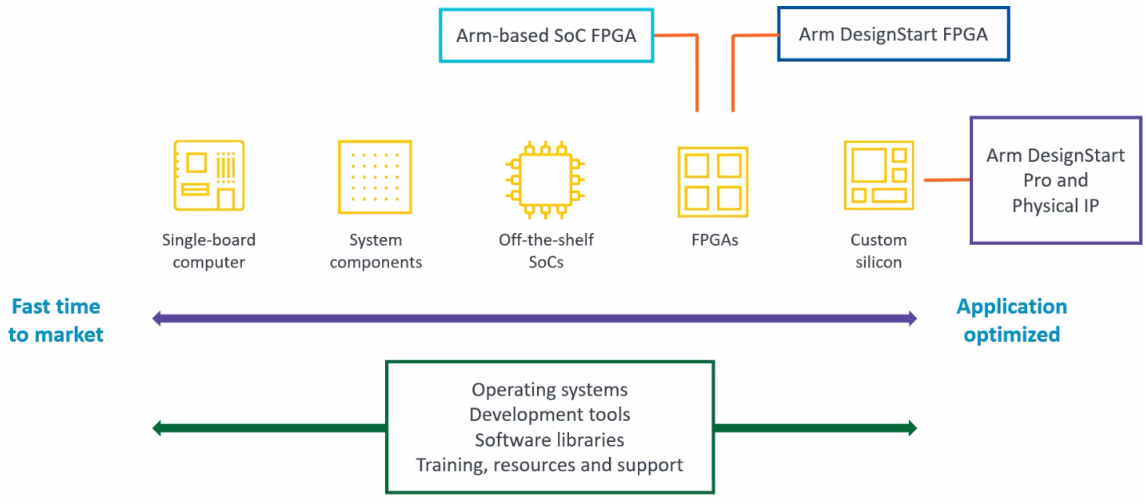
System Development with FPGAs

13 May 2020

Consistent Architecture Lowers Development Costs



Rapid Time-to-Market with Simplified Development Flow

Design hardware → **Develop software** → **Deploy on FPGA**

Simple drag-and-drop integration of CPU

Benefit from broadest embedded ecosystem

Reuse existing code

Access widest range of third party software

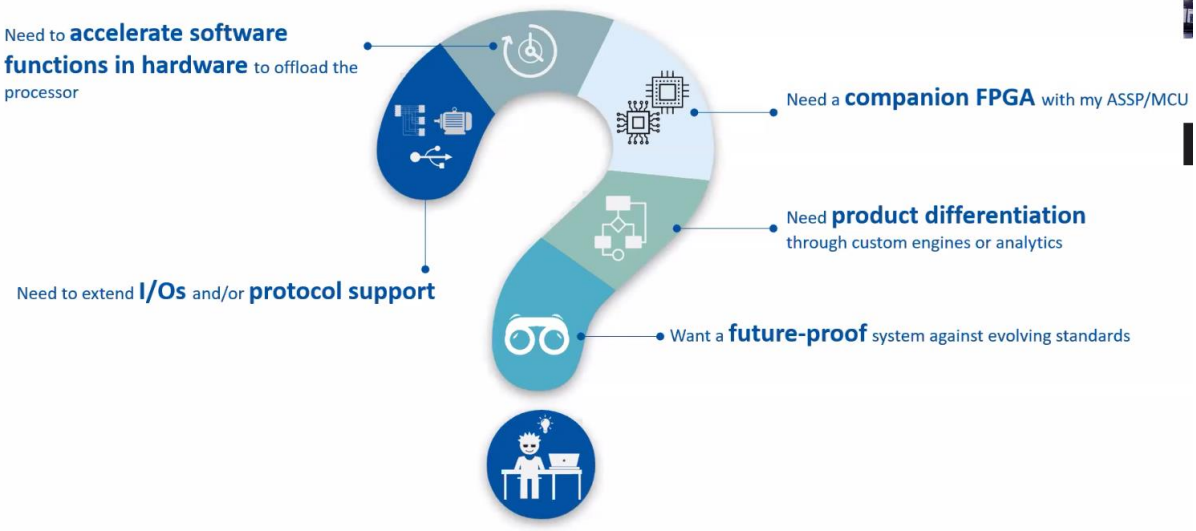
arm KEIL

IAR SYSTEMS

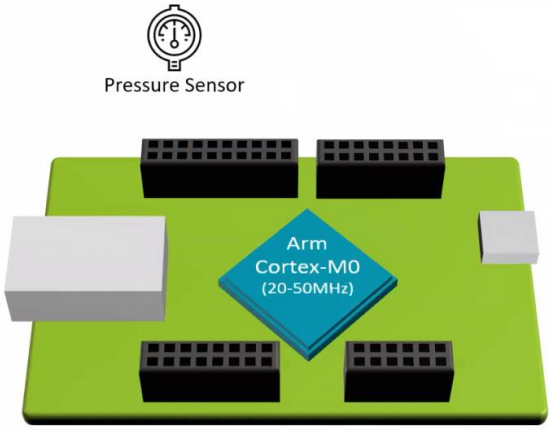
Deploy to any development board

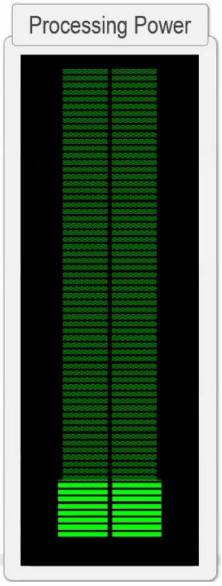
Pre-integrated on development boards

Why an Embedded Solution from Xilinx?

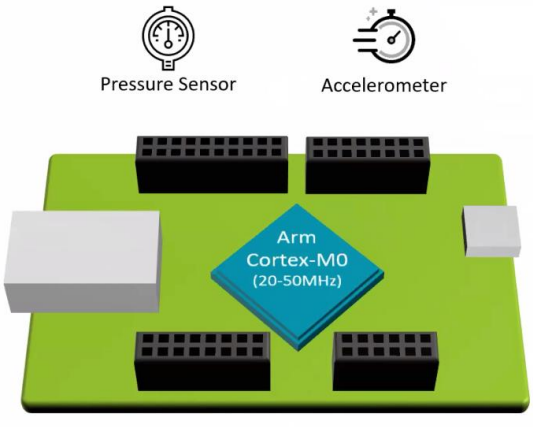


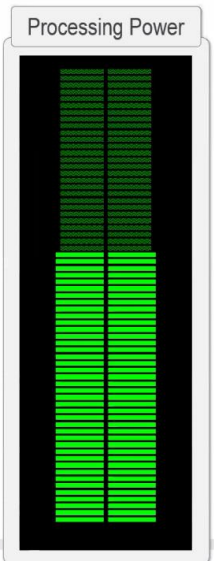
Low Cost ASSPs Don't Always Cut It



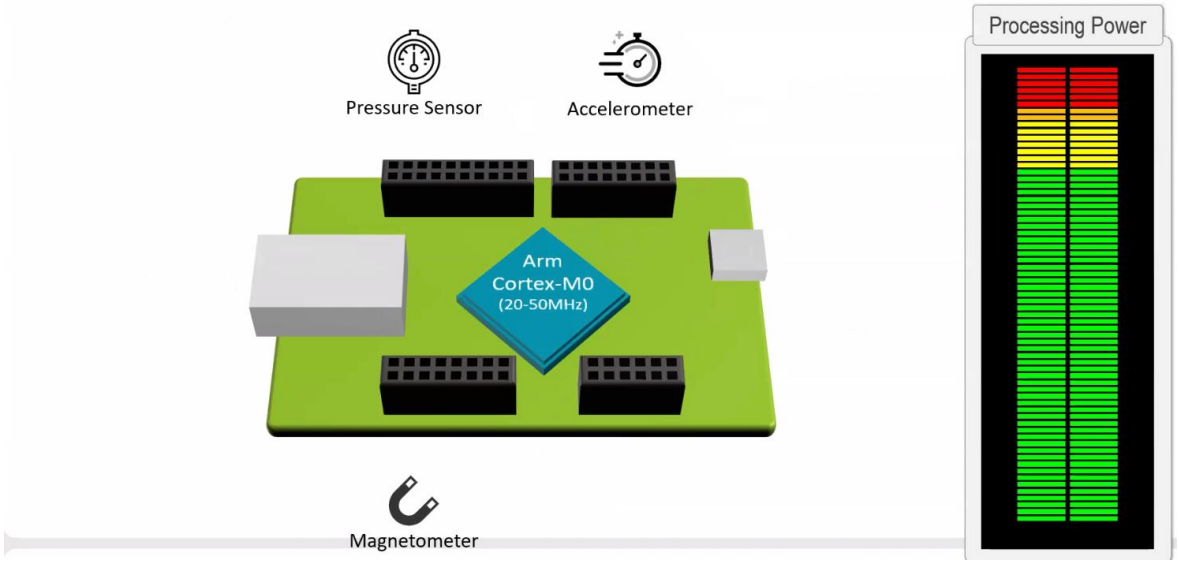


Low Cost ASSPs Don't Always Cut It

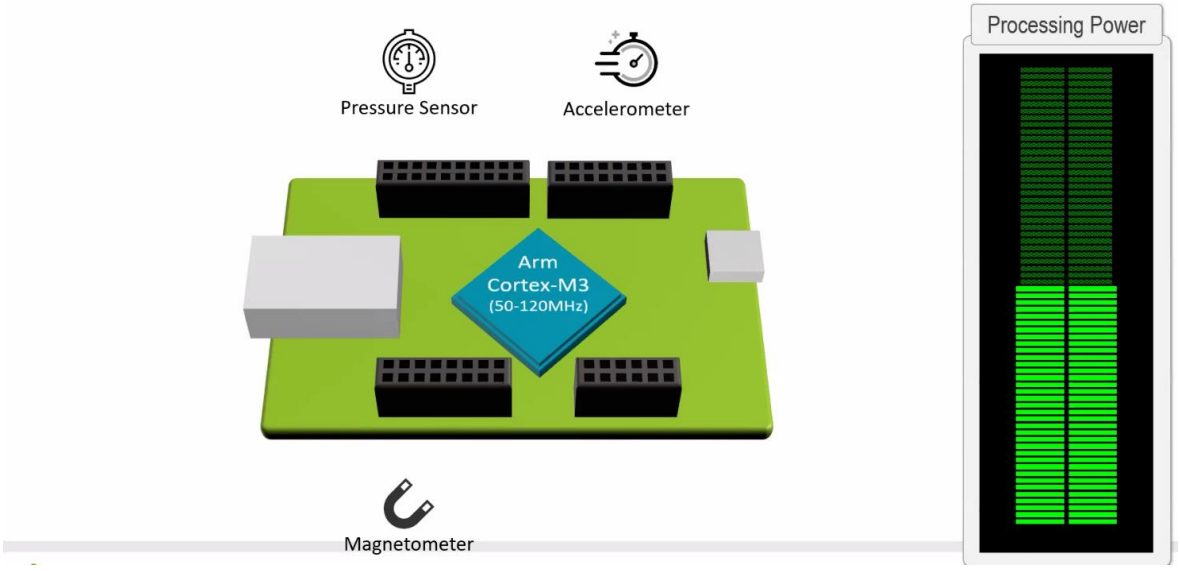




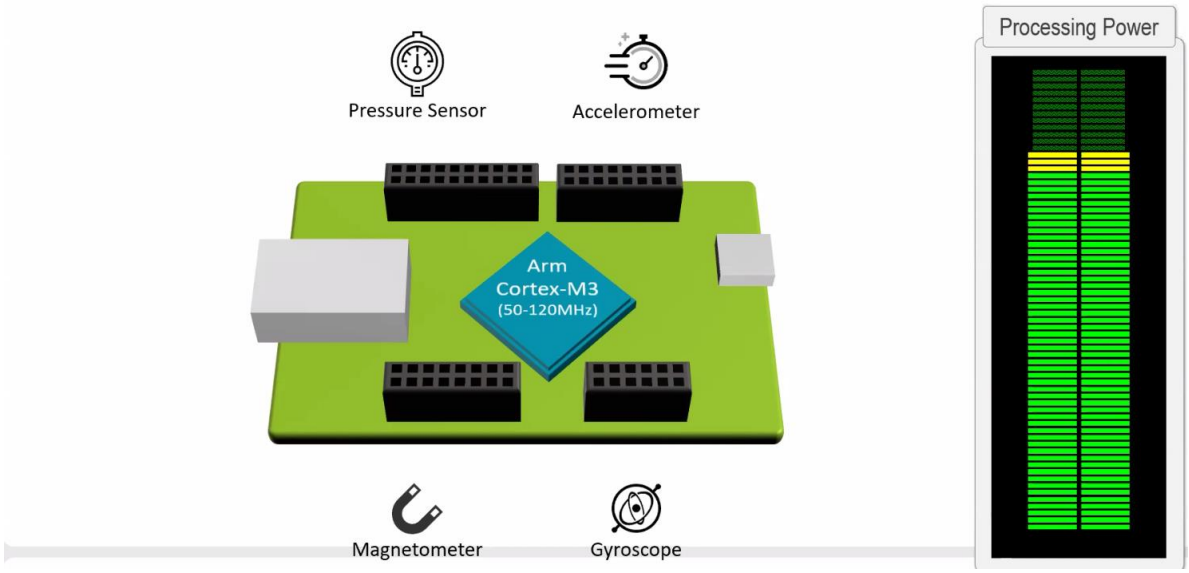
Low Cost ASSPs Don't Always Cut It



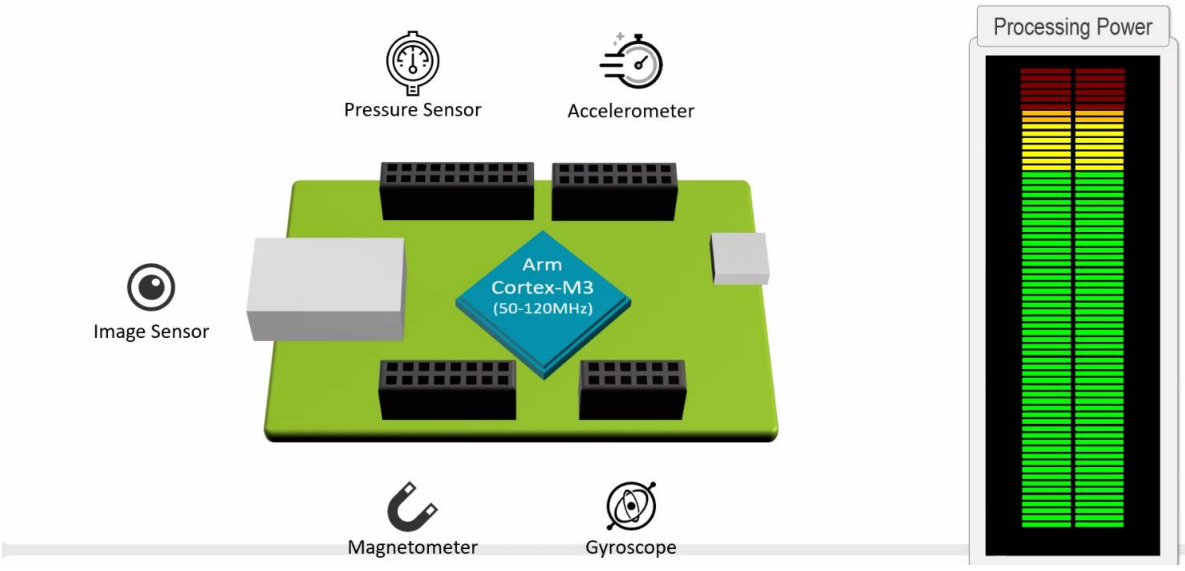
Low Cost ASSPs Don't Always Cut It



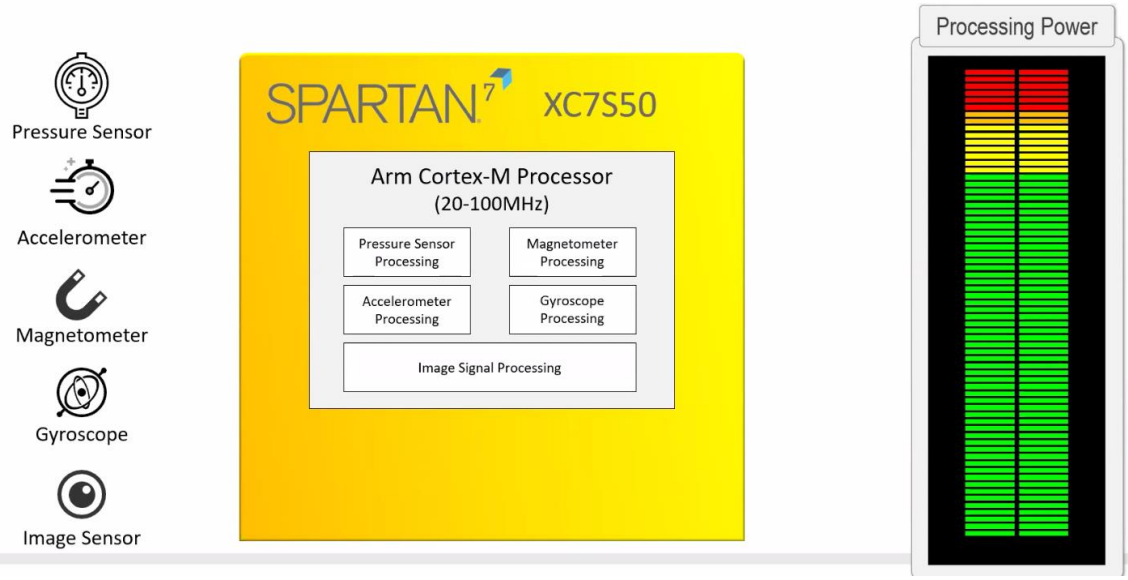
Low Cost ASSPs Don't Always Cut It



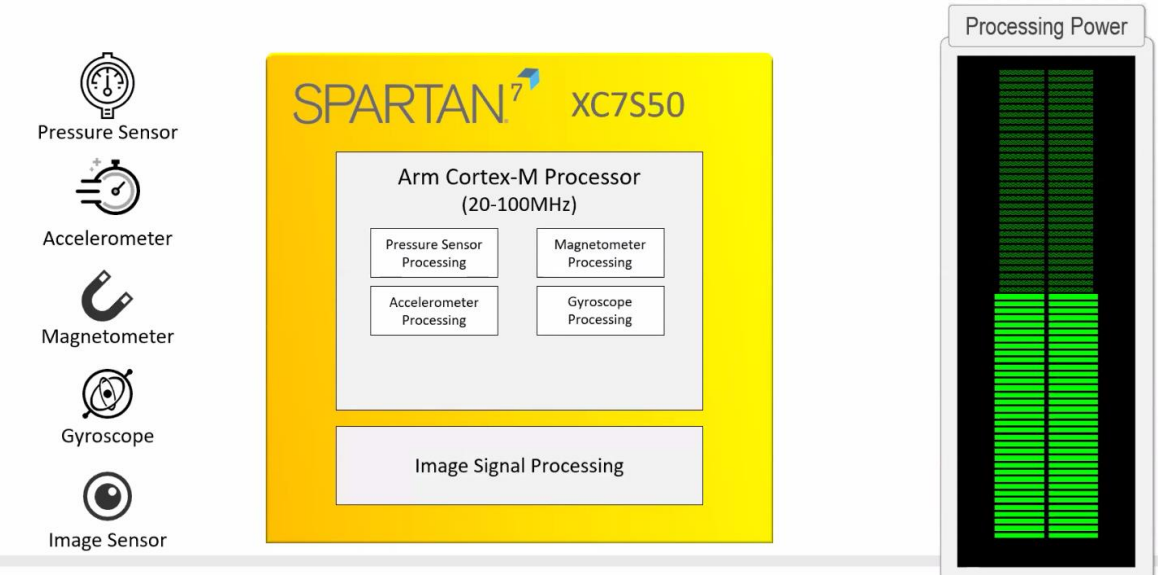
Low Cost ASSPs Don't Always Cut It



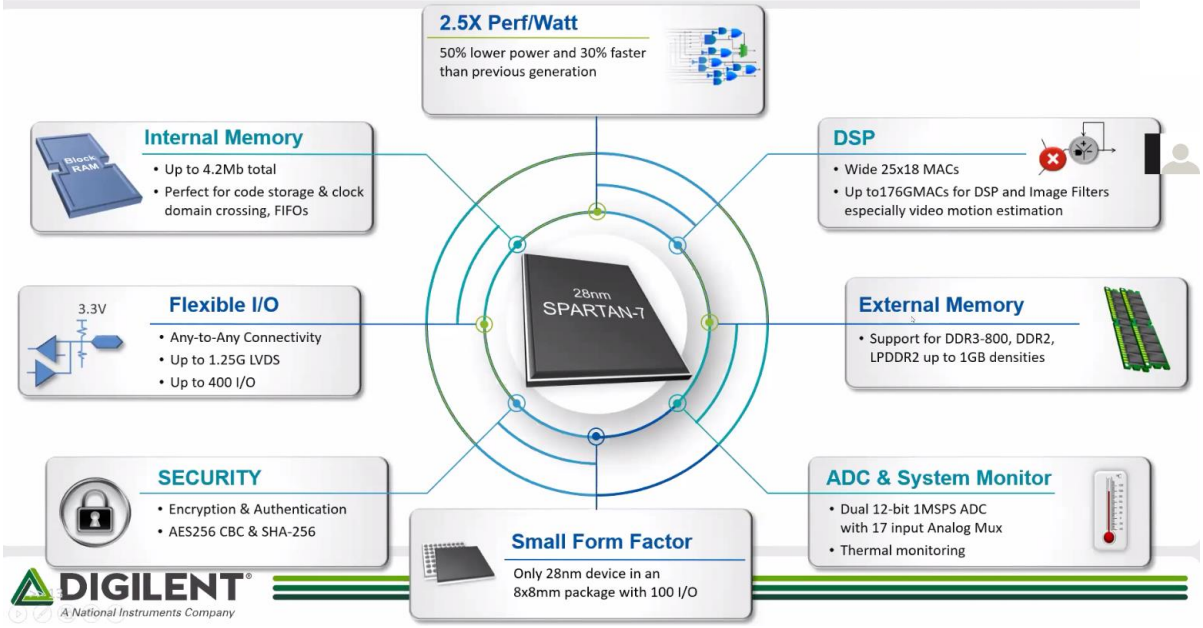
Spartan®-7: The Most Capable Cost-Optimized FPGA



Spartan®-7: The Most Capable Cost-Optimized FPGA



Spartan®-7 FPGA Overview



System-Wide Safety and Security

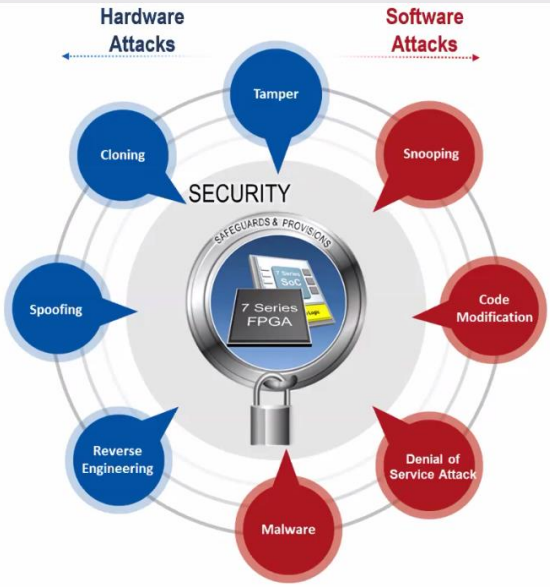
> Hardware (FPGA Fabric)

- AES-256 encryption[1] → anti-cloning & reverse eng.
- SHA-256 authentication → Ensures trusted source
- Temp/Volt. monitor → Flags 'out-of-spec' condition
- Isolated Design Flow (IDF) → Fault containment[2]

> Software (Zynq® SoC)

- Secure boot, protects from attack at startup
- Arm® TrustZone[3] to isolate 'main' OS from secure OS
- Memory protection against malware injection
- Rich ecosystem of run-time Security IP

1: NIST-Approved (National Institute of Standards and Technology)
2: Physical separation of safety-critical regions of the design
3: A compromised OS cannot access 'secured' data in the secure OS

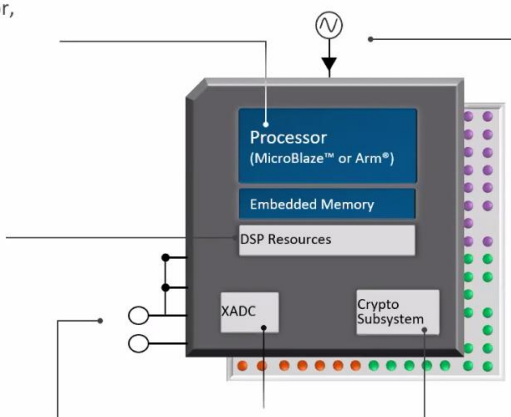


Devices Designed To Minimize System Cost

Replace Microcontroller, Processor, & External Cache Memory
($1 to ~$15 Savings)

Replace External DSPs
($1 - $2 Savings)

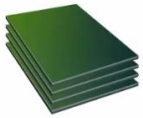
PMIC Support & Flexible Rails
Reduce # of Power Supplies
($1 - $2 Savings)
per Supply



Integrated AMS
Eliminates External ADCs
($1 to $2 Savings)

Clocking Structured Reduce
# of On-Board Oscillators
($1 - $2 Savings)

Packaging & Pinout
Reduces Board Layers
(Minimize PCB Cost)



Encryption & Authentication
Eliminates Security Device
($1 to $2 Savings)

Page 15

Time-to-Market Advantage

µP + FPGA — ***Months***

Choose µP → Choose FPGA → Partition Design → Determine Interface & Bandwidth → Board Design & Layout → Debug Board → System Level Programming → First Ship

- ✕ Must deal with IC Sequencing
- ✕ SI/PI issues

XILINX. arm

Hours

Choose SoC → Start System Programming w/Eval Board

- ✓ No additional device
- ✓ No partitioning
- ✓ No interface design
- ✓ High bandwidth

Cortex-M in Single-Core Zynq SoCs

ZYNQ® Arm® Cortex®-A9 + SPARTAN®-7

Device Name	Z-7007S	Z-7012S	Z-7014S
7 Series PL Equivalent	Artix®-7	Artix-7	Artix-7
Logic Cells	23K	55K	65K

Part Number	XC7S6	XC7S15	XC7S25
Logic Cells	6,000	12,800	23,360

- Most cost-optimized Zynq® device (Z-7007S) features 23K logic cells! (3rd largest Spartan-7)
- Cortex-M1 minimal configuration would consume less than 1/10th of device
- Block RAM can be used as on-chip memory
- Cortex-M Resource Utilization – Example Design

Default Configuration	Cortex-M3 Arty A7–35T		Cortex-M1 Arty S7–50T	
Freq. Max	50MHz		100MHz	
Slice Registers	4680	11%	2600	4%
Slice LUTs	12950	62%	3200	10%
BlockRAM	32	64%	24	32%
DSP	3	3%	3	3%
	64KB – ITCM 64KB – DTCM 32 IRQ		32KB – ITCM 32KB – DTCM 32 IRQ	

Minimal M1 Configuration	Cortex-M1 Arty S7–50T	
Freq. Max	100MHz	
Slice Registers	1722	3%
Slice LUTs	2400	7%
BlockRAM	10	13%
DSP	0	0%
	32KB – ITCM 8KB – DTCM 8 IRQ	

Tools

Keil MDK Tools

- Complete support for Arm Cortex™-M, Arm Cortex-R4, Arm7™, and Arm9™ devices
- MDK-lite: Free, restricted to 32KB
- Industry-leading Arm C/C++ Compilation Toolchain
- µVision4 IDE, debugger, and simulation environment
- Keil RTX deterministic, small footprint real-time operating system
- TCP/IP Networking Suite USB Device and USB Host stacks
- Complete GUI Library

MDK-Arm Microcontroller Development Kit

Arm C/C++ Compiler	µVision Project Manager, Editor & Debugger
RTX Real-Time Operating System	
CAN Interface	File System
USB Host	USB Device
TCP/IP Networking Suite	GUI Library

Required Hardware and Software

Hardware

- Arty S7-50
- Arm DesignStart DAPLink Board (Optional but recommended)
- Pmod NAV
- Pmod Hygro
- Micro and Mini USB cables

Software

- Vivado **2018.2**
- Digilent Board files from GitHub
- Arm IP from ARM Design Start FPGA
- Arm Keil MDK Tools
- Terminal Program