



TI Innovation Day 2010

Les processeurs ARM9 & Cortex A8 au coeur des applications Industrielles

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Purpose

- Review Main Industrial Requirements
- Discuss how ARM Core Processor & suitable Peripheral Integration enable a smart System Approach with high Performance
- Review How Strong Software offering is required to Enable such systems
- Detail the Industrial Protocol & Fieldbus support on TI MPUs
- Highlight the User Interface Evolution & its differentiation capabilities
- Understand how the ARM MPU Processing Capabilities can be maximized using DSP Core

Different market segments with different Requirements

Automation & Drives



Safety/Security



Power & Energy



Medical Electronics



Audio



Electronic POS/Kiosks



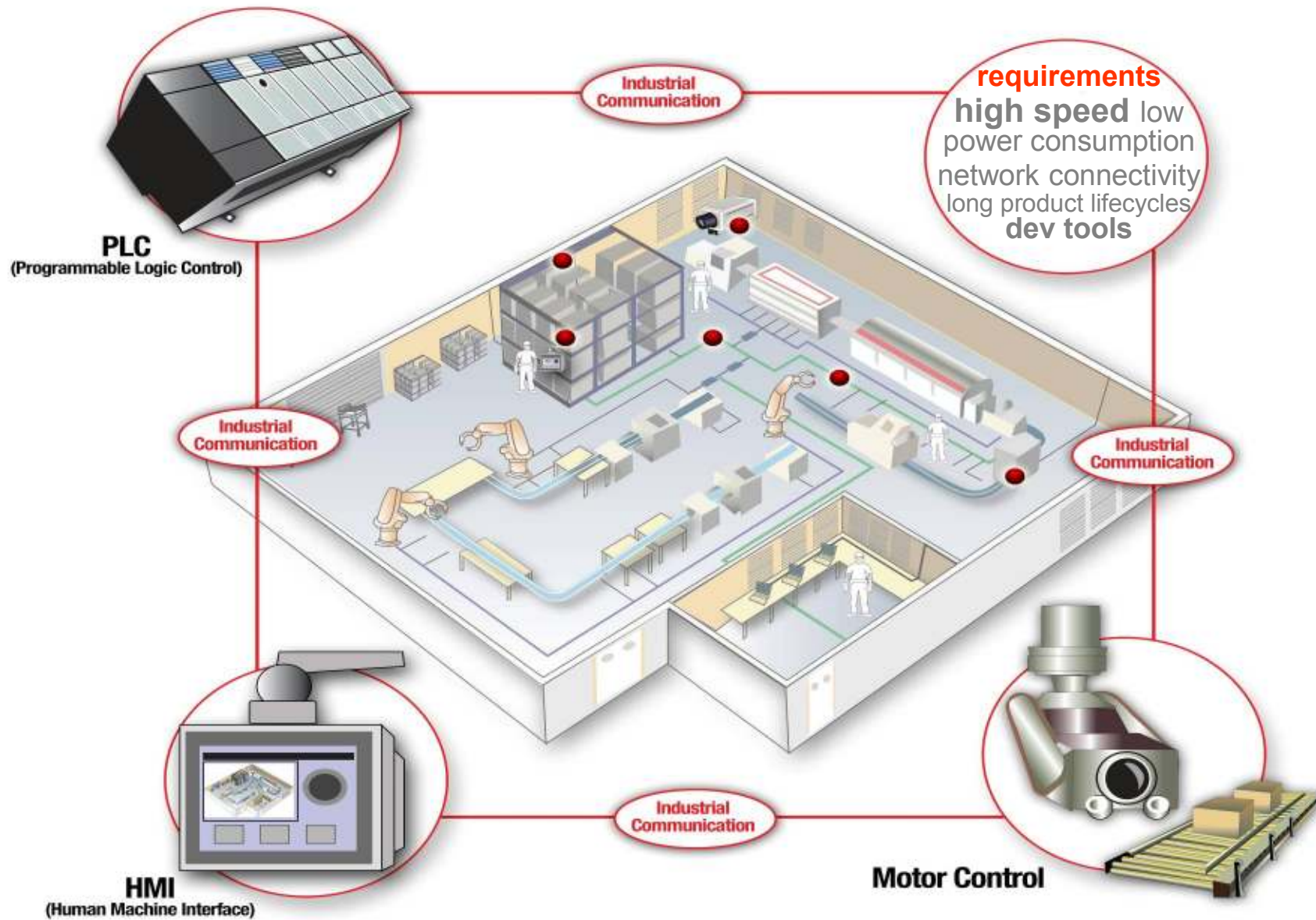
Connected Consumer



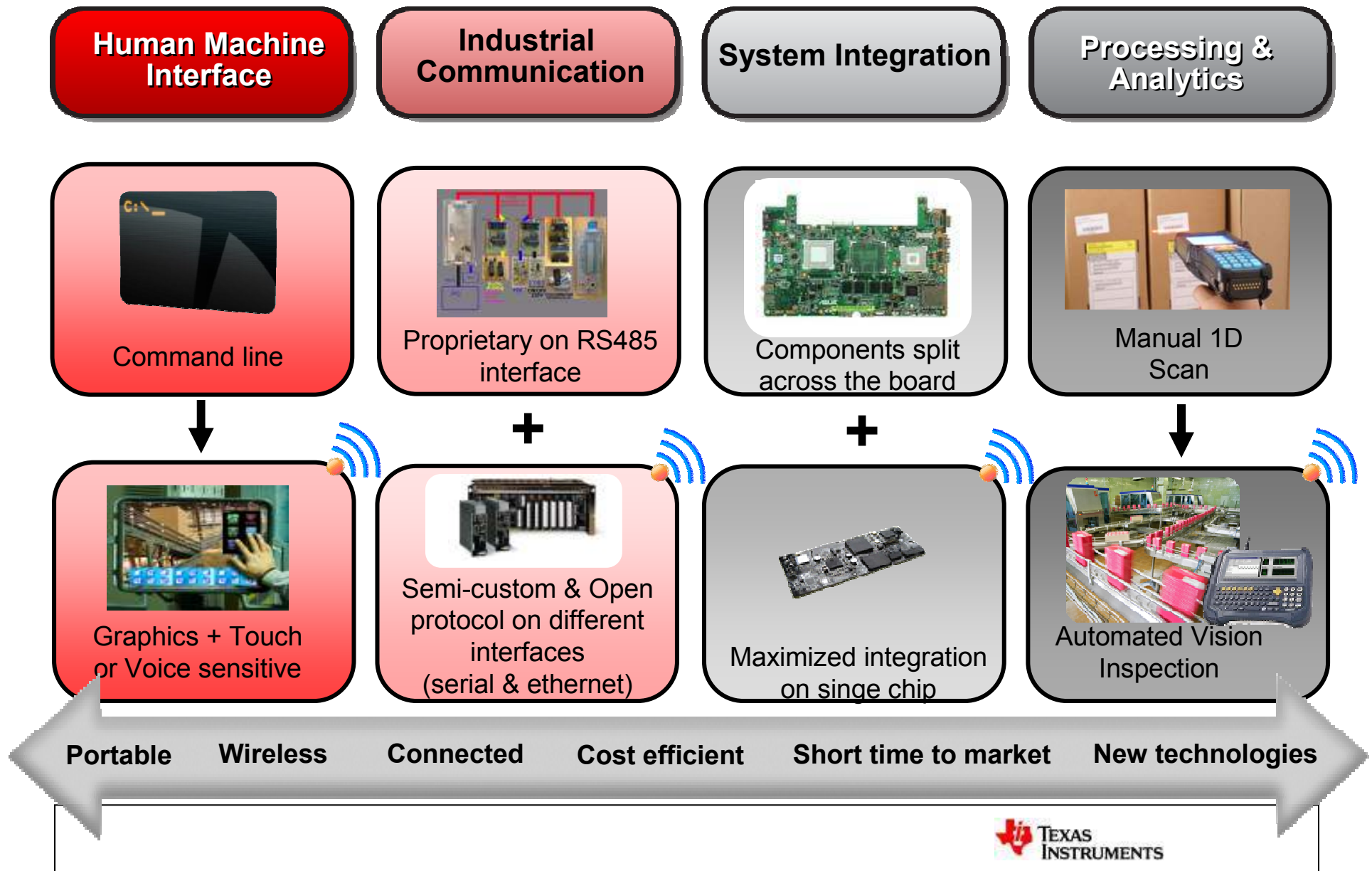
Test & Measurement



Industrial Automation: The Factory Today and Tomorrow



Trends for Innovations



Industrial Automation Requirements

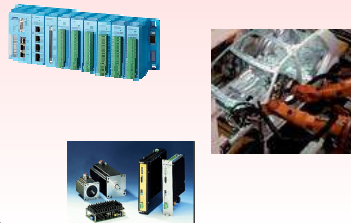
Human Machine Interface

- Efficient HMI
- Increase Display resolution + Multi-screen handling
- Different Input mechanisms (Voice, Touch,...)
- Graphics Acceleration
- Low power consumption



Industrial Communication

- Long product lifecycle w/ focus on reliability / quality
- Extended temperature
- Industrial Connectivity (Ethernet/ CAN,...)
- Advanced & Flexible package options



System Integration

- Scalable Processor Cores
- Integrated peripherals for low system cost & Efficient Interfaces for wired & wireless communications
- Bundled Software & ease of development

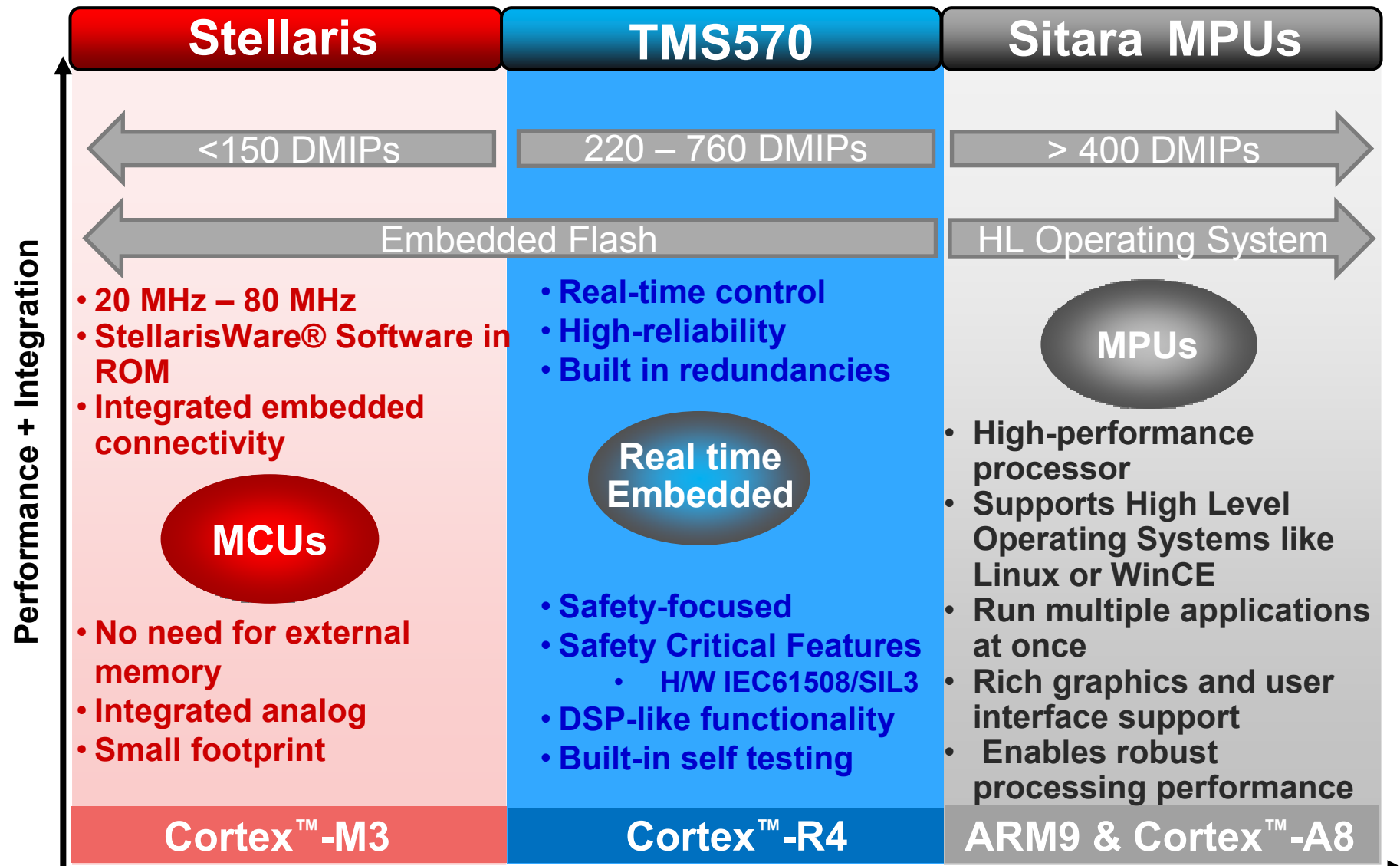


Processing & Analytics

- Real Time capabilities
- Wide Dynamic & High precision floating point
- Intensive signal processing based on Raw input (Video sensors, ADC,...)
- Multi-format, multi-codec support



System Integration : TI Family of ARM Products



System Integration :

TI Embedded Processing portfolio

TI Embedded Processors

Microcontrollers (MCUs)

ARM®-Based Processors

Digital Signal Processors (DSPs)



Software & Dev. Tools



16-bit ultra-low power MCUs

32-bit real-time MCUs

32-bit ARM® MCUs

32-bit ARM® MPUs

DSP DSP+ARM®

Multicore DSPs

Ultra Low power DSPs

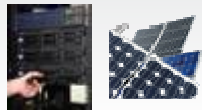
MSP430™

Up to 25 MHz



C2000™
Delfino™
Piccolo™

40 MHz to 300 MHz



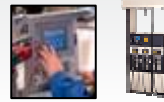
Stellaris®
ARM® Cortex™-M3
& TMS570
ARM® Cortex™-R4

Up to 160 MHz



Sitara™
ARM® Cortex™-A8
& ARM9

Value line to 600 MHz
Perf. Line to 1.5 GHz



C6000™
Integra™
DaVinci™
Video processors
300 MHz to >1.5GHz
Floating point +
Video Accelerators



C6000™
Up to 10GHz
Multi-core,
fixed/floating
+ Accelerators



C5000™
Up to 300 MHz
16-bit fixed
point + FFT
Accelerator

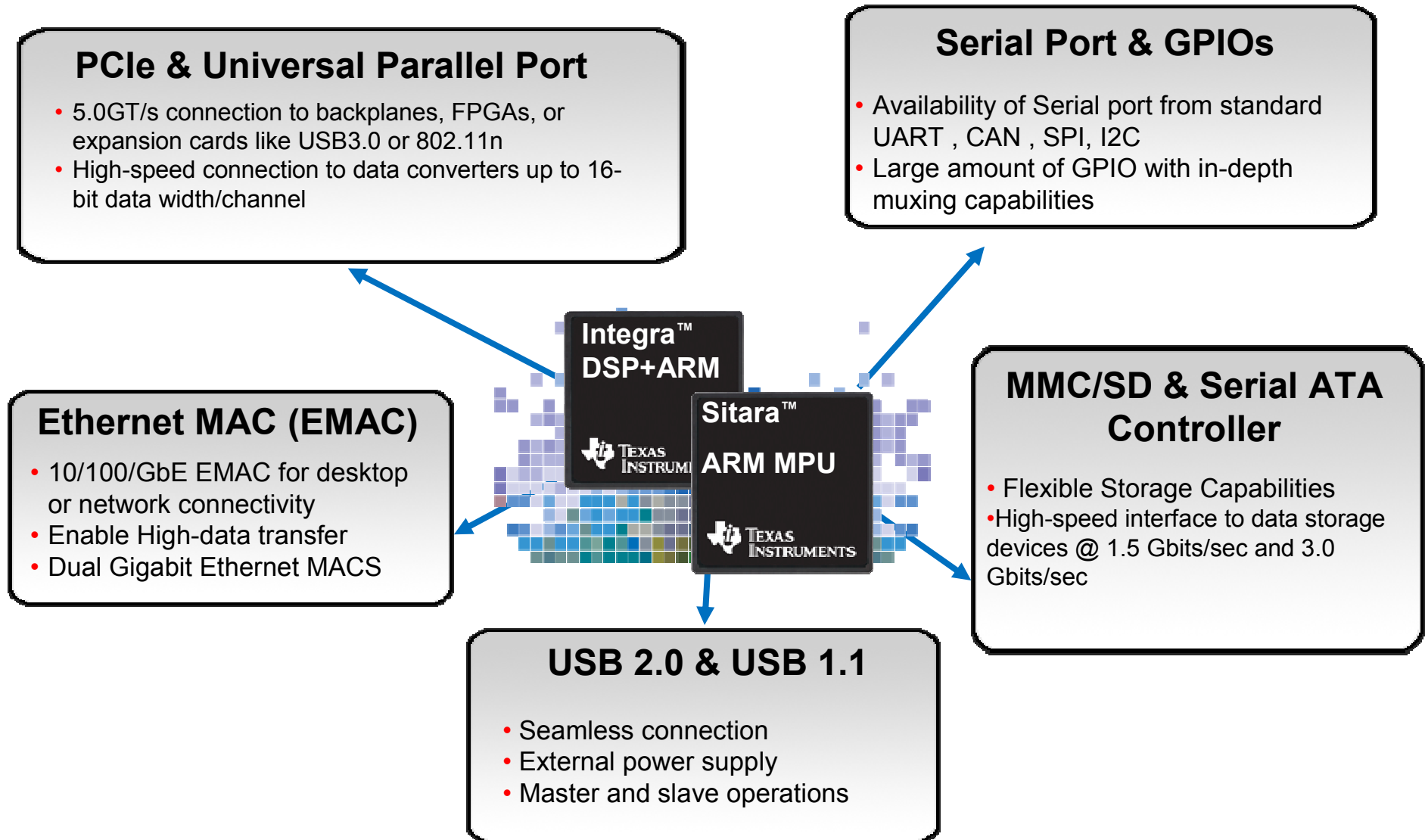


MPUs – Microprocessors



System Integration:

MPUs with Multiple connectivity & storage options



System Integration : Sitara ARM® based processors

Differentiated Features and Benefits (AM389x):

CPU speed

Highest performance single-core ARM Cortex-A8 on the market enables faster completion of computing tasks, more simultaneous applications, more responsive GUI, and fast reaction time

DDR2 / DDR3

Dual DRAM interfaces at up to 1600MHz (fastest in the industry) enable more and faster simultaneous applications

10/100/Gigabit Ethernet (x2)

Dual Gigabit Ethernet MACS provide a fast network connection

PCIe

Two-lane PCIe gen2 with integrated PHY enables a 5.0GT/s connection to backplanes, FPGAs, or expansion cards like USB3.0 or 802.11n

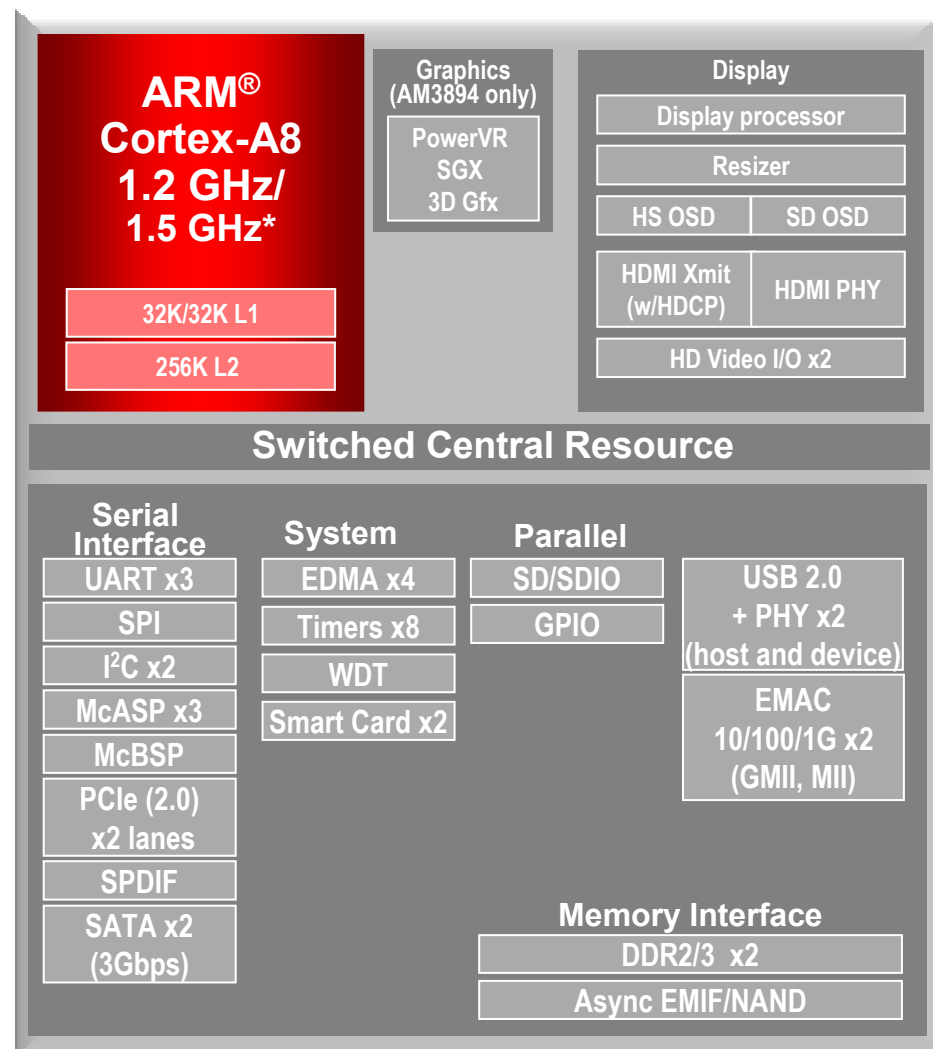
SATA

Connect to abundant storage with SATA2.0 support at 3.0Gbps for up to two hard disks

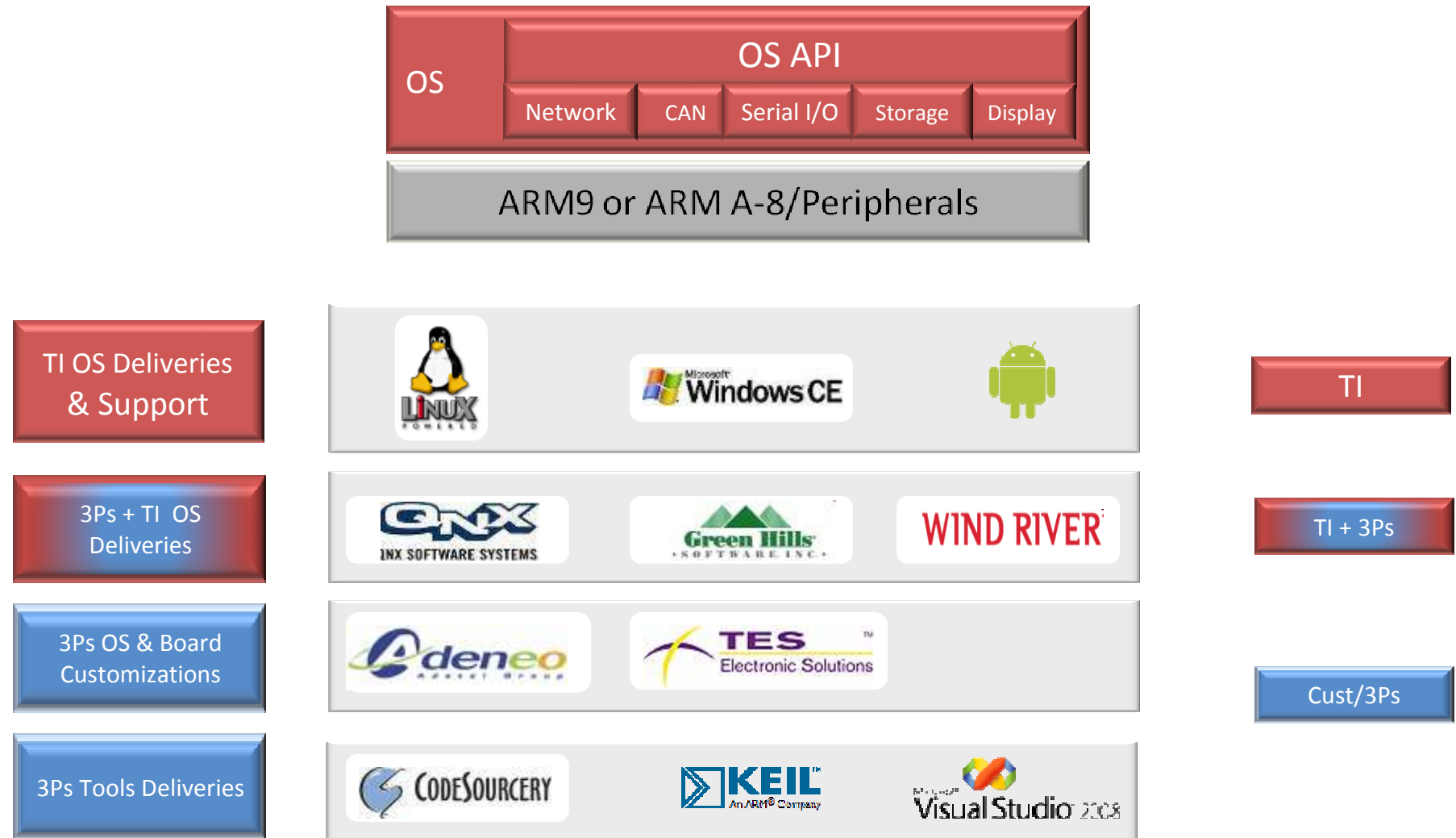
EDMA x4

An industry best DMA with 4 controllers and 16 channels/controller enables peripherals to directly access memory, freeing CPU to work on executing programs more quickly

Graphics & Display Capability – Enable a rich GUI via the 3D graphics engine, video output for two different displays at up to 1920x1080 resolution each, and HDMI output

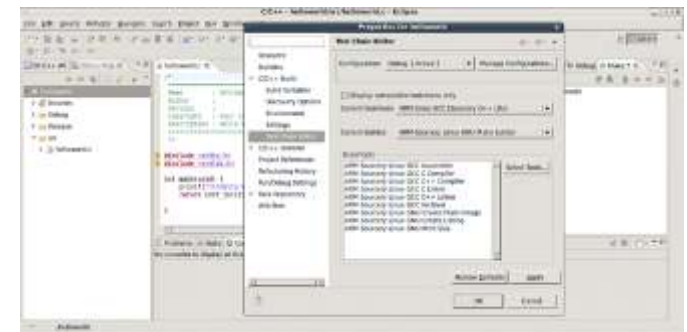
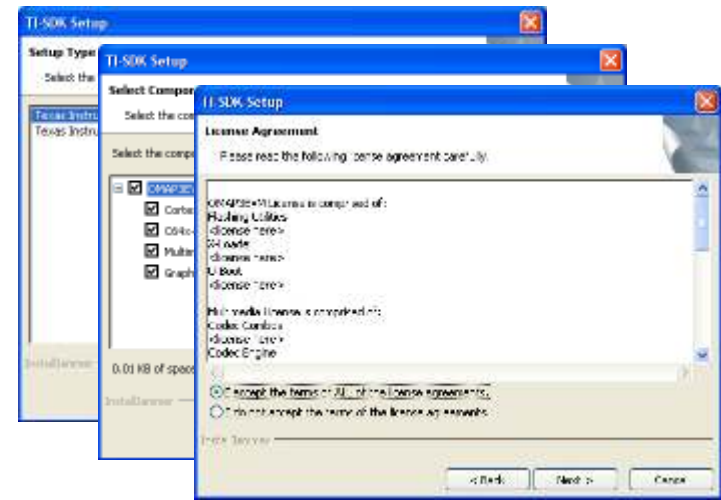


System Integration : S/W architecture & OS Availability



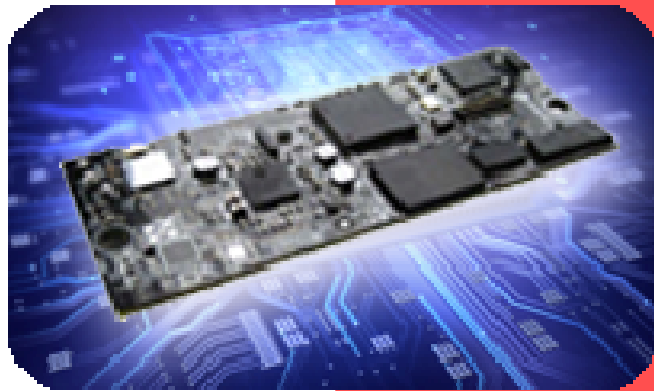
System Integration : TI SDK 4.0x

- Enables customers to quickly develop applications on TI platforms and products
- Includes **source-code** and **royalty-free libraries**
- Components
 - **Installer – All in One package**
 - Easy installation of all SDK components including all target and host software components
 - **Operating systems**
 - Linux®, Microsoft® Windows® CE, Android™
 - **SW Drivers for peripherals, connectivity and display**
 - Highly tested & documented
 - **Touch screen graphical application launcher**
 - Matrix Launcher
 - **Example and graphics starter code**
 - Benchmarks, 2D/3D demos, GFX SDK, Web browser, WLAN/*Bluetooth*® support
 - **CCSv5 Beta (Eclipse IDE) – Beta**
 - Compile, build, debug (CodeSourcery Lite gcc tool chain)
 - Qt SDK plug-in
 - Preconfigured projects for all example applications
 - **Utilities**
 - Flashing Tool, Pin Mux configuration
 - **Documentation**
 - Quick Start Guide, SW Developer's Guide, User Guides



System Integration : Sitara™ ARM® MPUs Benefits

Single board computing systems need:



Example application:
Single-board computing,

Fast, robust products running simultaneous applications

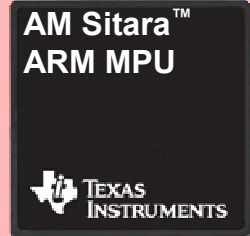
High system throughput to process large amounts of data

High-capacity storage to retain large amounts of data

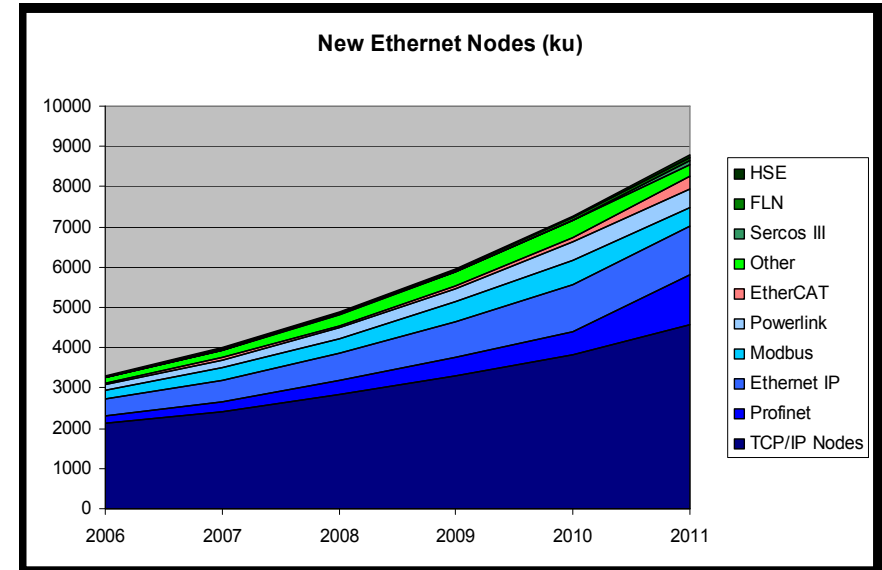
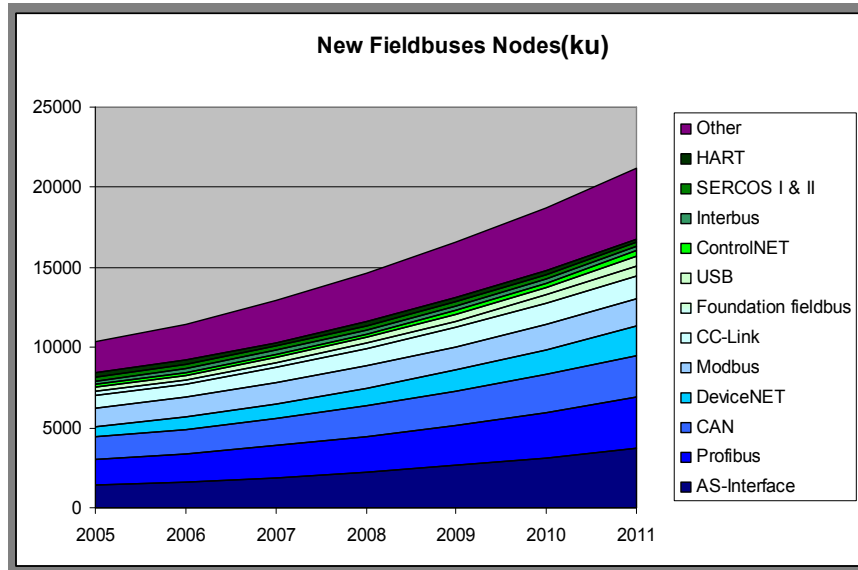
SW Offering

Sitara ARM MPUs provide:

- Up to 1.5 GHz ARM® Cortex™-A8
- Two 32-bit DDR2/DDR3 – up to 1600 MHz
- mDDR for lower power Systems
- PCIe Gen2 two lane – 5 Gbps
- 10/100/1000Mbps Ethernet MACs
- High Speed Serial & // ports
- On-chip SATA 2.0 interface
- SD/MMC Interfaces
- TI SDK for easy development
- Mature, Tested & Supported Device Drivers



Industrial Automation: Communication Standards



At a high level there are 2 types of industrial communication segments

- Serial Based Fieldbus Protocols – Examples: Profibus, CAN
- Ethernet Based Protocols – Examples: Profinet, EtherCAT






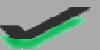











Challenge

- The challenge is to address the various industrial communication protocols with an integrated product

Industrial Automation: Sitara Serial Based Protocols

Extensive support for Industrial Communication Standards

Integrated Industrial Serial Fieldbus HW Support

Product	AM18x	AM35x	AM335x	AM383x	AM386x	S/W Stack Partner
CAN : CANOpen						PORT /TCS
CAN : DeviceNet						PORT
Profibus Slave						TMG
Profibus Master DPV1						TMG
Profibus Master DPV2						TMG
Modbus						TCS
IO-Link : Master						MSECO

TI has partnered with software vendors to provide an eco-system for turnkey solutions



Industrial Automation: Sitara Ethernet Based Protocols

Extensive support for Industrial Communication Standards

Integrated Industrial Ethernet HW Support

Product	AM18x	AM35x	AM335x	AM383x	AM386x	S/W Stack Partner
Ethernet/IP Master						MOLEX
Ethernet I/P Slave						MOLEX
Profinet Master						MOLEX
Profinet Slave						MOLEX
EtherCAT Master						Beckhoff/TCS
Powerlink Master						PORT
Powerlink Slave						PORT
Modbus TCP/IP						TCS
Sercos III						(TBD)
EtherCAT Slave						Beckhoff/TCS
CC-Link IE Master/Slave						TCS

TI has partnered with software vendors to provide an eco-system for turnkey solutions



Industrial Automation: Usage of Smart Resources

TI Integration

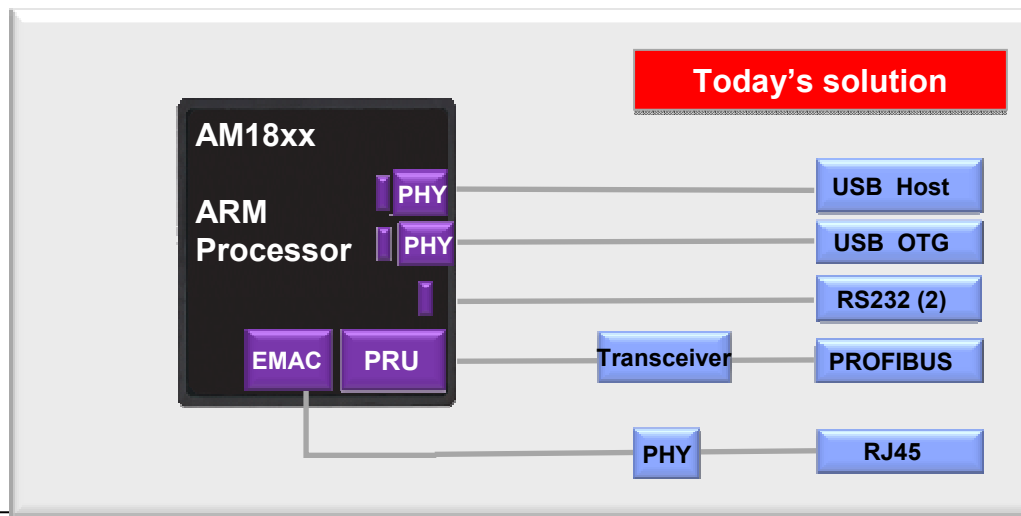
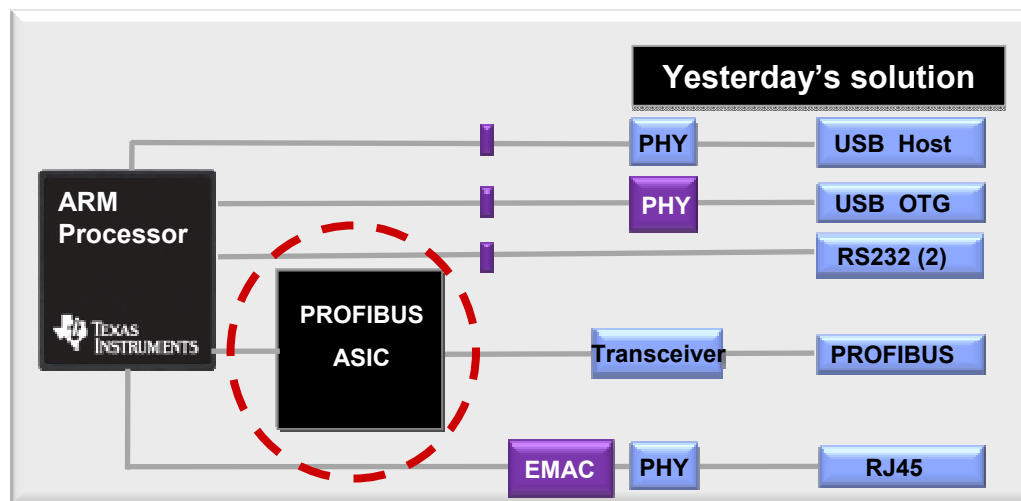
Programmable Real-time Unit (PRU)

- Programmable RISC-based processor – Code can be written for any of the 120 communication protocol standards
- Replaces the need for a separate ASIC Communication Module
- With full system visibility – Can be used to increase peripheral count or tailored for specific application needs

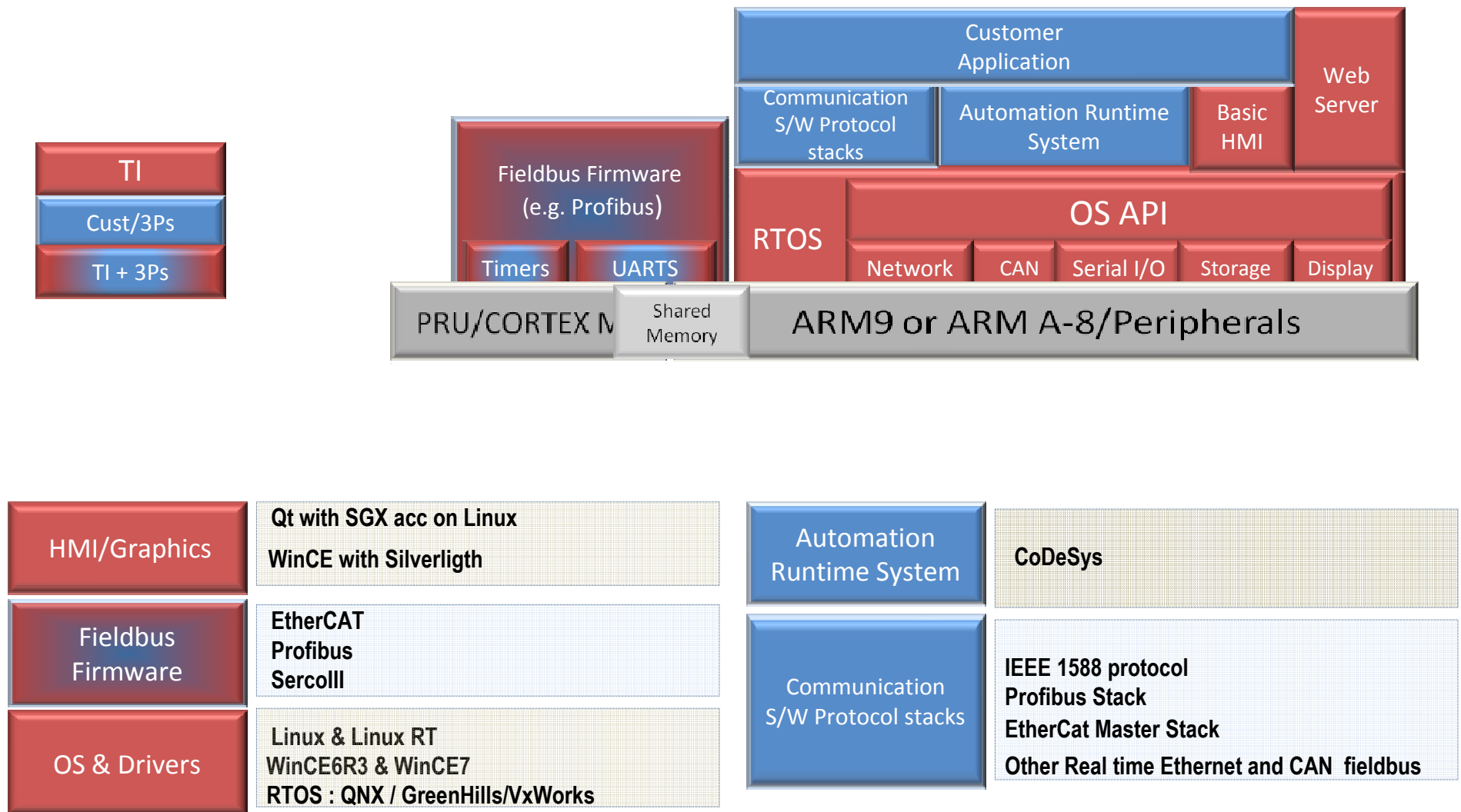
Benefits

- Enable Open Standard Protocol Adaption
- Enable Semi-Custom protocol creation
- Enable expend SoC capabilities & performances without HW modifications

** System simplified to illustrate deltas

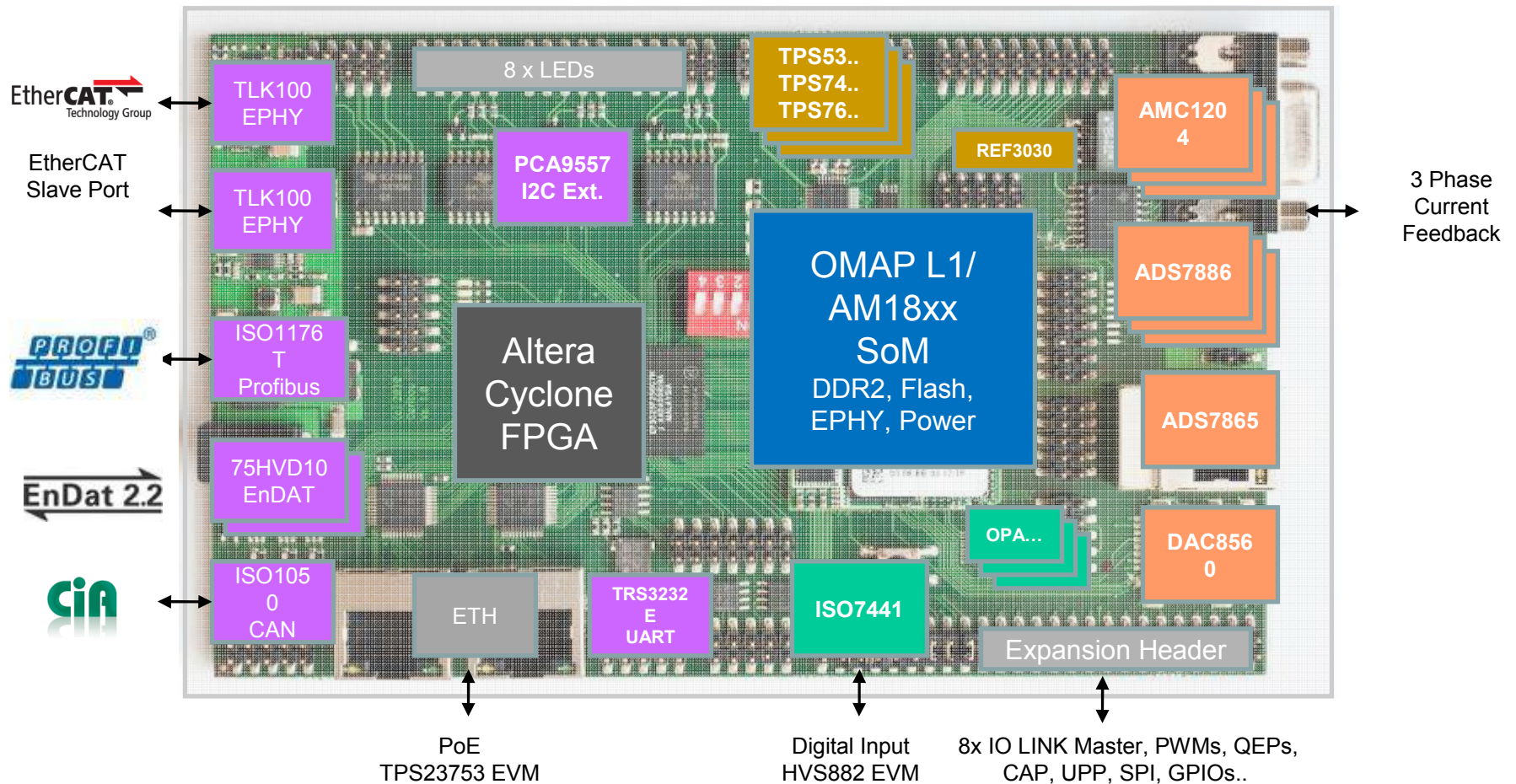


Industrial Automation : S/W Architecture



Industrial Automation :

“Caribou” – Industrial Communication Board



Industrial Automation : Sitara™ ARM® MPUs Benefits

PLC systems need:



Example application:
Programmable Logic Controllers (PLC)

Mission critical system event handling @ low power

Long product lifecycle

Extended Temperature

Advance package options

Address industrial communication standards by various equipment manufactures

Sitara ARM MPUs provide:

TI ARM core offering provides Scalability enabling high performance at limited power consumption

Sitara™ ARM MPU



Many devices in production for 15+ years & product longevity assured

Products with standard and extended temperature options

Multiple package options including enhanced plastics

Multiple Connectivity options : RS485 , CAN, USB, RT Ethernet, Programmable Real Time Unit (PRU) for specific protocol handling

HMI : Evolution of User Interface

No Graphics & Keyboard



- Command text based
 - Execute what's "typed" ,
 - log what's happening ..
- Direct mapping between command & execution...
- but complex commands , less "real-time" execution
- Scripts helps to automate things ..
- Logs still need to be read ...

2D Graphics & Touchscreen



- Ability to render complex things in 2D diagrams
- Text entry replaced by touch screen & smart icons for better view of the reality (Gauge vs Text ..)
- Response time is critical
- Evolution to Vector Graphics
 - Increased scalability
- ..missing one dimension ?
- Product differentiation associated with the quality of the product

3D Graphics , Gesture & Voice



- Key driver for evolution
 - Volume rendering
 - Increased efficiency
- Volume Rendering needs to be done on larger displays
- Increased efficiency is obtained by precise & clear rendering
- Remote Control is evolving
 - Voice recognition or speech synthesis for real-time interactions

HMI : Rendering Technologies Evolution

- **Why it is evolving :**

- Increased Accelerated 3D GUIs are pervasive today
- Custom GUIs provide the best route to the product differentiation of end customers need
 - “Beauty” of the interface is associated with the quality of it ...
- Desktop technologies are rapidly moving to the mobile space (programmable shaders)
 - you don't need a desktop to do the same !!
- Larger display sizes require faster graphics
- Hardware accelerators use less power than software implementations

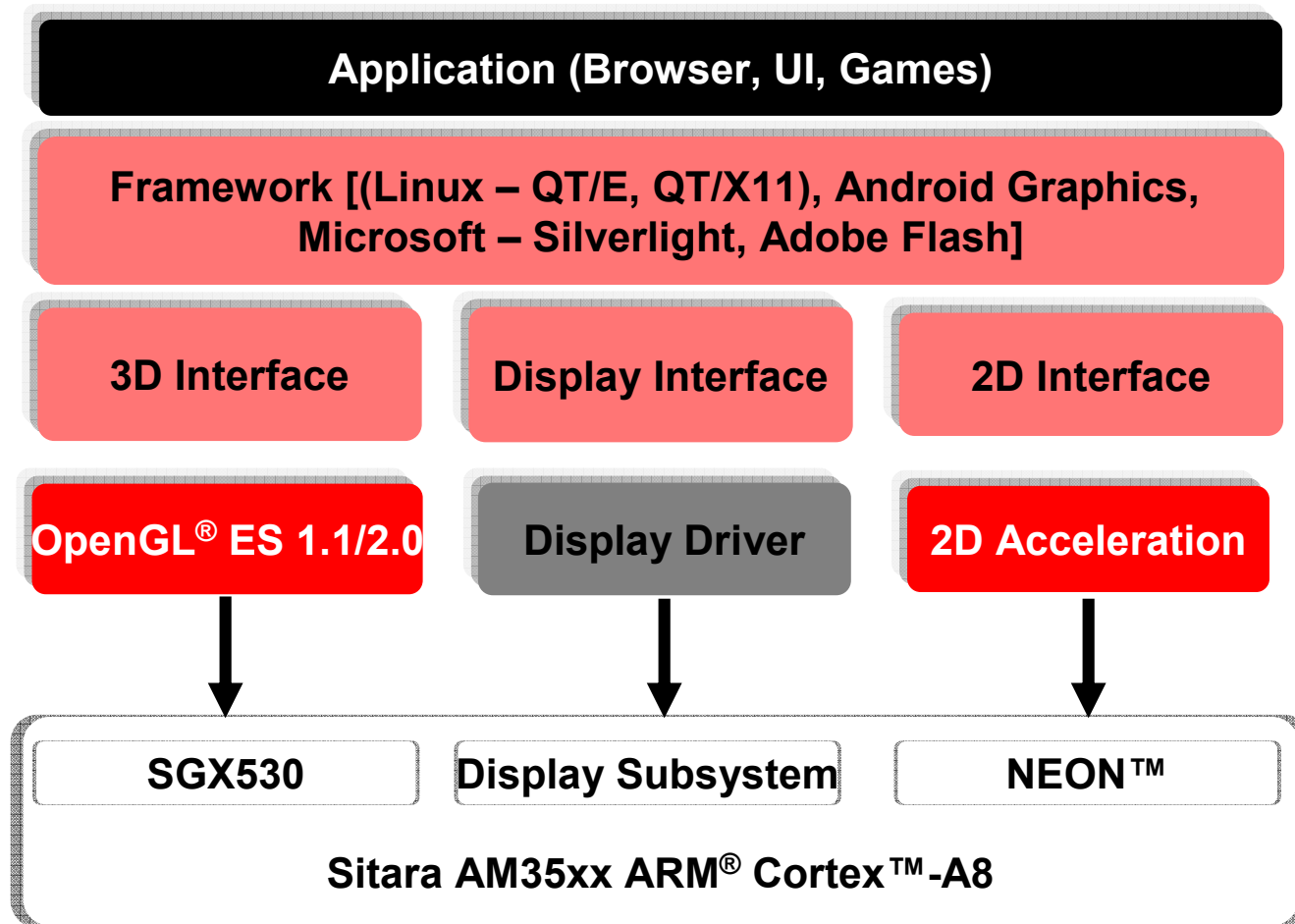
- **How is it evolving**

- From pure SW rendering to **HW accelerated rendering**
 - Keep High Quality whatever the size of the display
- From 2D acceleration (Bitblit type) of Bitmaps to **complex 3D representation of Real components**
- From Proprietary Graphic Acceleration techniques to Open Standard (OGLES1.1/OGLES2.0) ones enabling faster implementations & representation

- **The Goal of 3D representation:**

- Mapping the System Reality with System Volume & “Life-like” Rendering

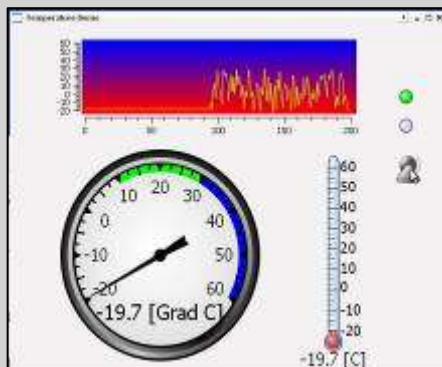
HMI : High level graphics architecture



-  = Frameworks/Middleware: multiple sources  = Customer App: customer
 = BSP Package: multiple sources  = Texas Instruments Accelerator Components

HMI : Graphics Rendering using TI MPUs & SDKs

Simple 2D UI (Qt)



Matrix UI – Webkit UI on Qt



Android



MSFT Silverlight



HMI : TI Graphics support

	Linux	Android	WinCE	Industry Standard APIs		
Framework	Qt	Surface Flinger/Skia	Silverlight/ DirectDraw	OpenGL® ES 1.1	OpenGL ES 2.0	OpenVG™ 1.1
ARM® only support (ARM9™ and Cortex™-A8)	✓	✓ (Cortex-A8 only)	✓			
2D graphics acceleration (NEON™)	✓	✓	✓			
3D graphics acceleration (POWERVR™ SGX)	✓	✓	✓	✓	✓	✓
Development Tool	Qt Creator	Android Development Tools (ADT)	Expression Blend/ Visual Studio			

- **Graphics acceleration for native application and framework on Linux, Android and Windows Embedded (CE) OS platforms, as well as Khronos Open API acceleration using POWERVR SGX 3D H/W accelerator.**
 - Available free to customers/App developers for CE, Linux and Android
 - Standard development tools available for Linux, Android and CE
 - Proof-of-concept demonstration and example software with SDK
- **Active 3rd party options and application specific solutions**

mentor
embedded

QNX
INX SOFTWARE SYSTEMS

TES
Electronic Solutions



TEXAS
INSTRUMENTS

HMI : Sitara™ ARM® MPUs Benefits

HMI systems need:

Fast response time

2D Graphics
Acceleration

Scalable Display resolution &
Multiple Screen Support

Advanced 3D Menu or Volume
rendering for intuitive & efficient
Interface



**Example
application:**
HMI for Efficient
Display & Interface

TI MPU Provides ...

Up to 1.5 GHz
ARM®
Cortex™-A8
enabling fast
context switch

AM Sitara™
ARM



Neon enabled 2D acceleration
in all major OSes subroutines
& UI framework

Display engine with
1920 x 1280 resolution
multiple pipelines & hw overlay

Integration of 3D Graphics
openGLES2.0 Core

Processing : Maximizing the Power of ARM with DSP

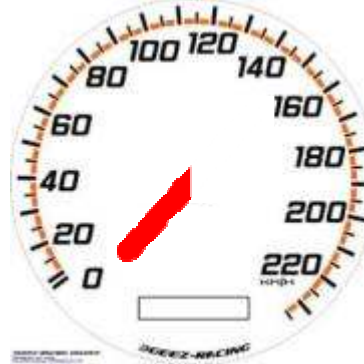
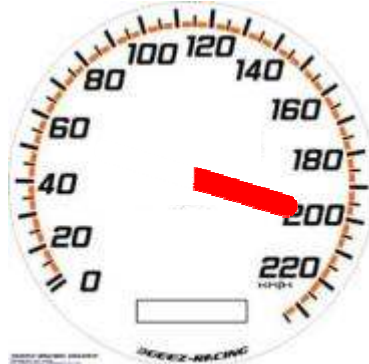
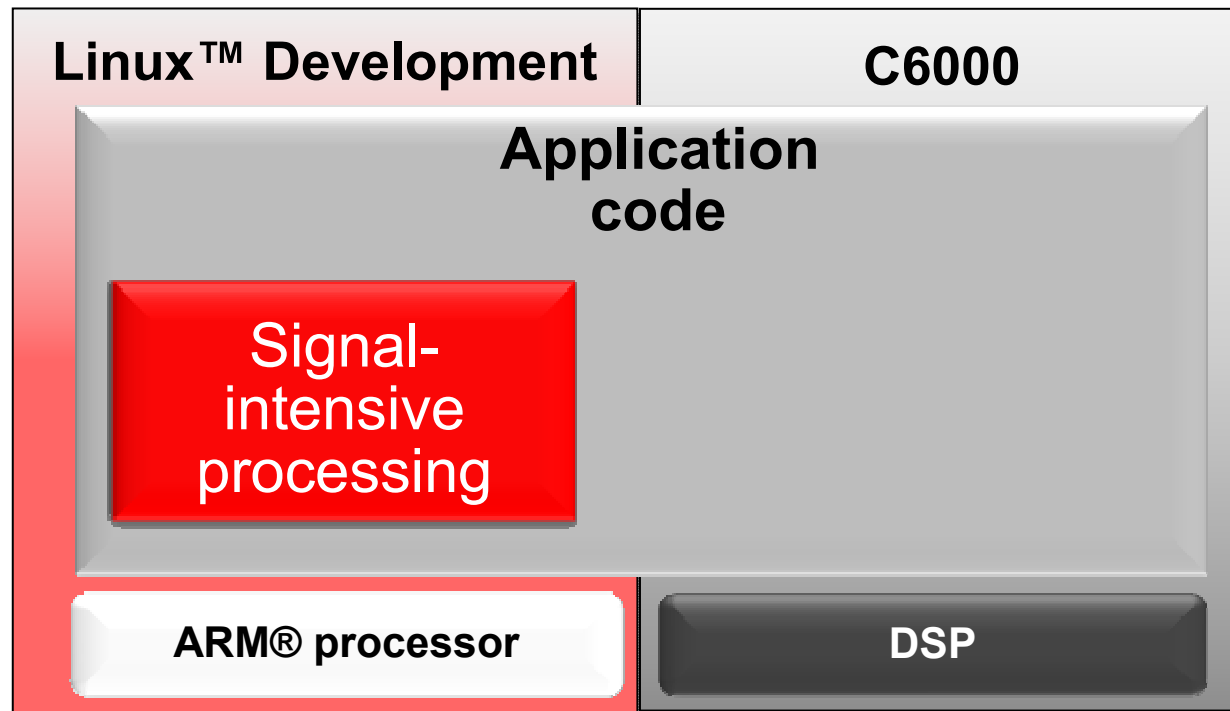
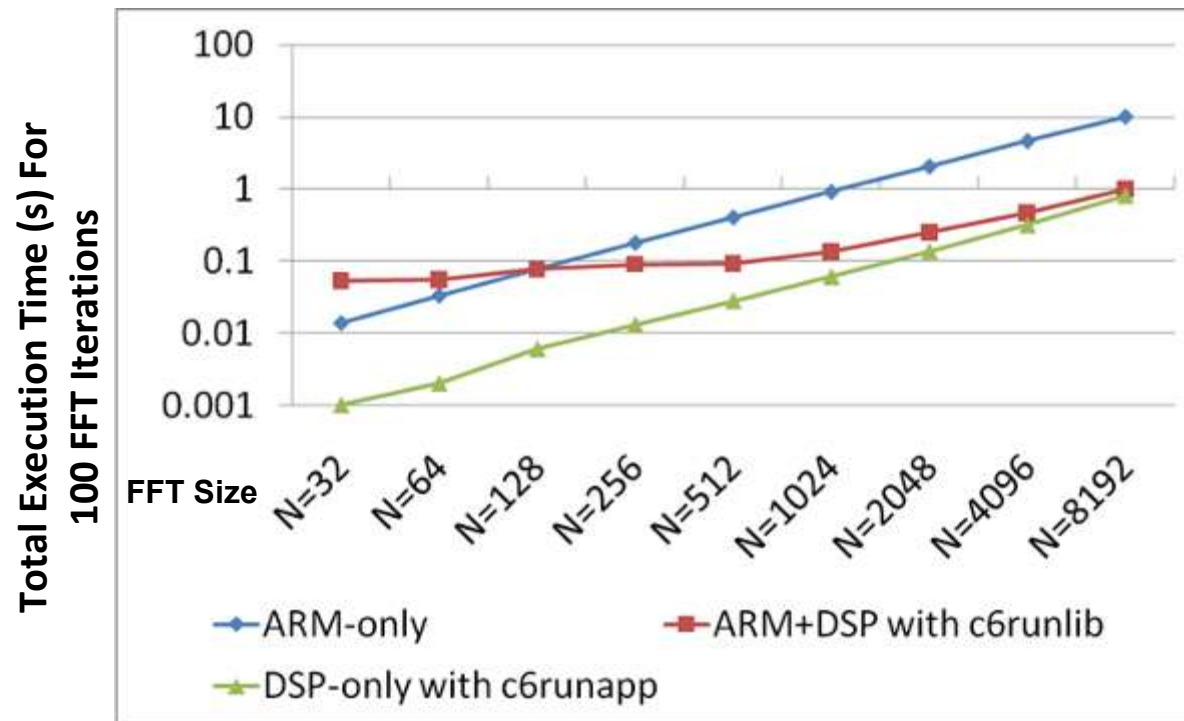


Image
Analytics

Processing : Complex FFT Performances



- ▶ FFT runs ~10x faster on DSP than on ARM.
- ▶ Small FFT size, overhead dominates, running on DSP does not provide advantage.
- ▶ Larger FFT size, overhead absorbed, running on DSP provides advantage.

NOTES

- Integra – c6L138 SoC: C674x DSP + ARM926J
- ARM/DSP Frequency: 300/300MHz
- Code & Data Location: External DDR2 Memory
- Instruction and Data Cache: Enabled
- Single-precision floating-point data buffers

Processing : OpenCV Lib Performances

OpenCV (Open Source Computer Vision)

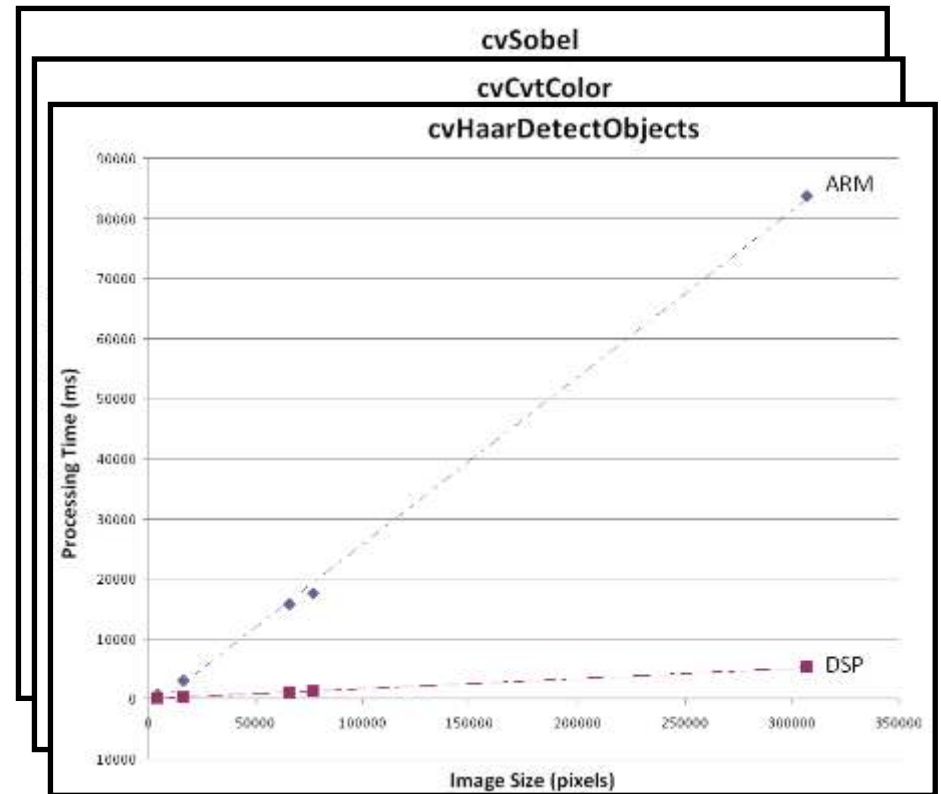
- ▶ Real-time computer vision library
- ▶ Over 500 optimized algorithms
- ▶ Provided under a BSD license

Preliminary Results

- ▶ Even with no DSP-specific optimization signal processing functions execute faster when running on the DSP
- ▶ DSP-specific optimization can further increase performance

NOTES

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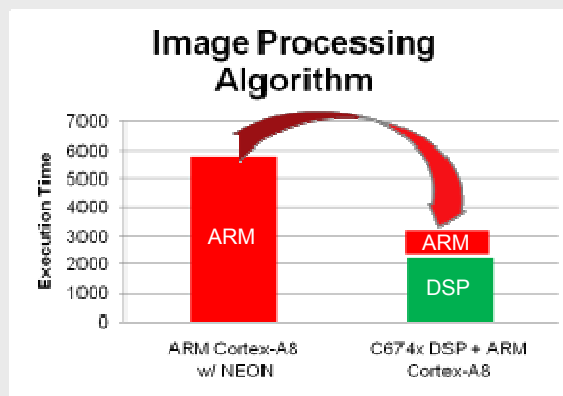
cvHaarDetectObjects: Finds rectangular regions in image likely to contain objects cascade was trained for.

Processing :

Why is DSP+ARM® better than faster ARM?

Isn't DSP difficult to use for an ARM programmer?

Why DSP+ARM?



- DSPs are up to 60% more efficient for signal processing tasks such as FFTs, digital filtering and image analysis
- Frees ARM resources for applications processing
- Increases overall system performance

DSP + ARM. Do more with less.

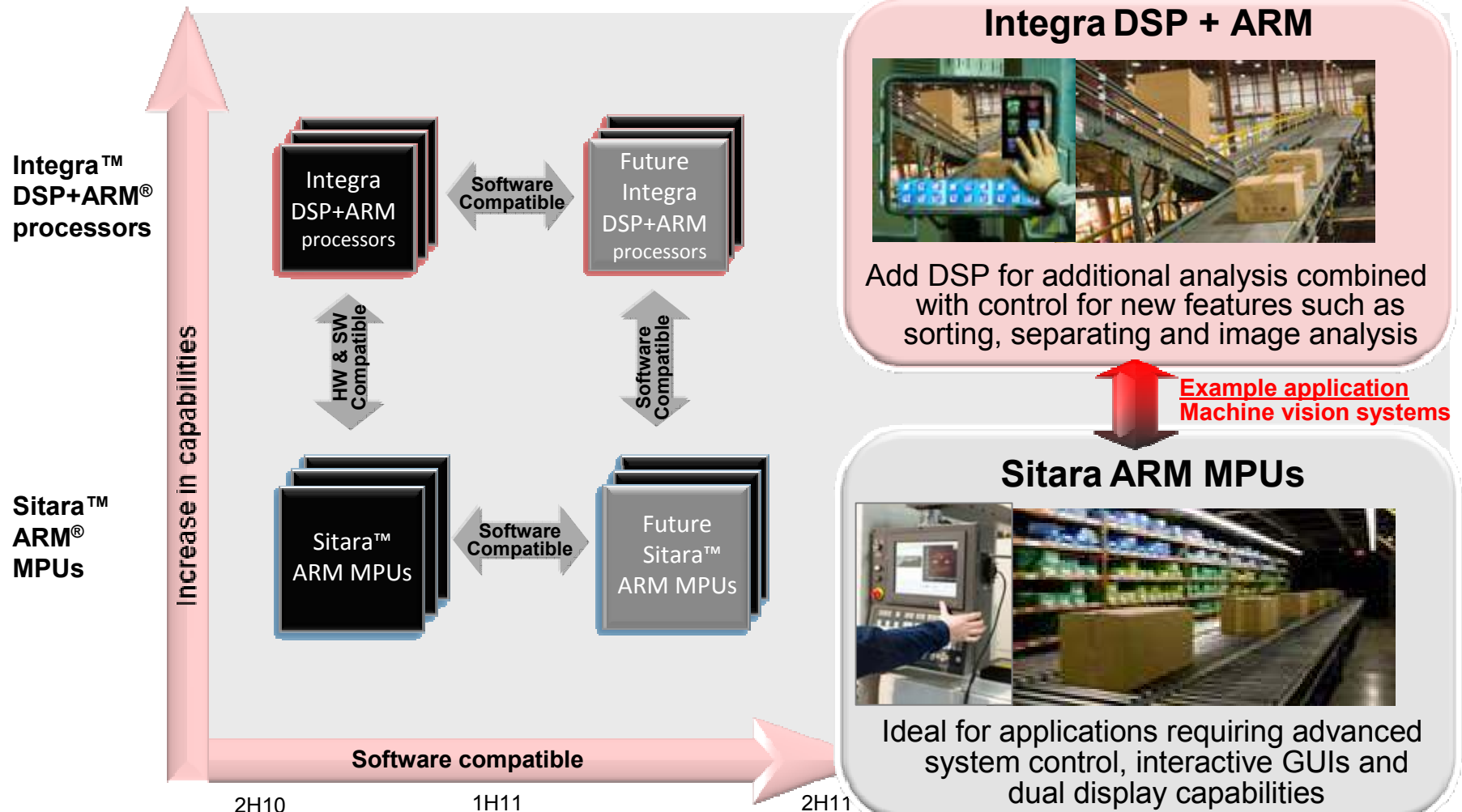
And, TI makes DSP programming easy for ARM developers:

- TI's [C6EZRun](#) for code porting – Enables developers to easily run ARM code on a DSP without learning DSP code
- TI's [C6EZAccel](#) library – Provides a library of more than 130 signal processing algorithms with ARM APIs to accelerate development time

Processing : Enabling scalability and reduced time to market

Compatible devices...

...allow new features and easy entry into new markets while reducing development cost



Processing : Integra™ DSP + ARM® Benefits

Vision systems need:



Industry-standard APIs for optimal software re-use

High system throughput to process large amounts of data

System control and high-speed connectivity for sending inspection results and/or raw images

Ability to prototype and adapt vision algorithms on a PC and port easily to an embedded environment

C6A816x Integra DSP + ARM provides:

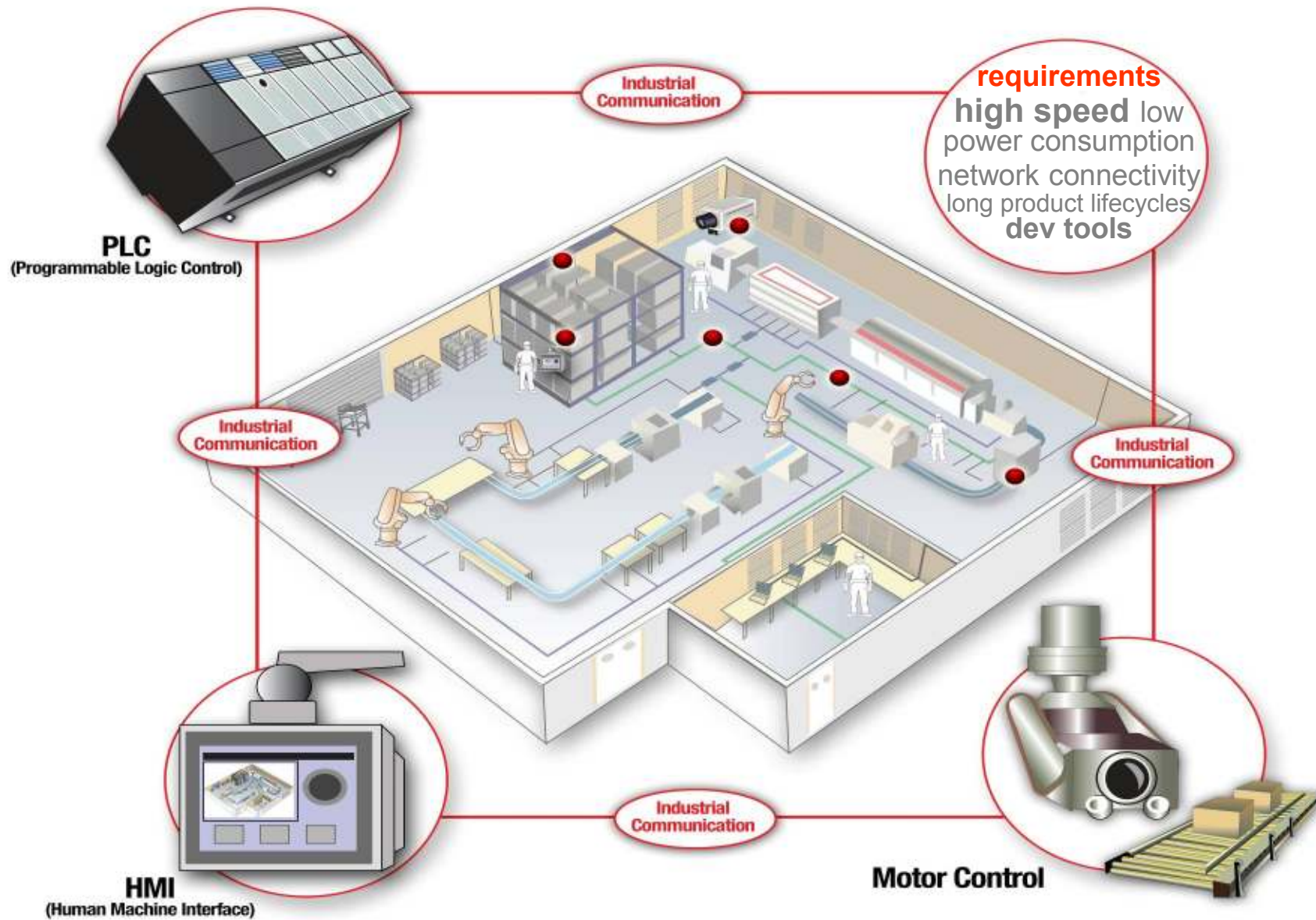
- OpenCV APIs for DSP-accelerated imaging and vision analysis algorithms
- Up to 1.5 GHz floating- and fixed-point DSP
- Two 32-bit DDR2/DDR3 – up to 1600 MHz
- Integrated up to 1.5 GHz ARM Cortex™-A8
- Two Ethernet MACs – 1 Gbps
- Up to 1.5 GHz floating-point DSP

Integra™
DSP+ARM



Example application:
Machine vision systems, such as automated/visual inspection

Industrial Automation: The Factory Today and Tomorrow



Summary

TI works in providing MPU & Peripherals solutions fitting the Industrial market and its requirements

TI's broad portfolio includes analog and embedded processing to enable a flexible system development

TI provides a wide range of development tools, services and solutions to enable you to easily develop your system & Bring Innovation