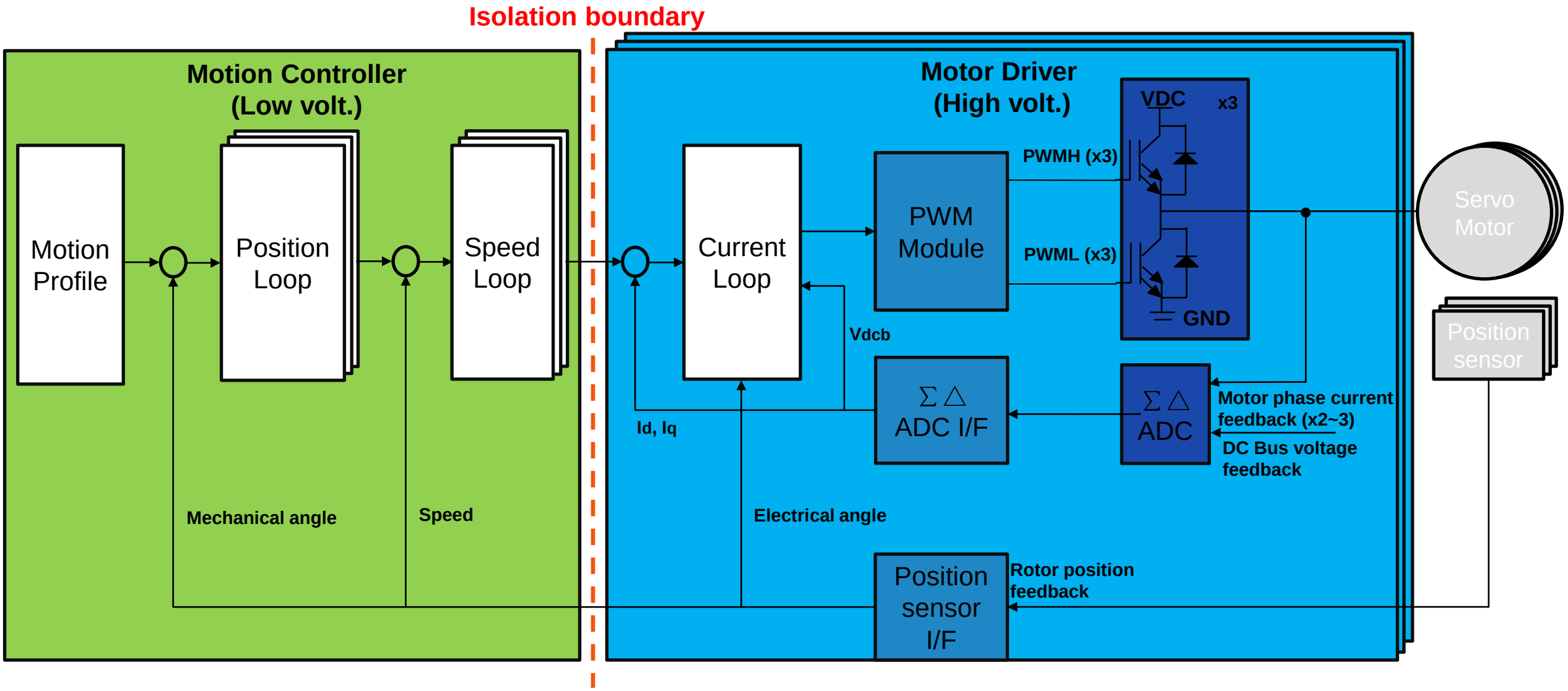
- Audio PLL
  - Fractional PLL which can generate very accurate audio clock
  - Support on-the-fly frequency change

- Audio Master clock synchronization
  - Flexible master clock synchronization between each SAIs and SPDIF
  - Independent master clock option for RX and TX
  - MQS is tightly coupled with SAI-3 block

CENTRALIZED CONTROL



DECENTRALIZED CONTROL



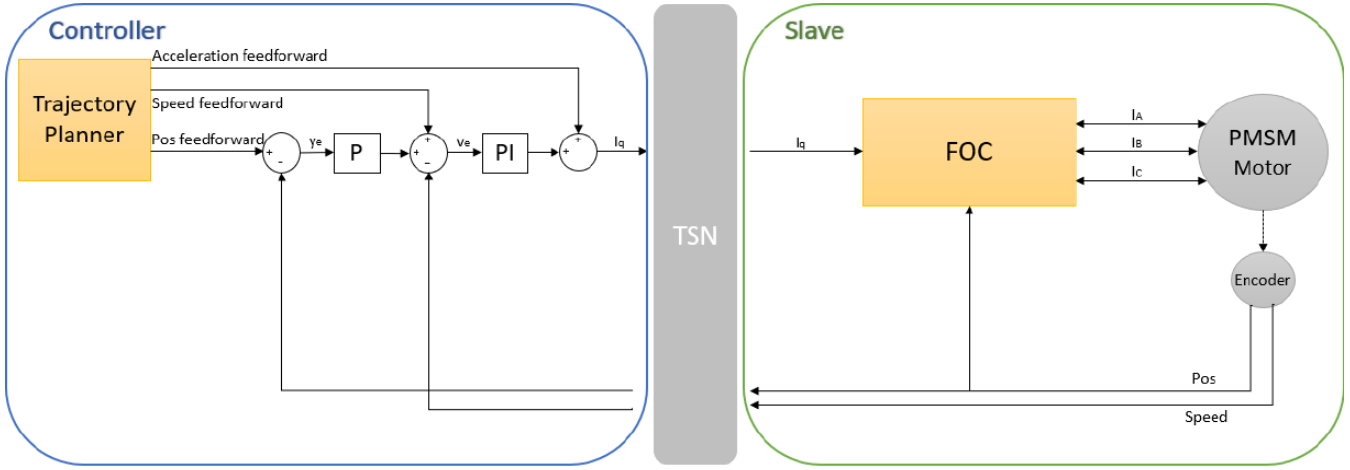
DECENTRALIZED CONTROL VS. CENTRALIZED CONTROL

Features	Decentralized	Centralized	Benefits of decentralized control
Motion controller	Only processes slow control loops or no control loop	Processes all control loops, supports all motor control peripheral interfaces	Simplified controller with less real time processing performance and no motor control peripheral interfaces
Motor driver	Intelligent driver with motor control loop	Simplified driver board	Improved motor control performance
Connection wires	Less with only communication cable	Many	Low cost, high reliability
Control loop performance	High real-time with low feedback delay	Long feedback delay and multiple motors control in one location	High control performance with low delay
Driver-to-drive communication	Fast communication to synchronize each other	Not used	N/A
Electrical isolation	Isolated communication	Isolated actuation and feedback signals	Low isolation cost
Cabinet cost	Low with less components and small size	High	Low labor and materials cost

TSN DISTRIBUTED MOTOR CONTROL DEMO

Key Features:

- Based on RT1170 as TSN endpoint and LS1028A as TSN switch
- One RT1170 TSN endpoint works as the motion controller, two RT1170 TSN endpoint work as the motor controller slave
- TSN is used to communicate the torque command and current motor rotor position/speed information between motion controller and motor controller slave
- Supports back-to-back mode and TSN bridge mode



MORE INFORMATION ACCESS

- AVB/TSN stacks development package for supported i.MX RT crossover MCUs:
  - Can be download @ https://www.nxp.com/design/software/development-software/mcuxpresso-software-and-tools-/wired-communications-middleware-for-nxp-microcontrollers:WIRED-COMM-MIDDLEWARE?tab=Design_Tools_Tab
  - Compatible with MCUXpresso SDK v2.10.x
  - It includes release note, user guides, programmer's reference guide, application notes, AVB/TSN library, SDK, example applications source code etc.

- More RT1170 information:
  - Please access nxp.com @ https://www.nxp.com/products/processors-and-microcontrollers/arm-microcontrollers/i-mx-rt-crossover-mcus/i-mx-rt1170-crossover-mcu-family-first-ghz-mcu-with-arm-cortex-m7-and-cortex-m4-cores:i.MX-RT1170

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