Texas Instruments

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SERVO DRIVES

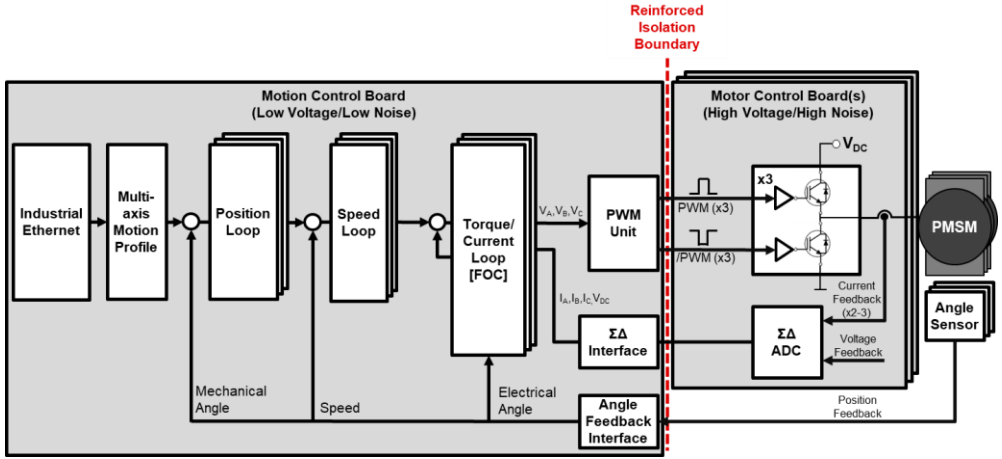
MOVE YOUR REAL-TIME CONTROL CLOSER TO THE ACTION WITH TI'S DECENTRALIZED, MULTI-AXIS SERVO DRIVE ARCHITECTURE

Agenda

- Architecture options
- Sitara AM64x for motion control
- Fast Serial Interface (FSI)
- C2000 real-time microcontrollers for motor control
- Get started

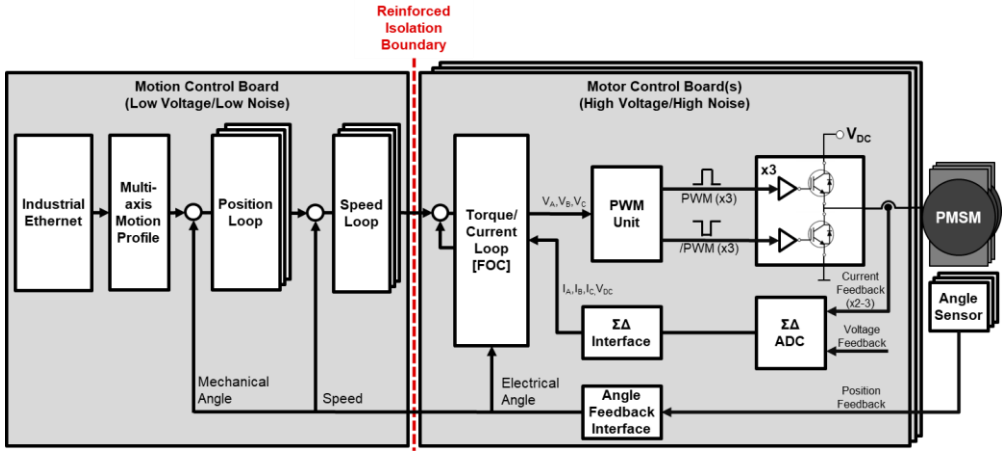
Architecture

Centralized and decentralized multi-axis servo control



Centralized

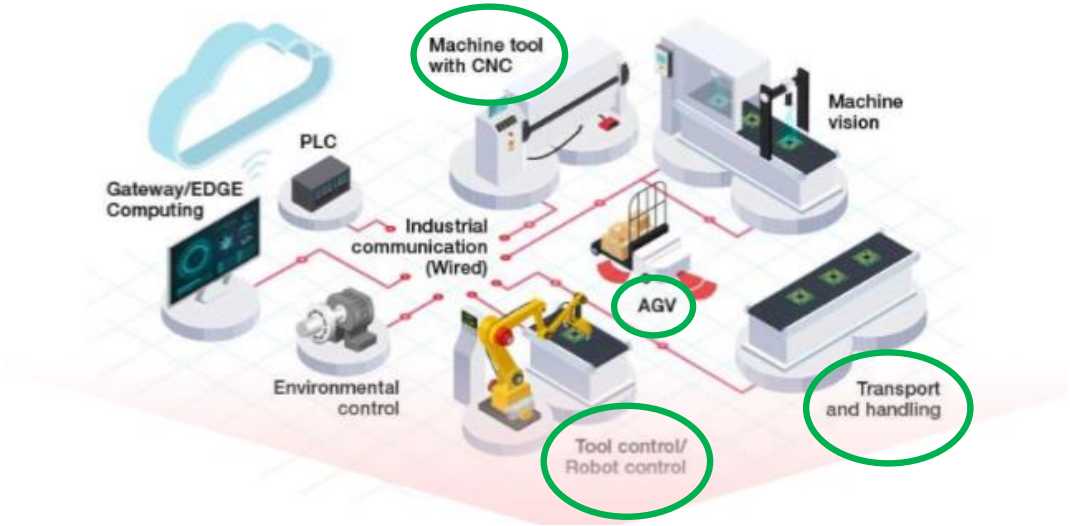
- Control loop processing all in one location
- Isolated actuation/feedback signals
- Simplified power stage boards



Decentralized

- Control loop processing distributed across system
- Isolated communication between control boards
- Simplified motion control board

Where and why to use decentralized control



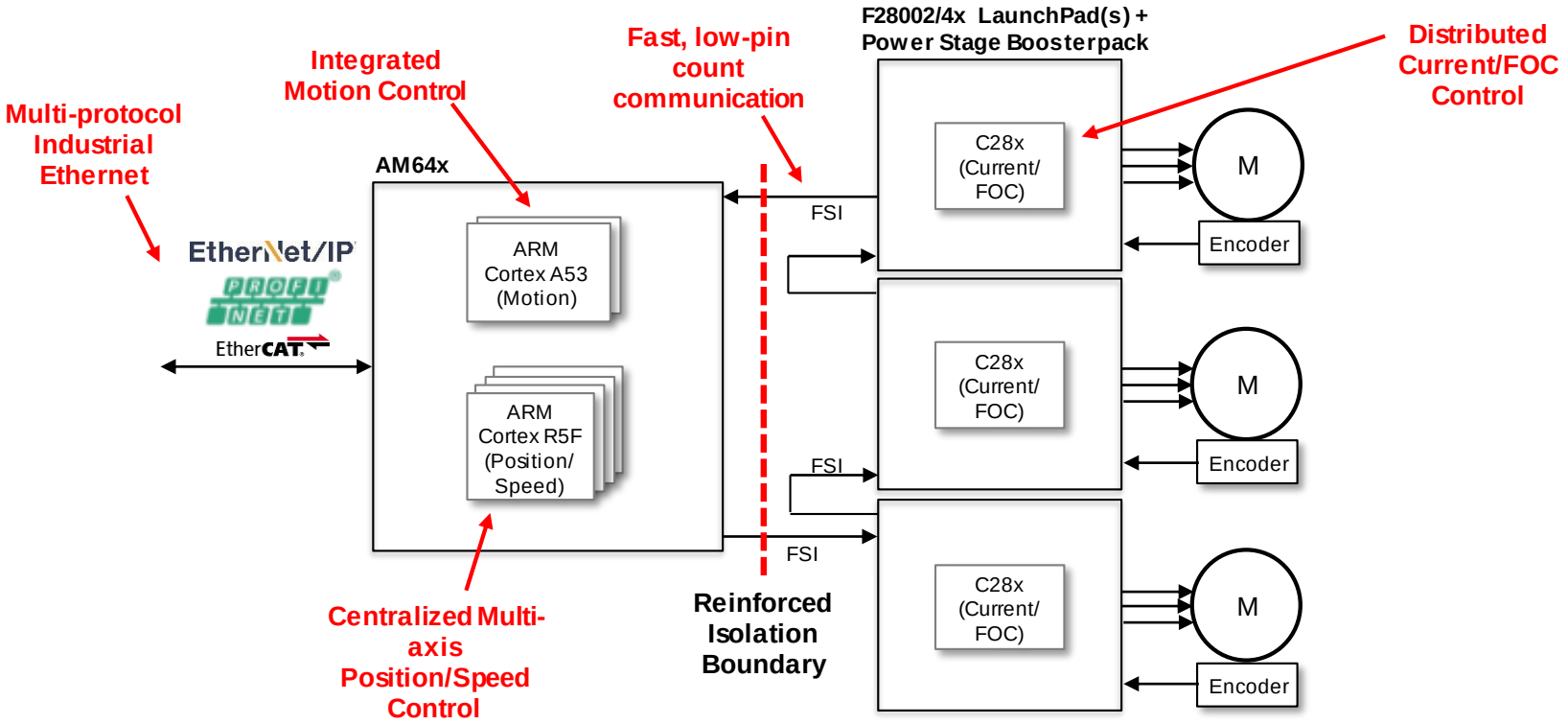
Where?

- Multi-axis robotics
- Linear transport systems
- CNC machines
- Autonomous Guided Vehicles

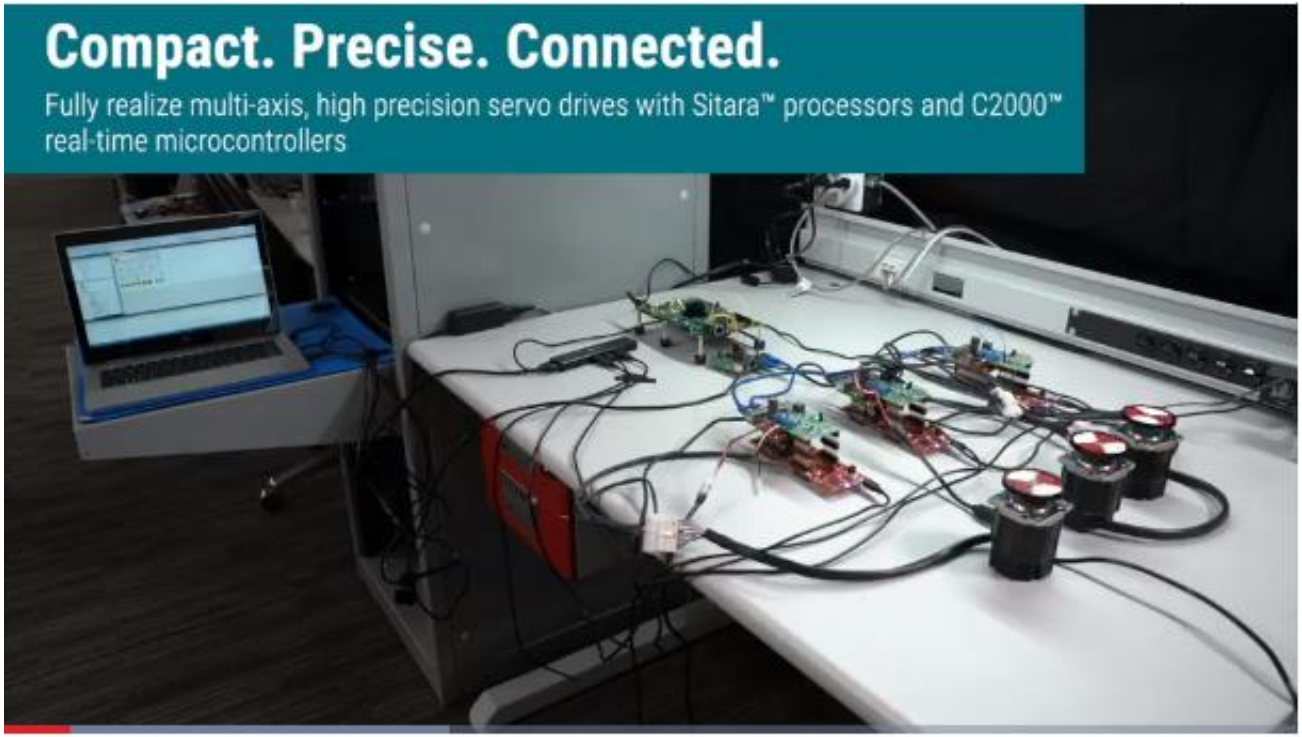
Why?

- More intelligence at the motor drive
- No external control cabinet needed
- Reduced system cabling costs
- Improved control loop performance

Example AM64x + F28002/4x decentralized architecture



Demo



Sitara™ AM64x processors: Outer control loops with CiA402 drive profile run on a Sitara™ AM64x processor using EtherCAT® communication from a PC

Adapter boards: Real-time, low pin-count, robust communication up to 200 Mbps over Fast Serial Interface (FSI) adapter boards

C2000™ real-time controllers: Inner current loops run on F2800x LaunchPad™ development kits

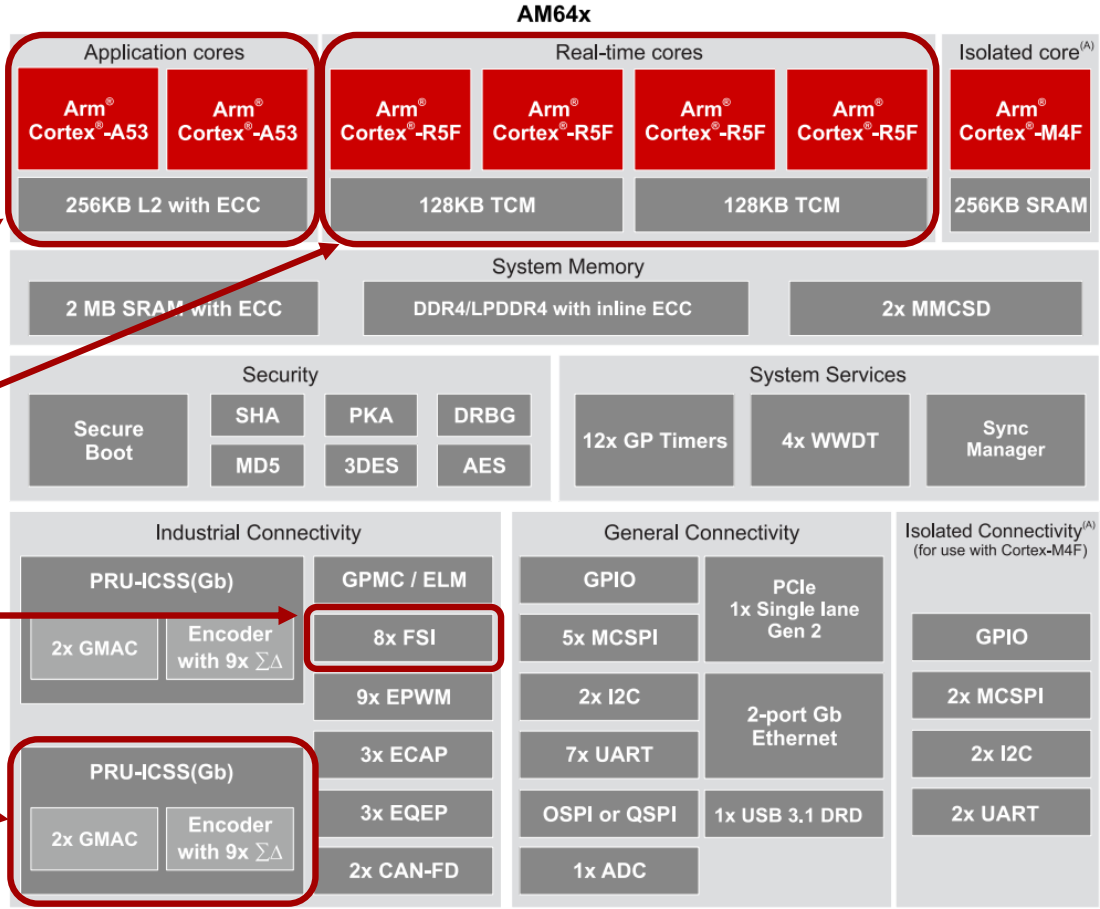
BoosterPack™ development kits: GaN three-phase inverter BoosterPack™ development kits

https://training.ti.com/decentralized-multi-axis-motor-control

Sitara AM64x Processors

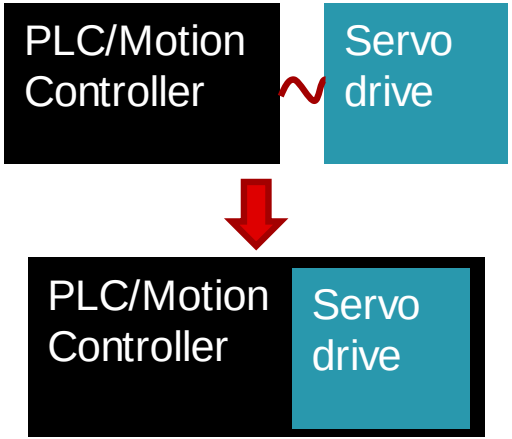
AM64x

- **Cores & Memory**
  - Dual Cortex-A53 up to 1GHz
  - Quad Cortex-R5F up to 800MHz
  - 2MB on-chip SRAM ECC on all critical memories
  - 16b LPDDR4/DDR4 controller with **inline** ECC
- **Industry 4.0 Services**
  - Dual-core Arm Cortex-A53 cores capable of running RT Linux enable high-level applications and networking
- **Multi-axis Control**
  - Up to 4x Arm Cortex-R5F cores running at 800MHz provide more than 5,000 DMIPs of processing for real-time control tasks
- **Fast Serial Interface**
  - FSI allows fast, serial communication across isolation boundaries with multiple C2000 devices
- **Multiprotocol Industrial Communications**
  - PRU-ICSS(Gb) subsystem integrates EtherCAT, PROFINET, EtherNet/IP capability into a single package



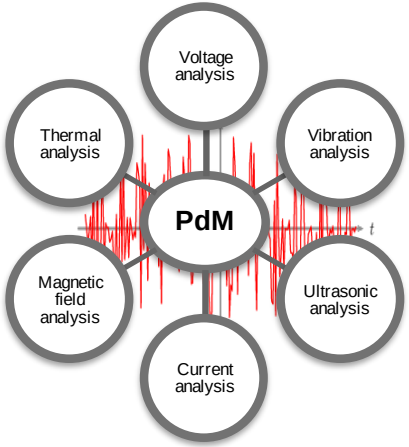
Industry 4.0 services

Integrated Motion Control



- Saves space and cost
- Faster possible refresh rates
- Seamless compatibility between amplifier and PLC

Predictive Maintenance

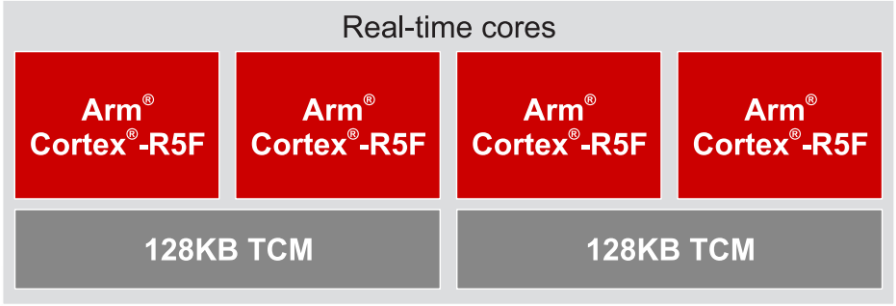


- Predict remaining useful life
- Predict time to failure

Remote Control

- Check real-time status of machinery
- Update control parameters remotely

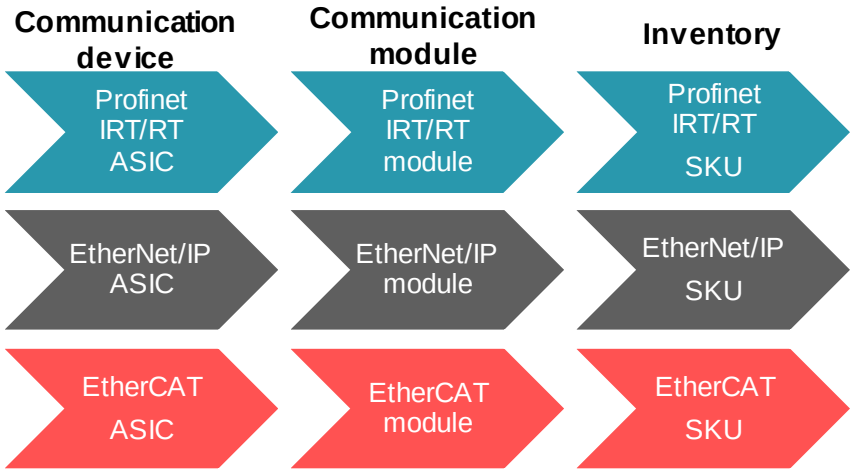
Multi-axis, real-time control



- Arm Cortex-R5F cores running at 800MHz provides greater than 5,000 DMIPs of processing power
  - Allows for tighter control loops, more advanced algorithms, and more background processing
- Tightly-coupled memory (TCM) for each core to allow deterministic, single-cycle access for instruction and data
  - Guarantees real-time deadlines are met on each iteration of the loop
- Up to 4x Arm Cortex-R5F cores provides software partitioning options
  - Pipelined approach: each core handles a specific function for all axes and then passes the result to the next stage in the pipeline
  - Distributed approach: each core handles all control code for one or more axes
- Software Development Kit provided including Real-time operating system (RTOS) and control libraries
  - Decrease getting started and overall development time

Multiprotocol industrial Ethernet

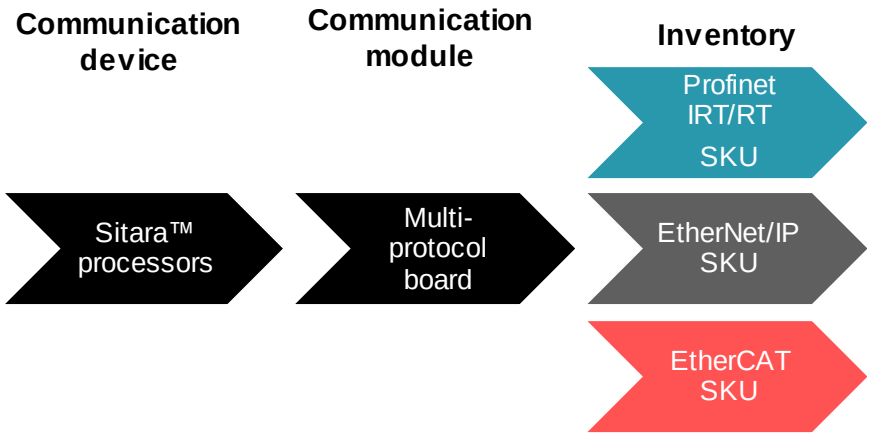
Traditional flow



The typical multi-protocol design process has many disadvantages including:

1. Complex inventory management and accurate forecasting needed for each individual protocol
2. Multiple silicon suppliers required
3. Separate hardware designs for each protocol
4. Expensive total cost when using multiple ASICs

Flow with Sitara

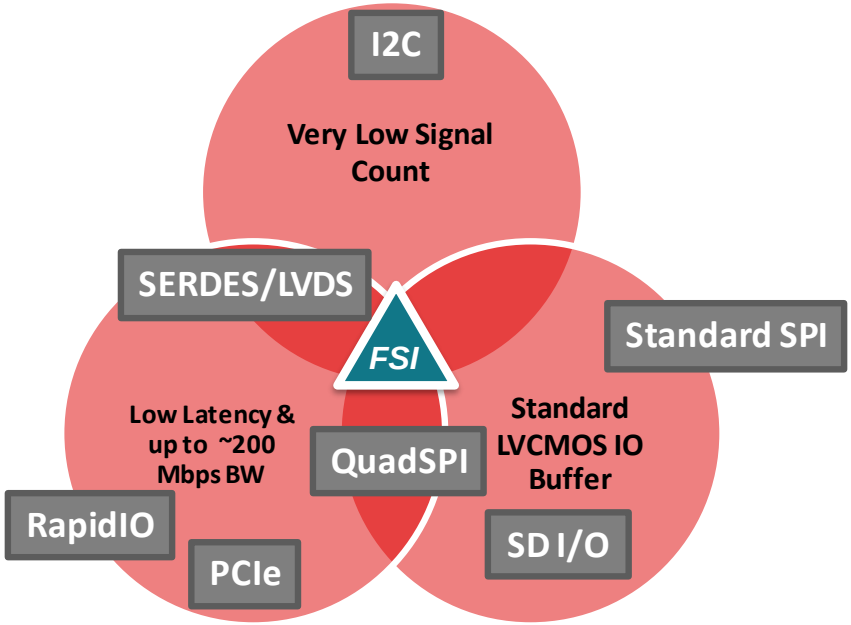


Sitara improves the overall development process and supply chain by:

1. Enabling re-allocation of inventory from one protocol to another **in minutes** to meet sudden demand changes
2. Narrowing down hardware procurement to a single vendor
3. Drastically reducing inventory management complexity
4. Providing a single hardware design to meet the needs of multiple markets

FSI

TI's FSI vs. standard serial interfaces

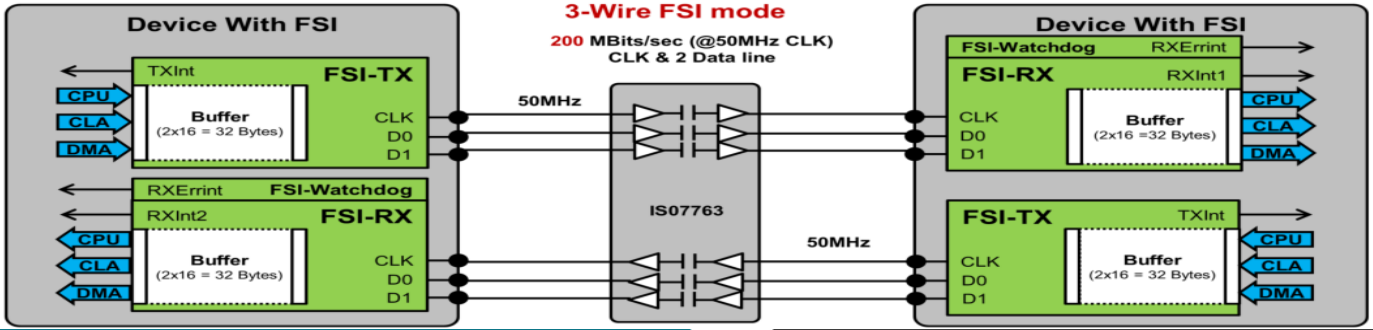


- Uniquely meets the three key criteria:
  - Very low signal count
  - Standard LVCMOS IO buffer
  - High bandwidth
- FSI includes:
  - On-the-fly CRC calculation
  - Hardware watchdog
- Use Cases:
  - High speed communications across air gap for power electronics isolation
  - On board chip-to-chip topologies
  - Alternative to parallel/EMIF interfaces

Available on select TI processors, microcontrollers, and library for FPGA

Enabling new options for drive architectures

Fast Serial Interface (FSI) enables high speed (200 Mbps/3-wire or 100 Mbps/2-wire) chip-to-chip communications while leveraging the latest in TI's galvanic isolation technology.



Features

- Fast transfer (100-200Mbit/sec @50MHz CLK)
- Line break detect
  - Ping frame: periodic frame for line break detect
  - Frame watchdog on receiver
- HW CRC- polynomial calculation and checker
- Signal line skew compensation
- Customizable tags and data
- Flexible topologies: point-to-point, star, daisy-chain

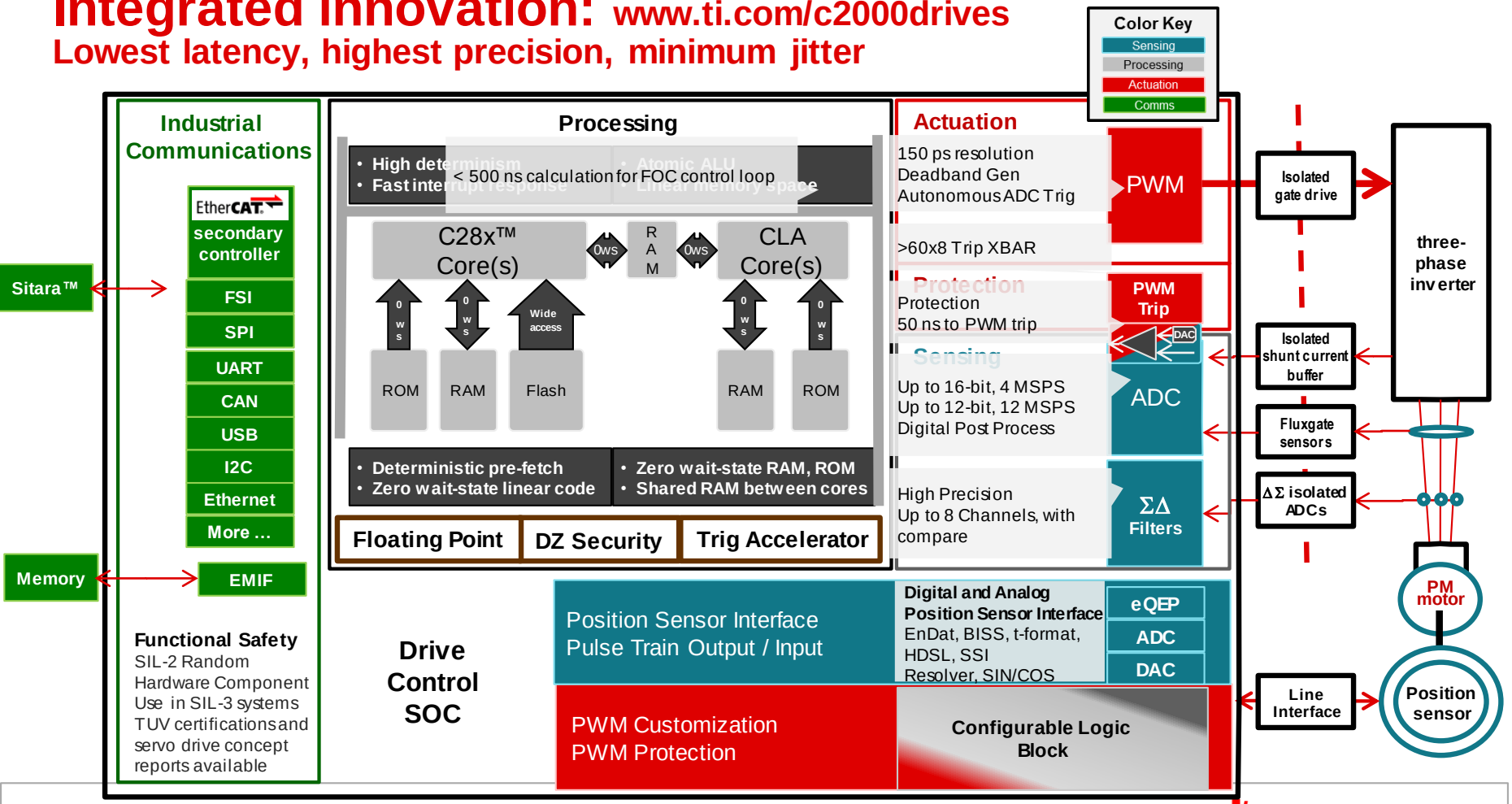
Benefits

- Reduces need for isolation components
- Enables real time loops to span air gap
- Enables new drive architectures
  - Smart sensing/Data concentrator
  - Smart sensor/resolver/position sensor
  - Host/Slave controller
  - Loop controller – actuation/sensing
  - Alternative to mixed signal ASIC/FPGA

C2000 real-time microcontrollers

Integrated innovation: www.ti.com/c2000drives

Lowest latency, highest precision, minimum jitter



Get started

Getting started

FSI documentation

- *See Device TRMs ex: TMS320F28002x Technical Reference Manual*
- *Using the Fast Serial Interface (FSI) With Multiple Devices in an Application*
- *Fast Serial Interface (FSI) Skew Compensation*

Evaluation modules

- *TMDSFSIADAPEVM*
- *LAUNCHXL-F280049C*
- *LAUNCHXL-F280025C*
- *BOOSTXL-3PHGANINV*
- *TMDS64GPEVM*

Reference designs

- *TIDM-02006 (C2000 F2838x outer loop controller – FSI – F28004x/2x nodes)*
- *AM64x Software Development Kit with FSI based Decentralized Servo example*
- *AM64x + C2000 decentralized servo demo*

Q&A

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