DAVE Embedded Systems

UNIVERSITY SEMINARS 2015

INTRODUCING MYSELF

- Andrea Marson
- R&D Manager
- 15 years experience on embedded system
- https://www.linkedin.com/in/marsonandrea

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AGENDA

- Introduction
- DAVE presentation
- Brief introduction to Xilinx Zynq architecture and state-of-the-art FPGA development techniques
- Internship/thesis proposals and real cases

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HISTORY

1998
Foundation

2004
First CPU Module

2008
First Presence at Embedded World

2012
Widest ARM Family

2014-15
In-House Production

90 00 10 20

DAVE Embedded Systems

WHAT WE DO

DAVE deals with design, manufacturing and testing of embedded systems since 1998. Our products are used by customers in different markets such as automation, telecommunication, biomedical, computer vision, image/video processing, transportation etc.

What is an embedded system?

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer, is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today.

source: Wikipedia

"THE ARDUINO EFFECT"

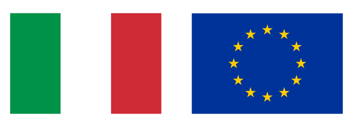
A concern expressed by many in the industry is that the "anyone can program" philosophy that is associated with the Raspberry Pi [and Arduino Ed.] tends to ignore the complexity involved in creating software for real-world systems and perhaps even devalues the engineering skills involved. For example, software for use in industrial systems must be developed in compliance with international standard IEC 61508, while developers of automotive systems must adhere to ISO 26262. Meeting these challenging and complex standards involves a wide range of different engineering skills.

It is fair to say that the Embedded Systems industry understands the motivation behind the Raspberry Pi and the need to encourage 'programmers' rather than 'operators'. Certainly the Pi does expose young people to the 'magic' that a microprocessor is able to deliver. Looking forward, it will be interesting to see how many of the Pi generation go on to become professional embedded systems engineers.

source: http://www.cambridgenetwork.co.uk/news/the-raspberry-pi-hero-or-zero-an-industry-perspective/

HEADQUARTER

Via Talponedo, 29/A
33080 Porcia (PN)
Italy



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COMPANY ORGANIZATION / SUBSIDIARIES

- **administration/sales: 5**
- **R&D: 7**
- **technical support: 3**
- **production: 8**
- **interns: 4**

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SUPPLY CHAIN AND PARTNERS

freescale semiconductor · SPANSION · XILINX ALL PROGRAMMABLE · TEXAS INSTRUMENTS · Micron

MANUFACTURERS

SILICA An Avnet Company · AVNET Memec · Digi-Key CORPORATION · MOUSER ELECTRONICS

DISTRIBUTORS

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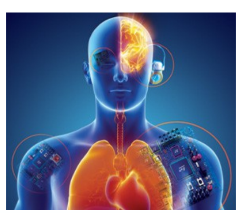
IMAMOTER moving research · LAUTERBACH DEVELOPMENT TOOLS

TECHNICAL PARTNERS

CUSTOMERS (B2B)



END CUSTOMERS (B2B, B2C)

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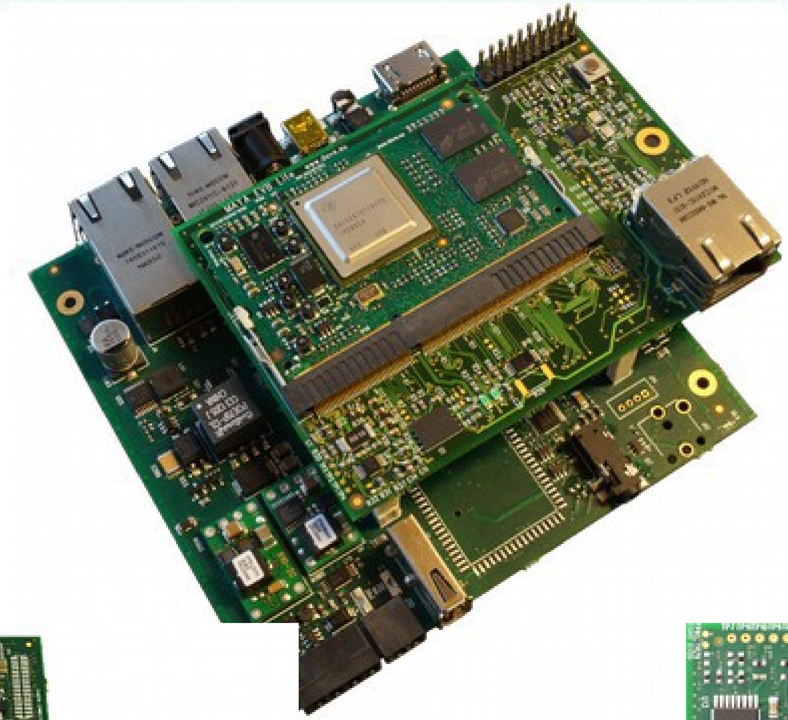
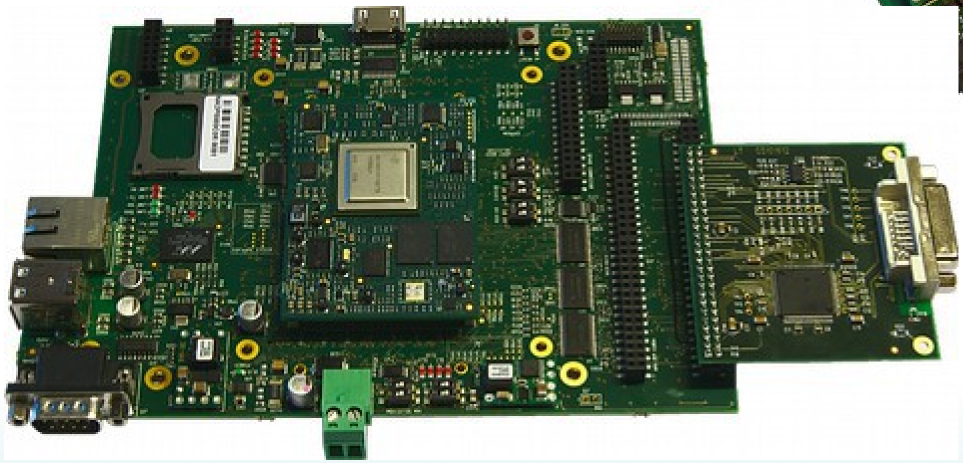
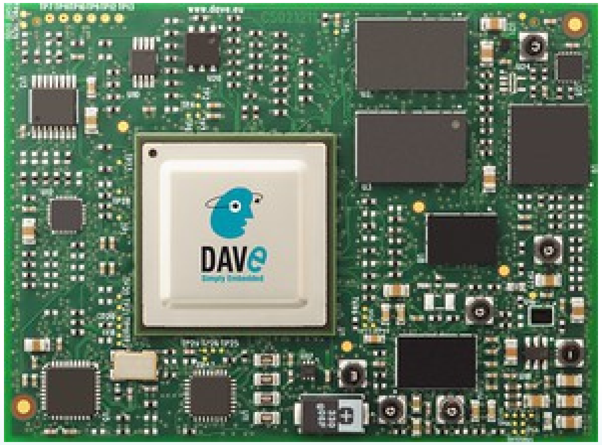
PRODUCTS /OVERVIEW







PRODUCTS /MAIN LINES

CPU Modules (aka SoM = system on module)

- Ultra
- Esatta
- Lite

Turnkey Systems

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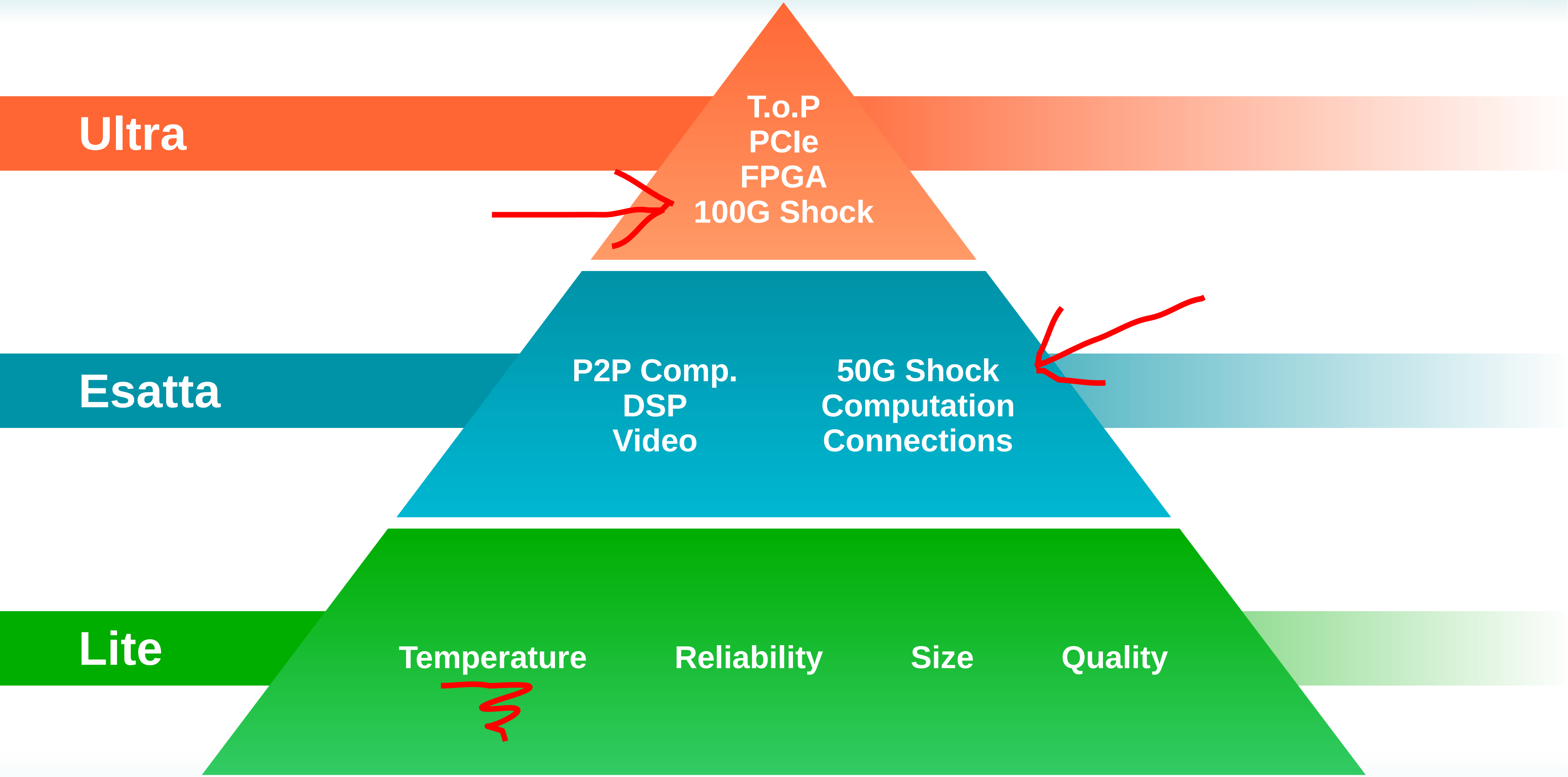
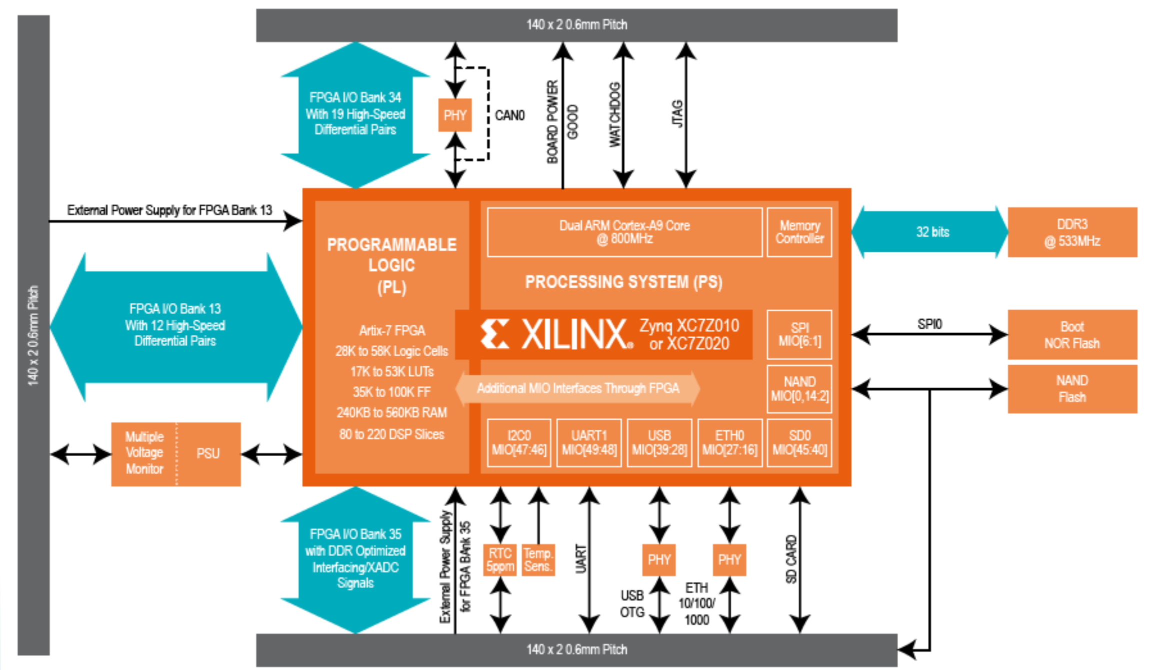
CPU MODULES /POSITIONING



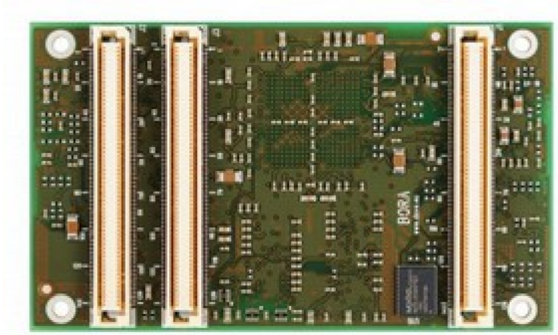
BORA – ZYNQ XC7Z010/XC7020

- Unmatched performance thanks to dual ARM Cortex-A9 @ 800MHz
- Enabling smarter system thanks to Artix-7 FPGA integrated on chip
- Highet security and reliability: voltage monitoring and power good enable
- Accurate timing application thanks to on-board 5ppm RTC



Top view

Bottom view



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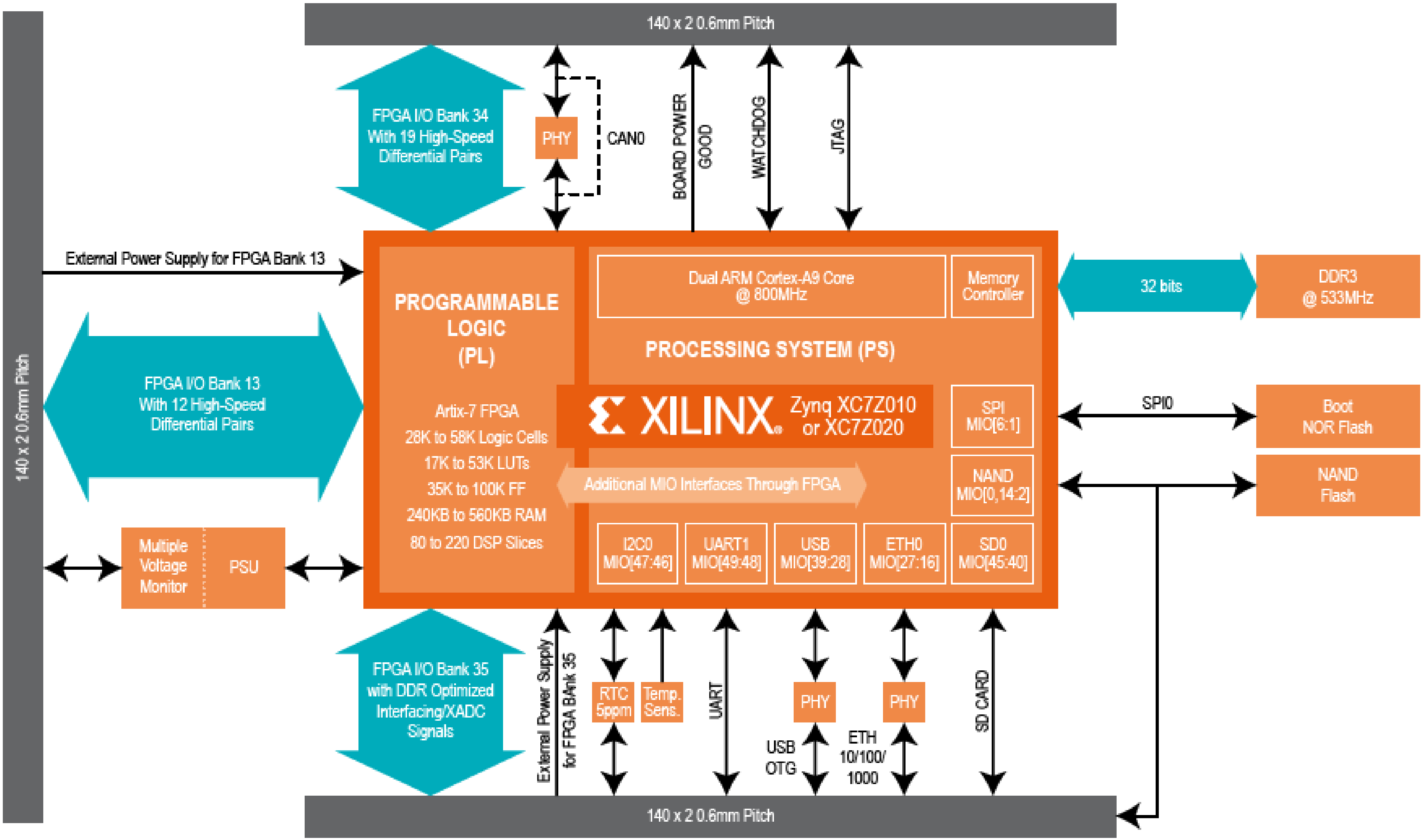
BORA – ZYNQ XC7Z010/XC7020



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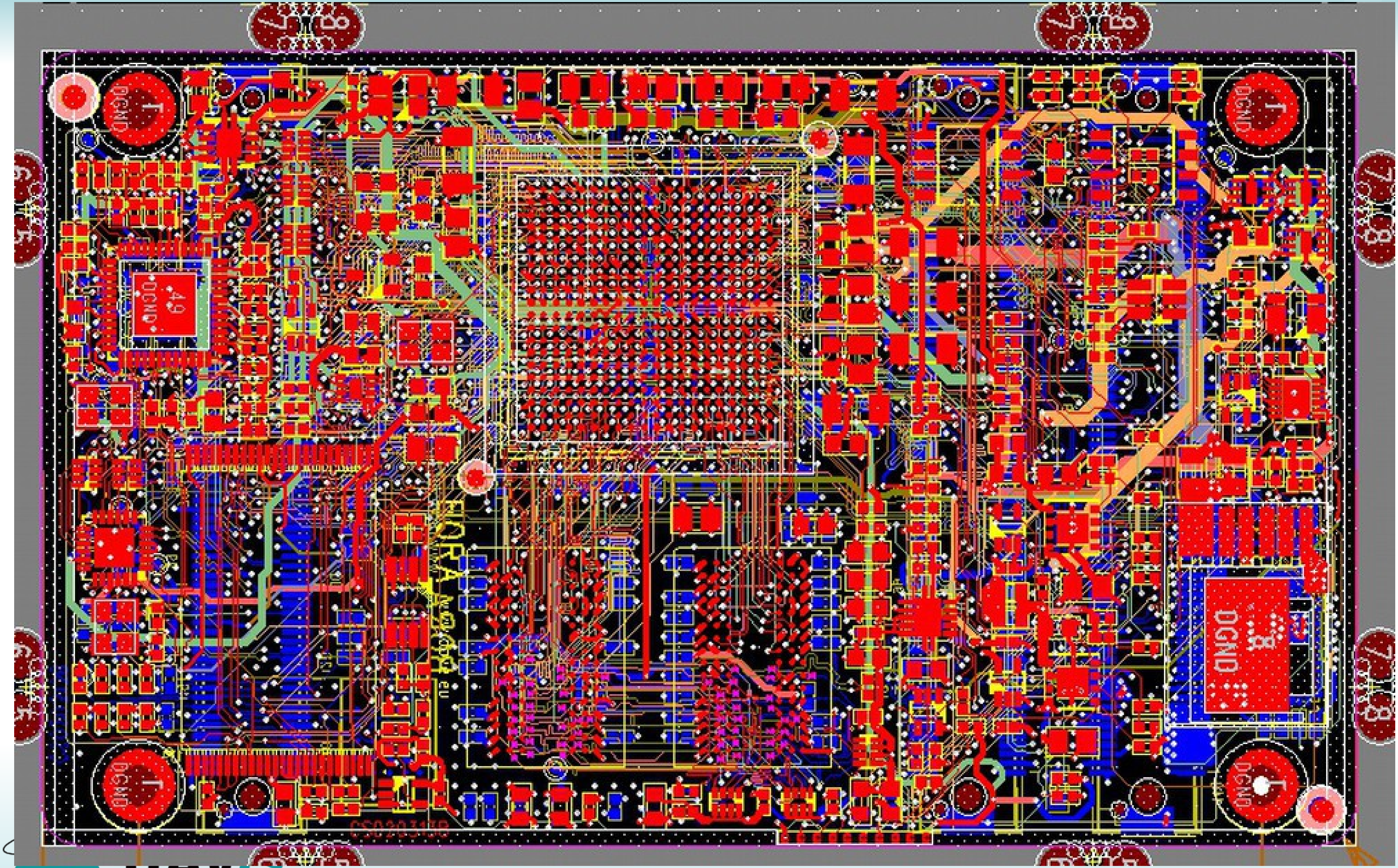
BORA – ZYNQ XC7Z010/XC7020



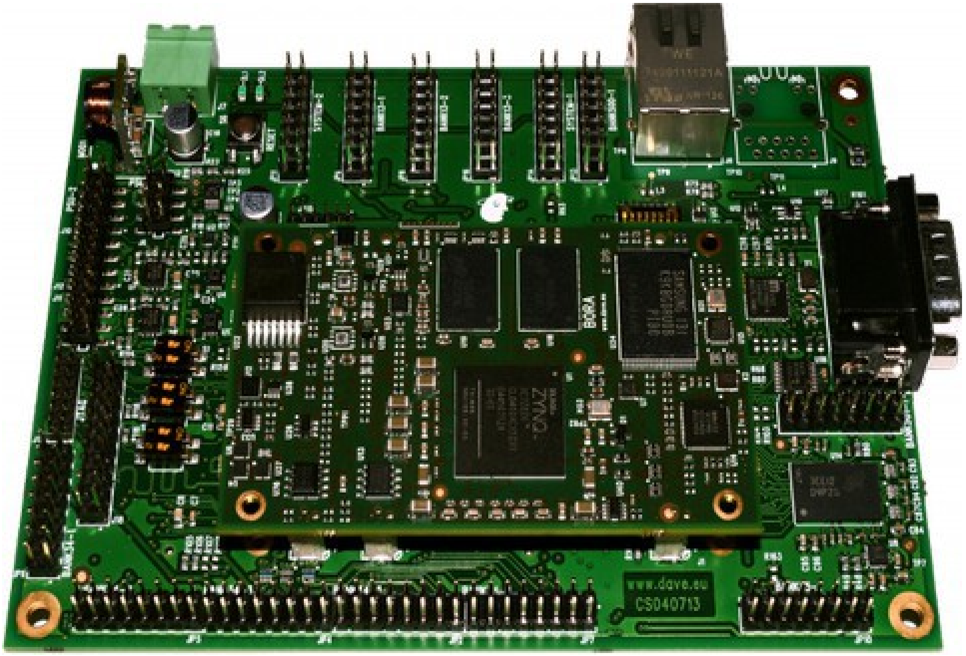
BORA Evaluation Kit

Bora Embedded Linux Kit provides all the necessary components required to set up the developing environment for:

- configuring the system (PS and PL) at hardware level
- build the first-stage bootloader (FSBL)building the second stage bootloader (U-Boot)
- building and running Linux operating system on Bora-based systems
- building Linux applications that will run on the target

The main kit components are:

- Bora SoM
- BoraEVB-Lite carrier board
- AC/DC Single Output Wall Mount adapter
  Output: +12V -2.0 A
- MicroSDHC card with SD adapter and USB adapter



Vivado/SDK can be viewed as a collection of programs required to deal with all of the development aspects related to Xilinx components (software running on ARM cores, FPGA fabric verification and programming, power estimation etc.). These include strictly FPGA-related tools such as Floorplanner and pure-software development tools such as SDK.

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TURNKEY SYSTEMS /EXAMPLE 1

Remote Localization Unit

- Remote Vehicle and Safety Systems Localization & Monitoring Unit
- Neptune CPU Module
- Based on x86
- Carrier Board with Common Interfaces (USBs, Compact Flash, etc.)
- Two Boards for Monitoring Services (GPS, Accelerometer, Gyroscope) and Video Recording
- Video recording (MPEG compressed)

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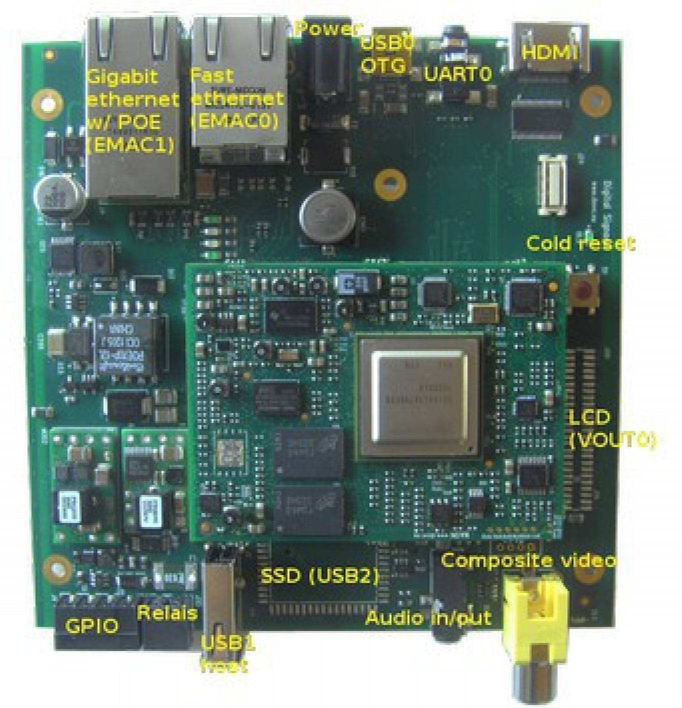
TURNKEY SYSTEMS /EXAMPLE 2



Passenger counting system

- Low power ARM-based CPU solution
- Fanless CPU Core for 24/7 Operation
- -40 °C to +85 °C Applications
- SoC TI DM8148 1GHz
- 750 MHz floating-point integrated DSP
- Internal Solid State Disk, Up to 16GB
- real-time operation

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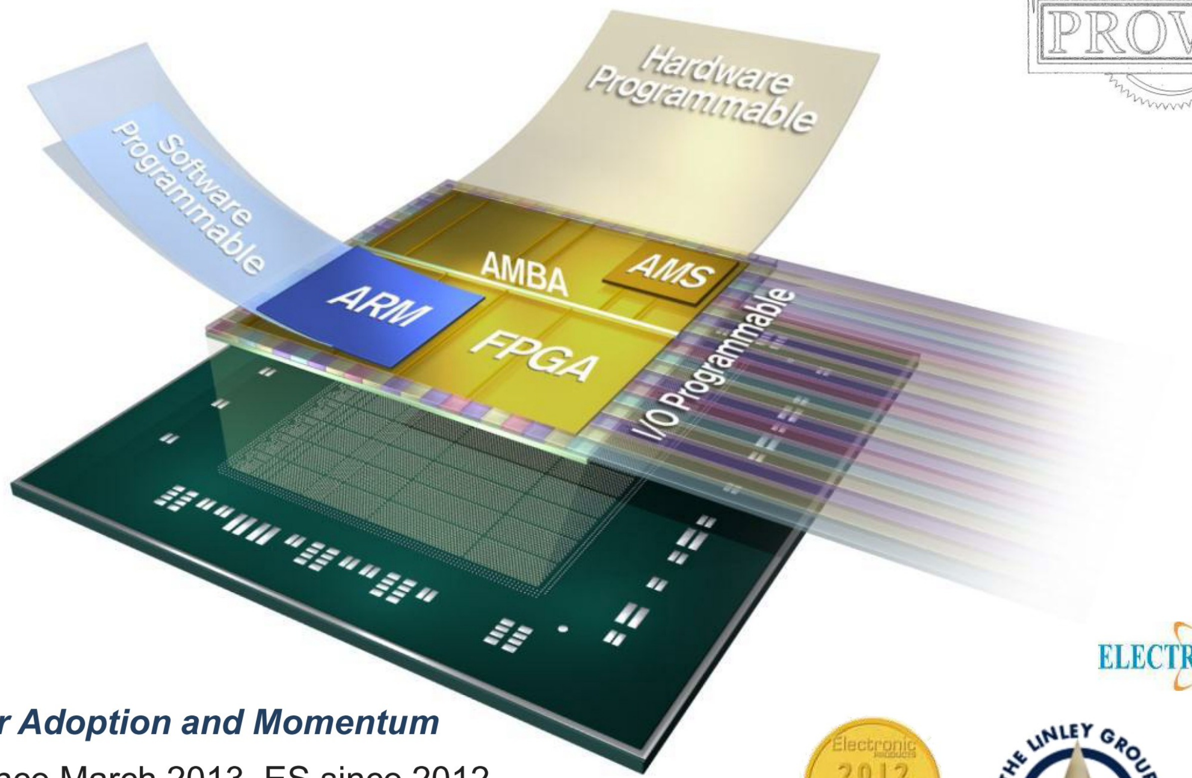
TURNKEY SYSTEMS /EXAMPLE 2

COLLABORAZIONI

- Università degli Studi di Udine
- Università degli Studi di Padova
- Università degli Studi di Trieste
- Università degli Studi di Ferrara
- Istituto IMAMOTER CNR di Ferrara
- Istituto Tecnico. S. T. "J.F. Kennedy" di Pordenone
- Associazione Cultura Informatica (AsCI) – Udine
- Texas Instruments
- Freescale
- Xilinx

XILINX ZYNQ (1/10)

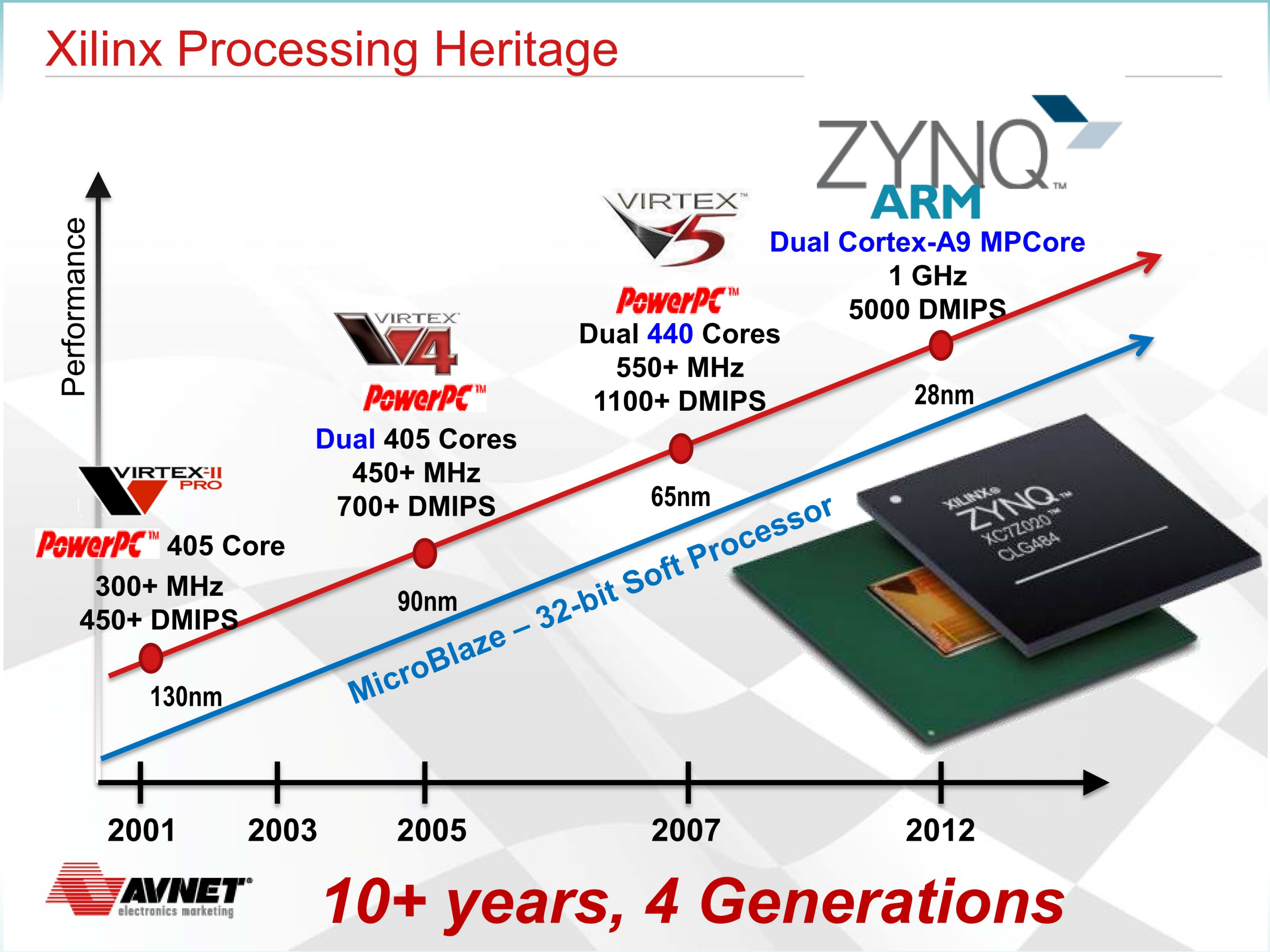
The First All Programmable SoC



Significant Customer Adoption and Momentum

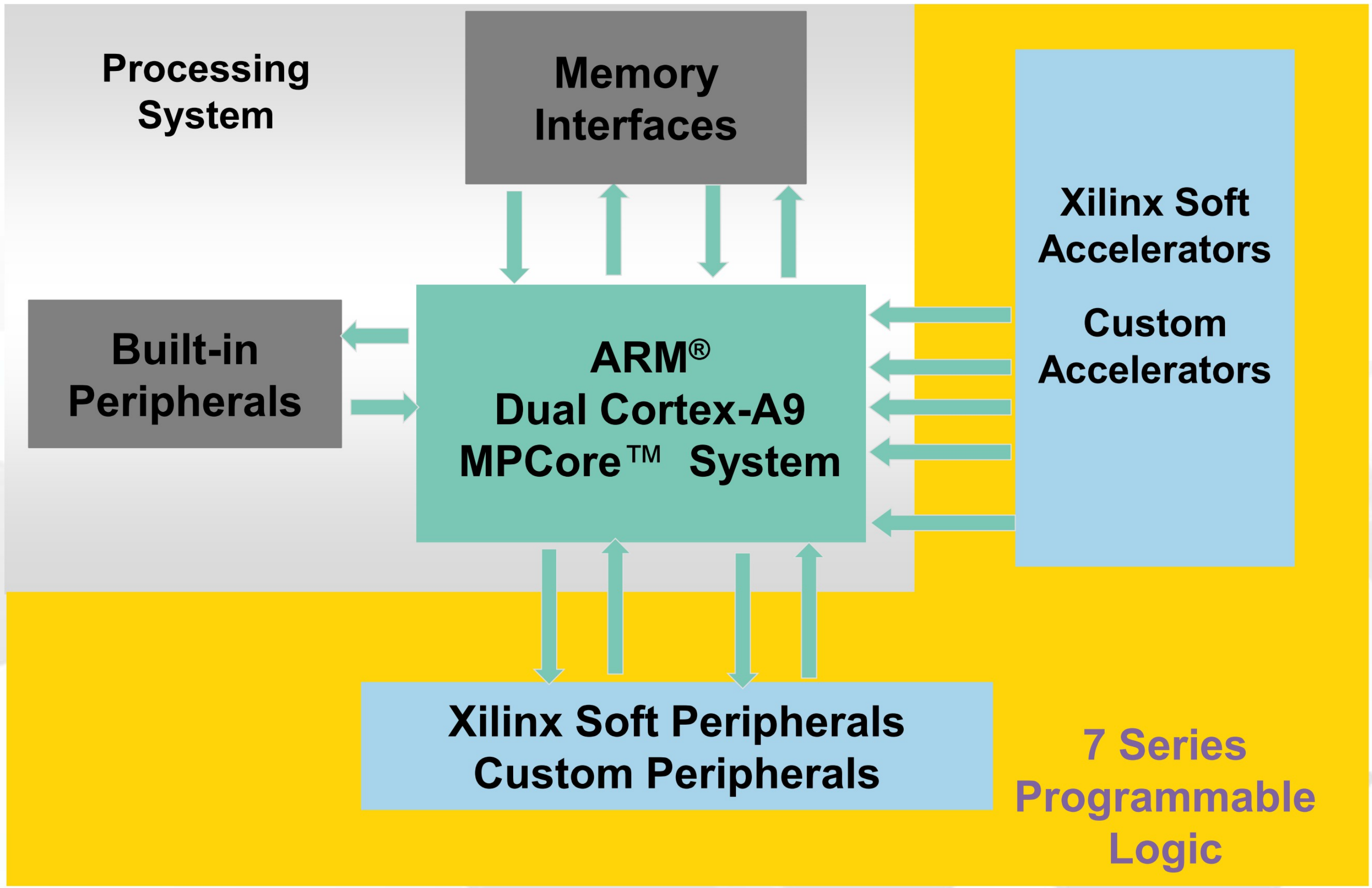
- ✓ In full production since March 2013, ES since 2012
- ✓ 500+ unique customers actively designing
- ✓ 100+ Zynq specific partners
- ✓ All major OSs supported and in use
- ✓ 20+ different development boards and SOMs

XILINX ZYNQ (2/10)



XILINX ZYNQ (3/10)

Zynq-7000 AP SoC Basic Architecture



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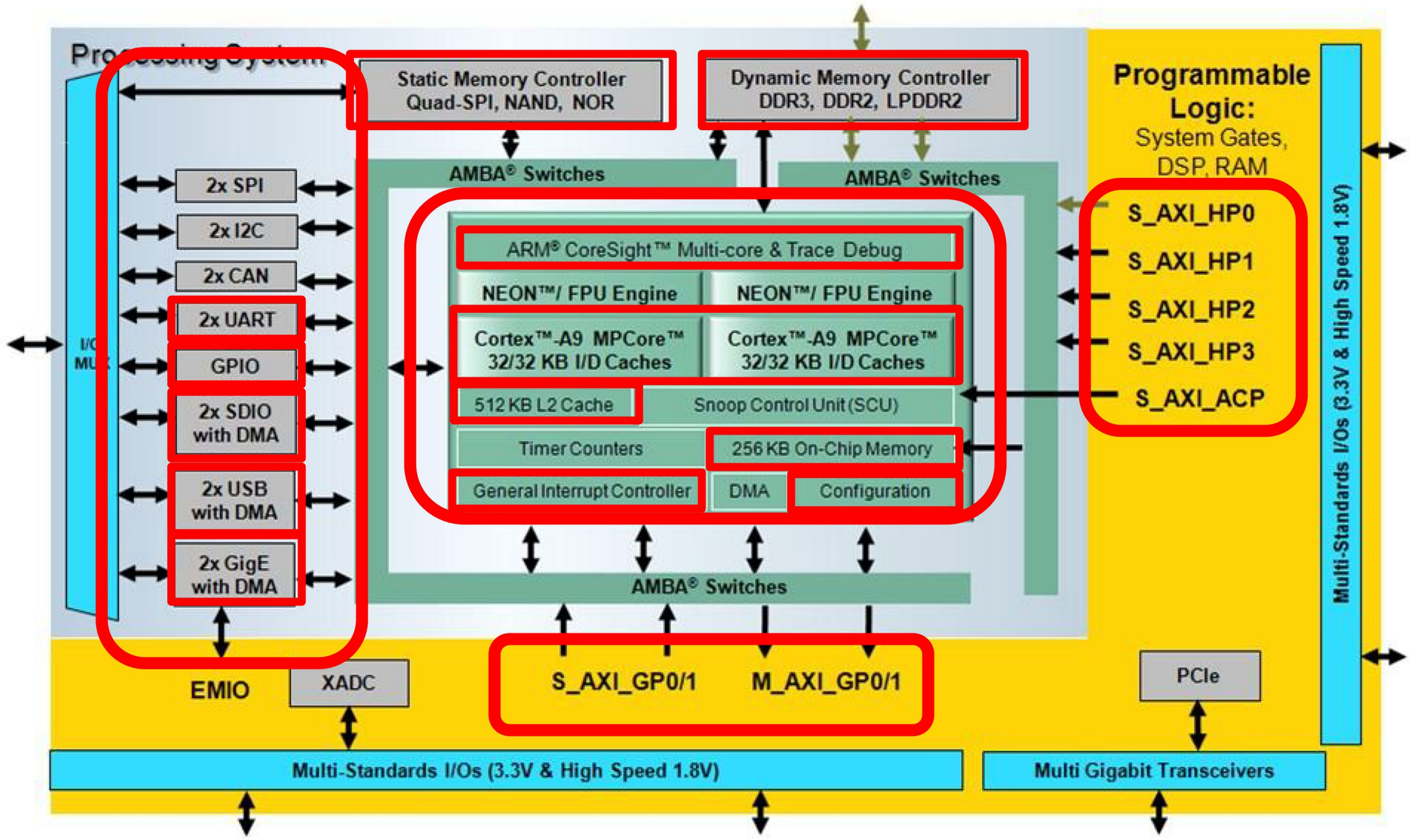
XILINX ZYNQ (4/10)

Zynq-7000 AP SoC Block Diagram



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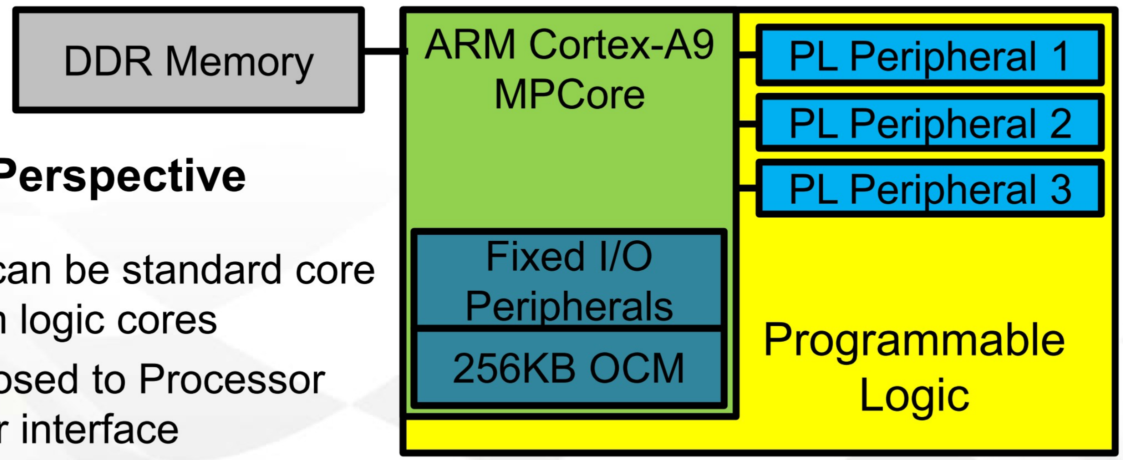
XILINX ZYNQ (5/10)

Connecting HW and SW

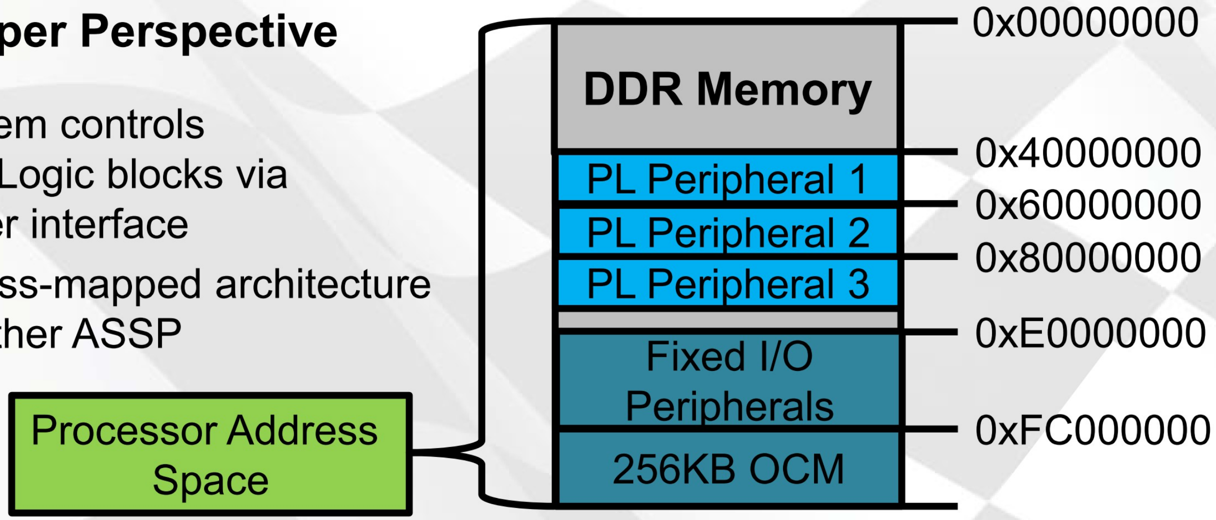


Hardware Designer Perspective

- Peripheral blocks can be standard core offerings or custom logic cores
- Logic controls exposed to Processor System via register interface

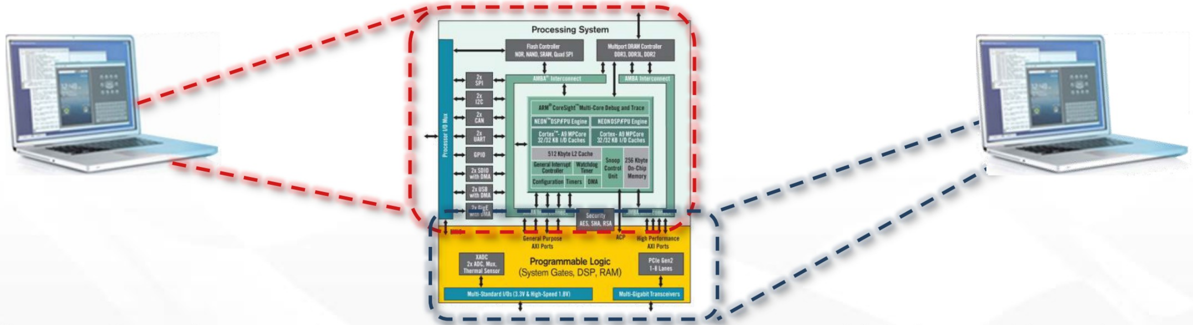
Software Developer Perspective

- Processor System controls Programmable Logic blocks via exposed register interface
- Standard address-mapped architecture similar to any other ASSP



XILINX ZYNQ (6/10)

Parallel Developments of your AP SoC Based Application



Software Development

- **Processor boots first like any ARM based SoC.**
- **SW developers can use their favorite SW tool to load / debug SW code over JTAG**
- **Programmable Logic can be left unconfigured while developing on real hardware**

Hardware Development

- **Reference SW boots processor first leaving PL up and ready to be programmed through JTAG**
- **Vivado Probe connects to Programmable Logic like to any other FPGA**
- **FPGA developer can start loading / debug like for any FPGA**

SW developments like any other ARM based SoC

HW developments like any other Xilinx FPGA

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XILINX ZYNQ (7/10)

System Bottlenecked?

- **Profiling indicates processor activity**
  - Is processor utilization exceeding 90%?
  - Processor Queue Length > 2?
  - If multiprocessor system, processor time > 50%?
  - Intensive reoccurring tasks?

- **Effects of overburdened Processors include:**
  - Increased Data Latency
  - Delayed Interrupt Handling
  - Lowered Data Throughput

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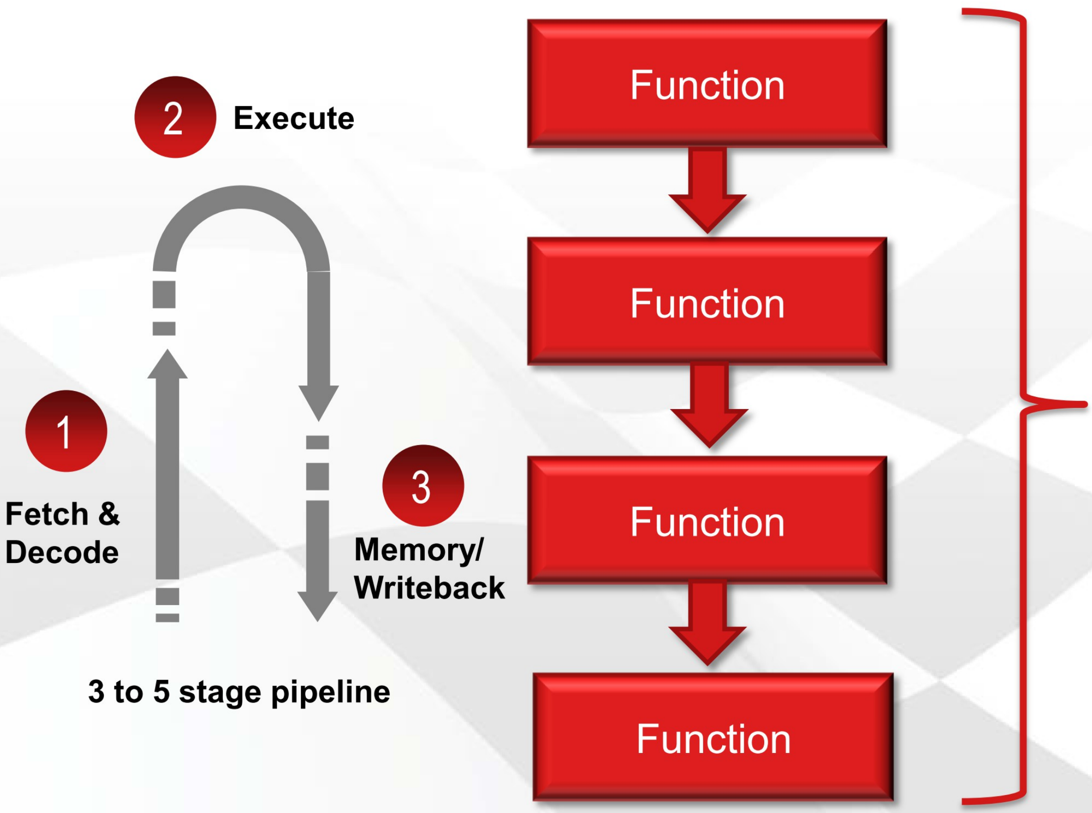
XILINX ZYNQ (8/10)

Software Engineers: Stuck in a Sequential World

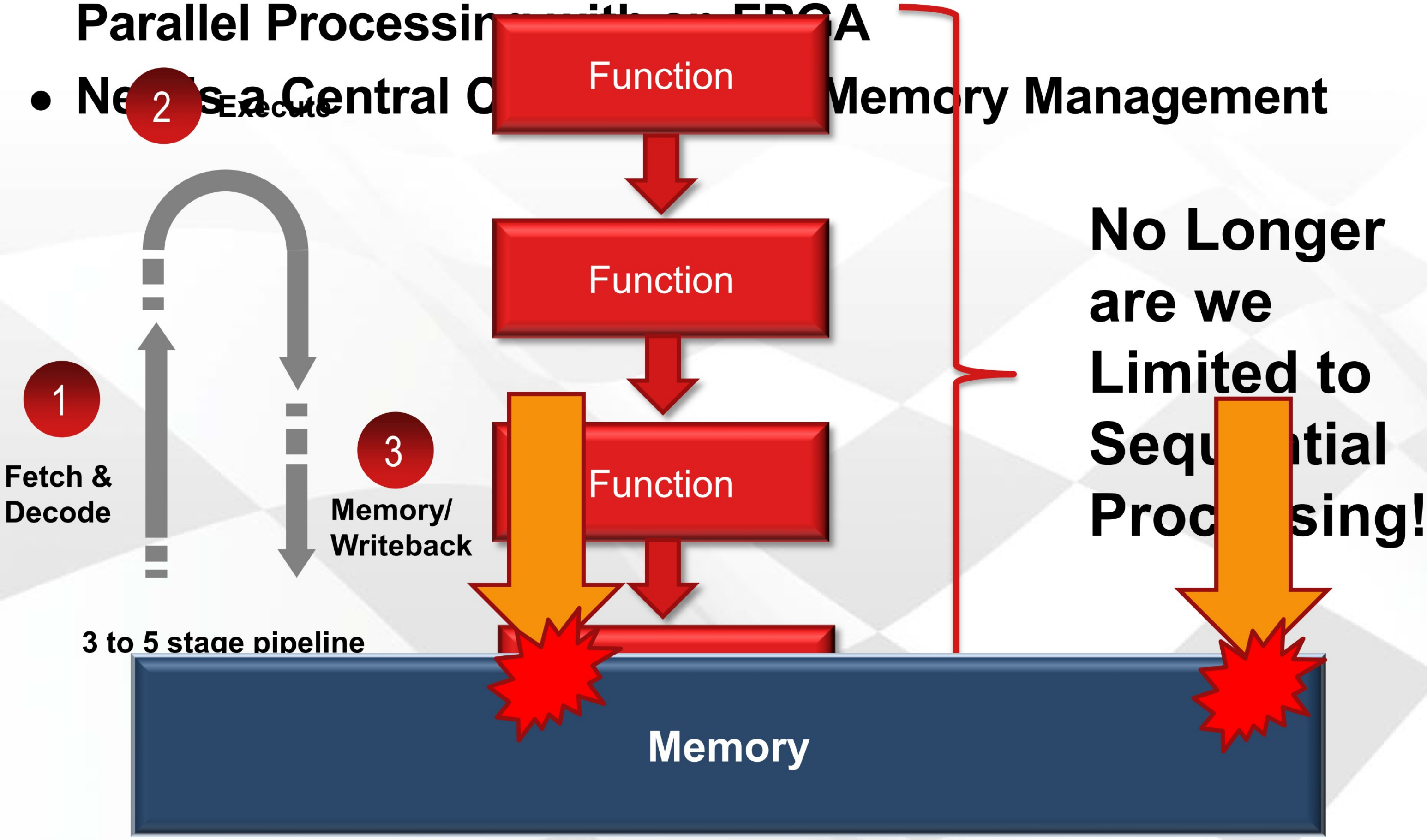


Sequential Processing limits performance

XILINX ZYNQ (9/10)

Parallel Processing is Efficient…

- **For critical systems and performance, Engineers utilize Parallel Processin[...]A**
- **Ne[...]s a Central C[...]Memory Management**



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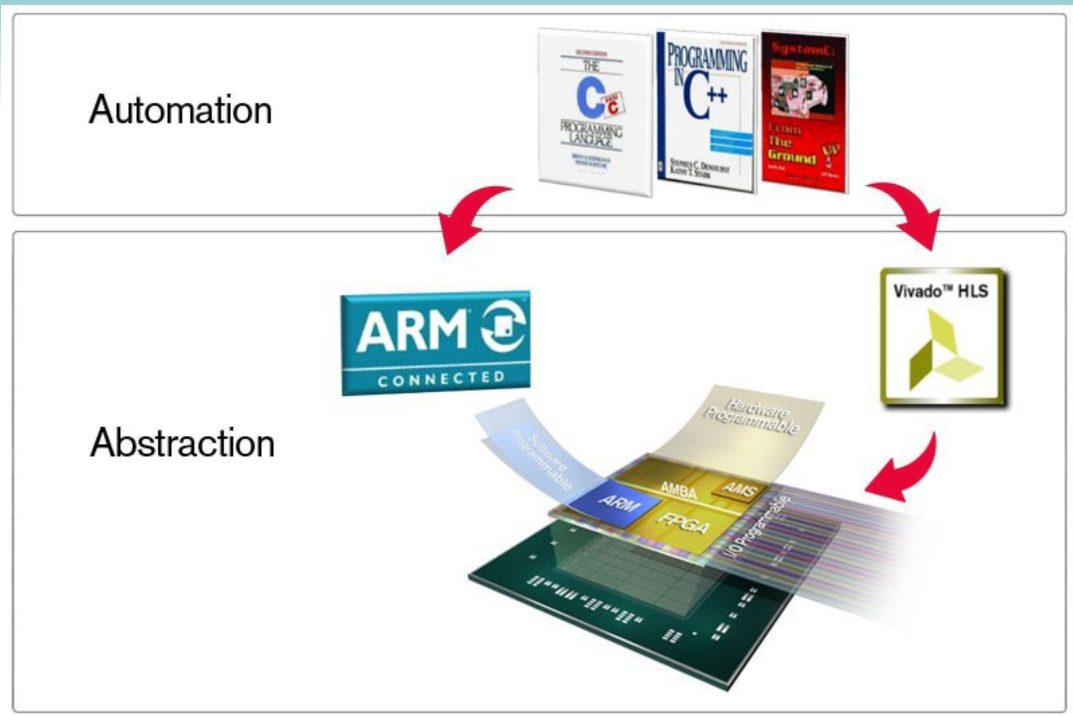
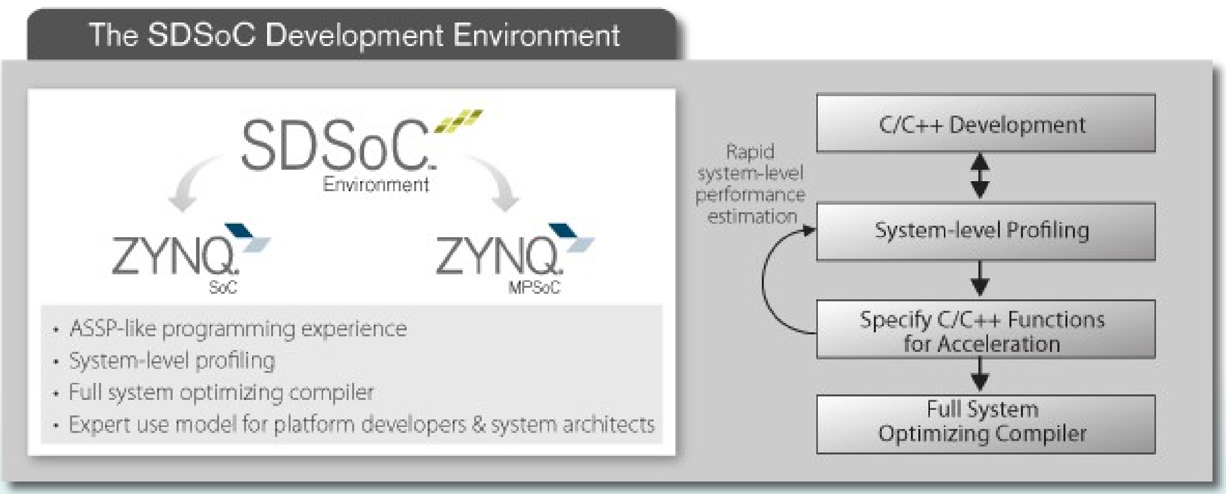
XILINX ZYNQ (10/10)



HLS

http://www.xilinx.com/products/design-tools/vivado/integration/esl-design.html

SDSoC



http://www.xilinx.com/products/design-tools/sdx/sdsoc.html

TESI DI LAUREA SPERIMENTALI (1/2)

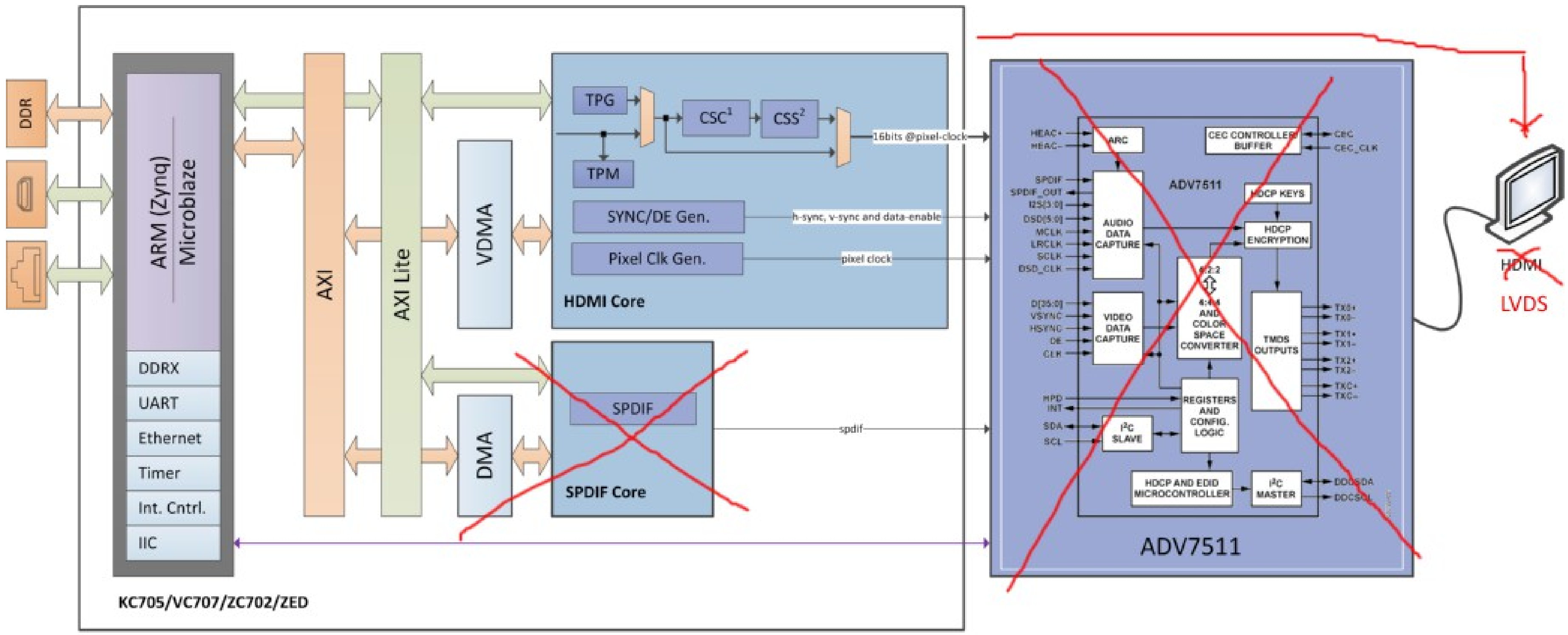
- applicabili sia ai corsi triennali (tirocini) sia alle lauree magistrali
- l'argomento trattato viene modulato in maniera opportuna, in accordo con lo studente, affinché il contenuto sia congruo con il percorso accademico del laureando
- possibilità da parte del laureando e del relatore di proporre delle variazioni
- previsto un periodo di presenza fisica presso i laboratori dell'azienda ma possibilità di svolgere parte del lavoro in remoto (vedi http://www.xilinx.com/support/university.html)
- premio di laurea o rimborso spese per studenti non residenti nelle vicinanze della nostra sede
- efficace anche come strumento di **preselezione del personale** (al momento della stesura di questa presentazione – Aprile 2015 – oltre il 60% delle risorse del reparto di ricerca e sviluppo di DAVE è composto da personale che è stato inserito nell'organico immediatamente dopo aver svolto la tesi sperimentale)

TESI DI LAUREA SPERIMENTALI (2/2)

- l'ingegneria dei sistemi embedded abbraccia numerose discipline e di conseguenza le tesi proposte hanno un carattere fortemente interdisciplinare
  - progettazione hardware (prevalentemente digitale ma anche analogica)
  - signal integrity
  - compatibilità elettromagnetica
  - sviluppo firmware e device drivers
  - sviluppo software di alto livello
  - sviluppo su FPGA
  - sviluppo su DSP
  - sistemi operativi e RTOS (real-time operating system)

ESEMPIO DI TIROCINIO (2014)

Integrazione in Zynq di un controller grafico con uscita LVDS



1. RGB to YCbCr Color space conversion (not applicable to VC707).
2. 444 to 422 Subsampling (not applicable to VC707).

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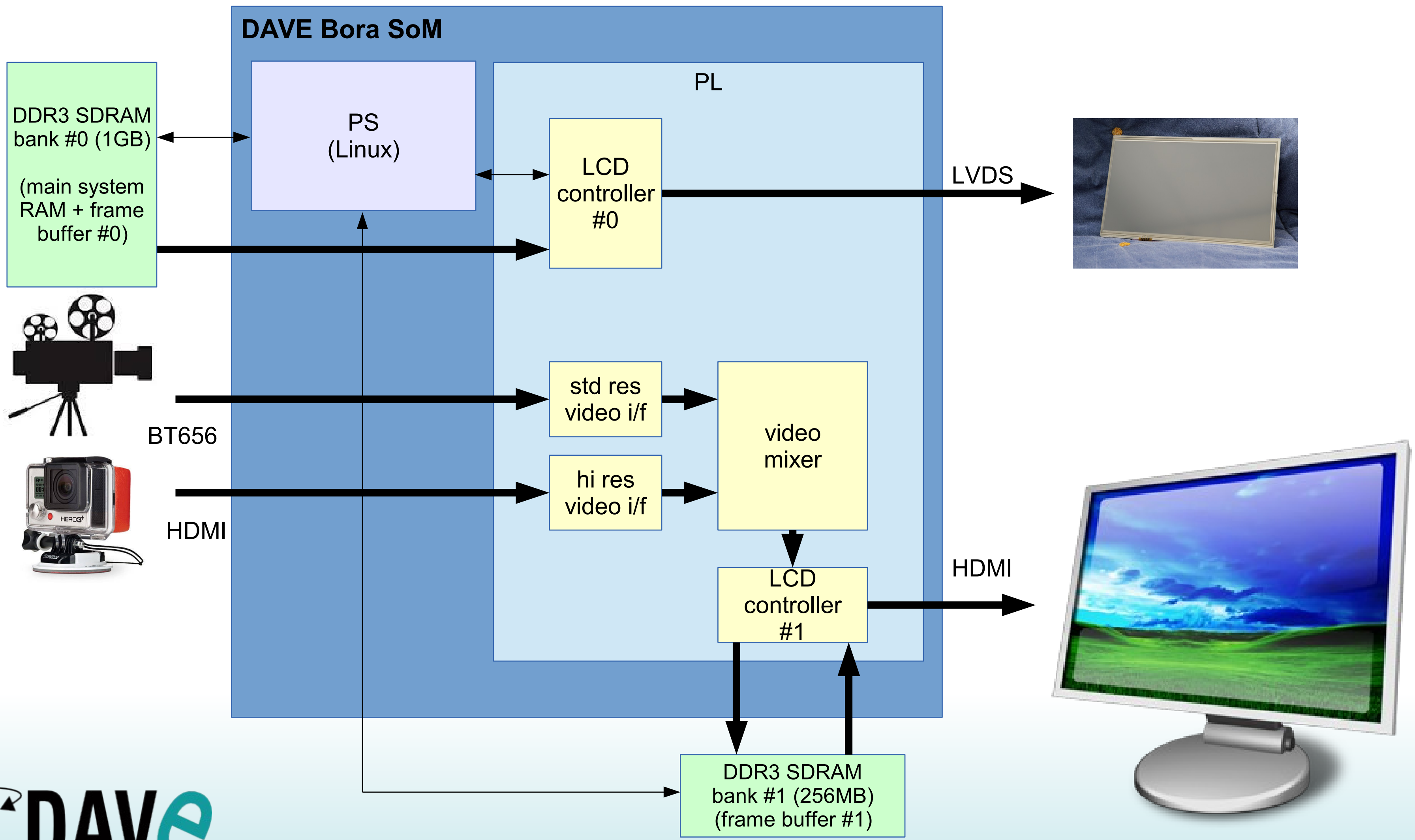
ESEMPIO DI TIROCINIO (2015)

Sviluppo di un controller video con doppia uscita <u>indipendente</u> (LVDS + HDMI)



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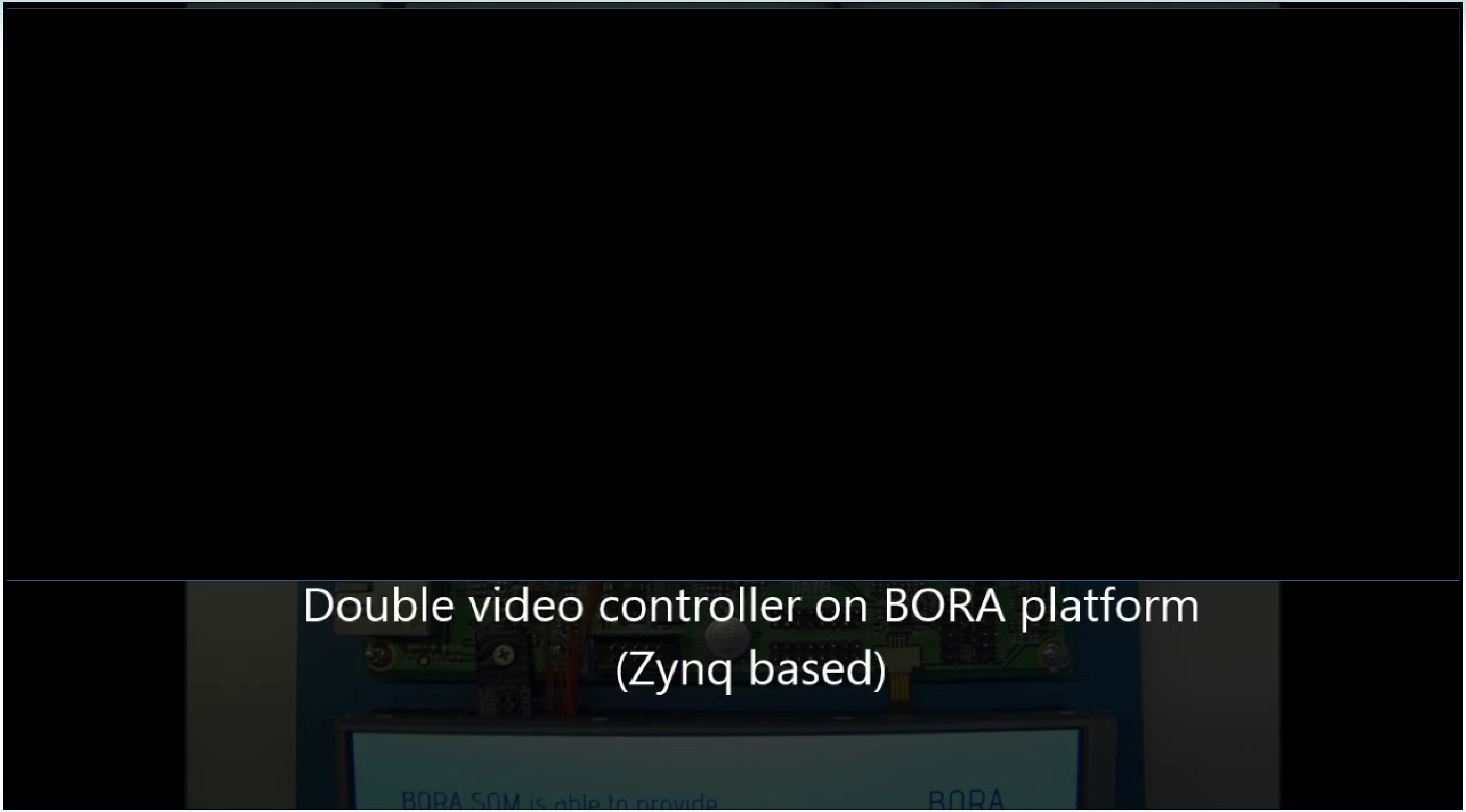
ESEMPIO DI TIROCINIO (2015)



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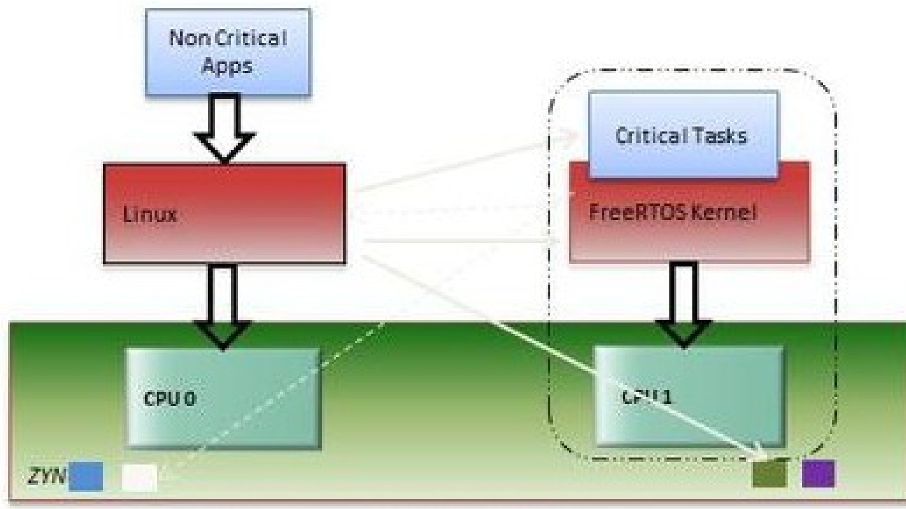
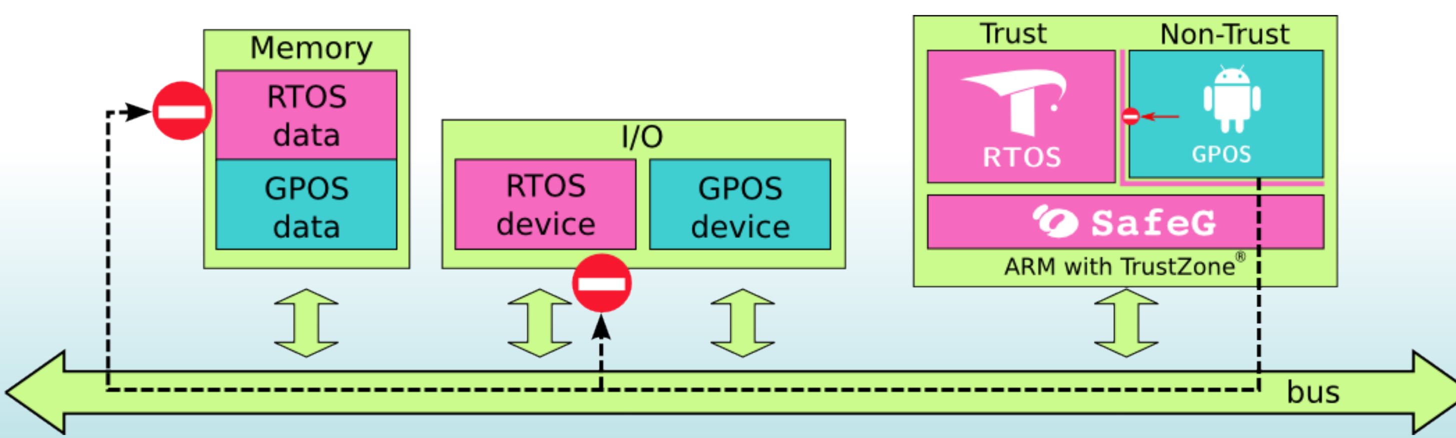
ESEMPIO DI TIROCINIO (2015)

Porting del monitor SafeG su processore multicore Freescale iMX6 (1/2)

- www.toppers.jp/en/safeg.html
- Asymmetric multi-processing (Linux + RTOS)
- TrustZone

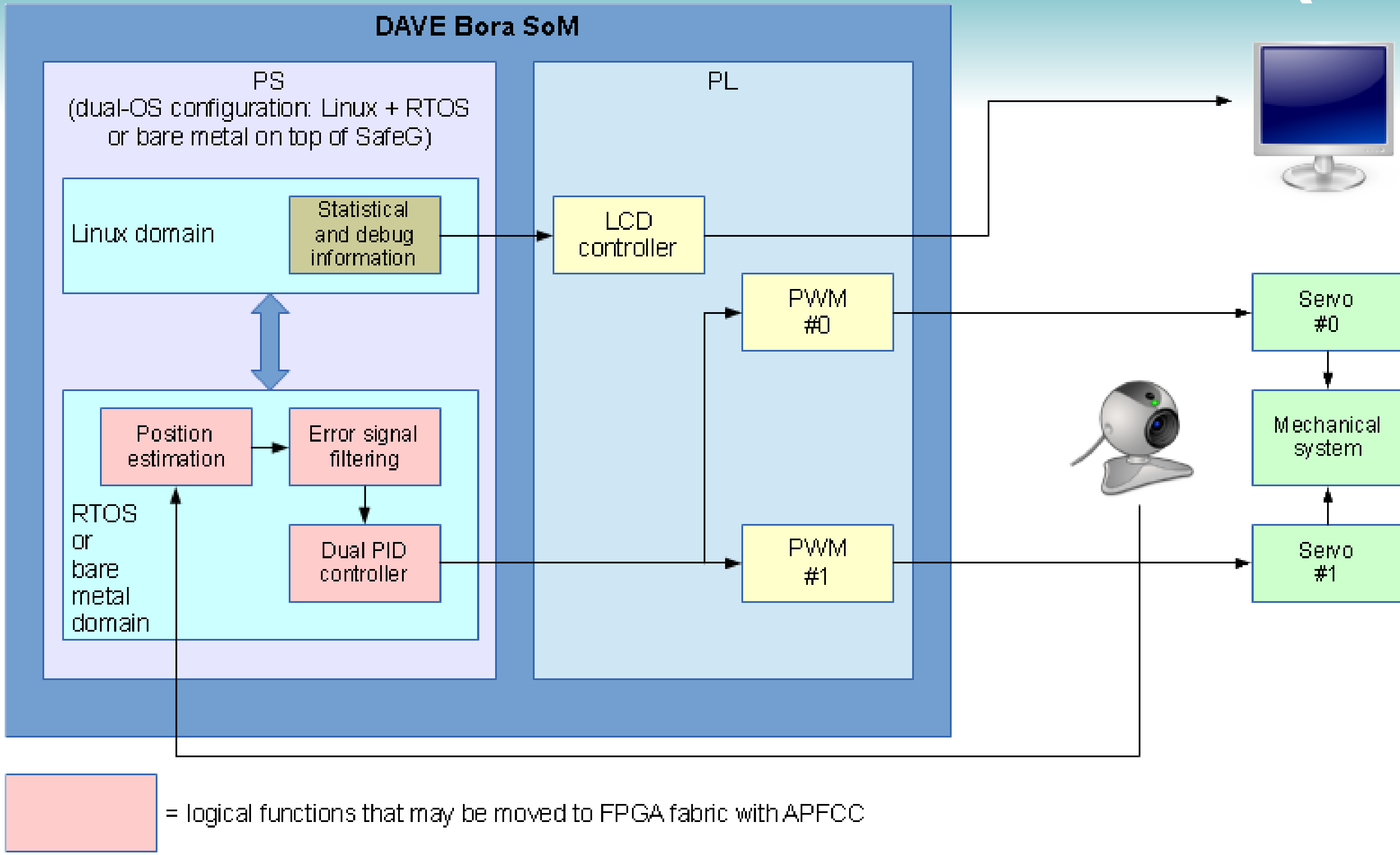




ESEMPIO DI TIROCINIO (2015)

Porting del monitor SafeG su architettura multicore ARM CortexA9 (2/2)

ESEMPIO DI TIROCINIO (2015)



The internship aims at implementing on Bora platform (Zynq based) a real-time detection and control system. This system is used to keep the balance of a mechanical system by acting on two servo motors. Servos are driven by independent PID controllers via PWM IPs implemented in FPGA. PID controller are fed by a signal error generated by image processing algorithms applied to a video stream. Video stream is generated by a camera shooting the mechanical system itself.
Time consuming portions of software are hardware accelerated, meaning that they are implemented in FPGA via high level languages such as C and C++.

ESEMPIO DI TIROCINIO (2015)

Accelerazione di algoritmi di elaborazione video in FPGA (2/2)

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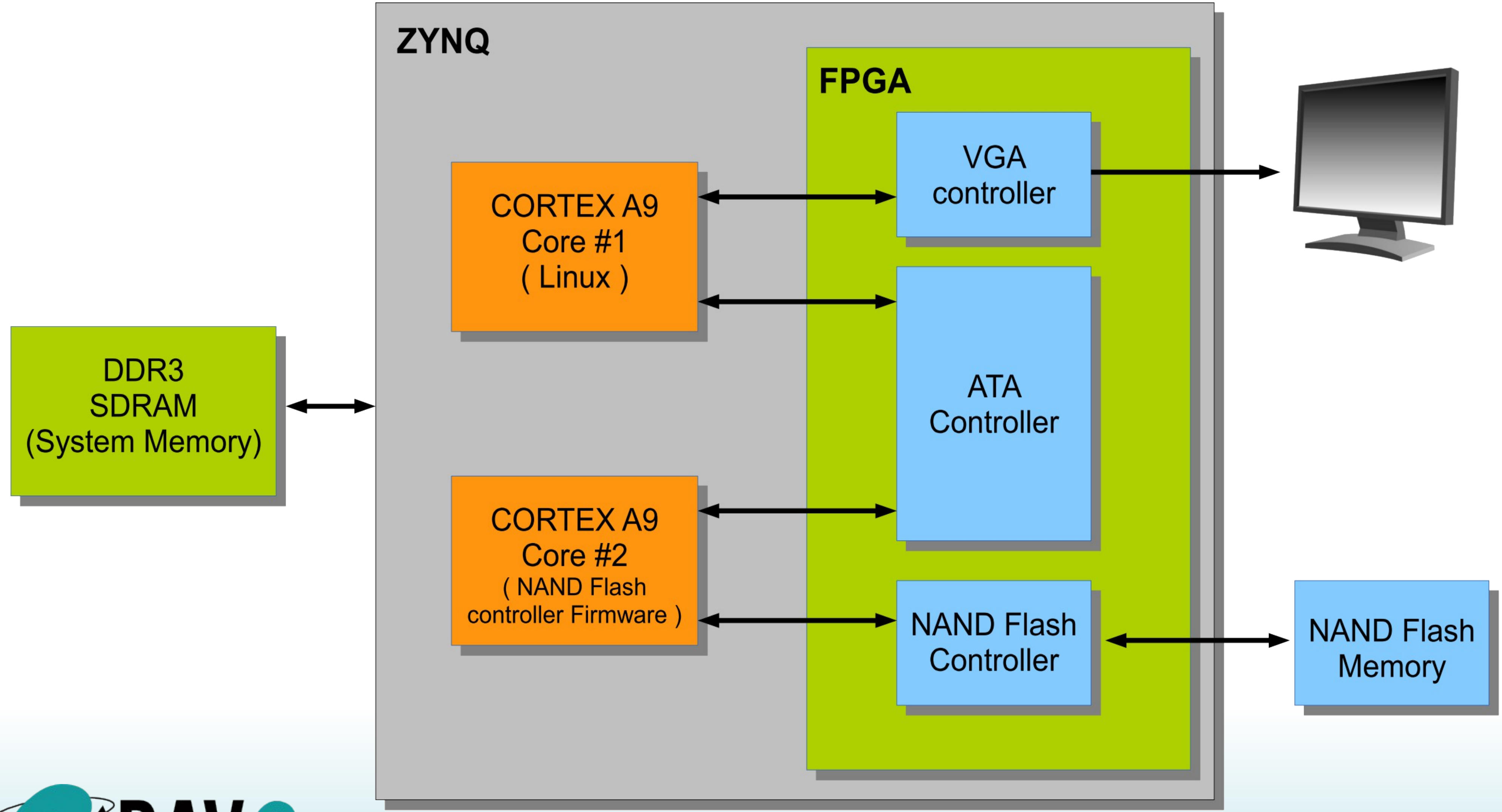
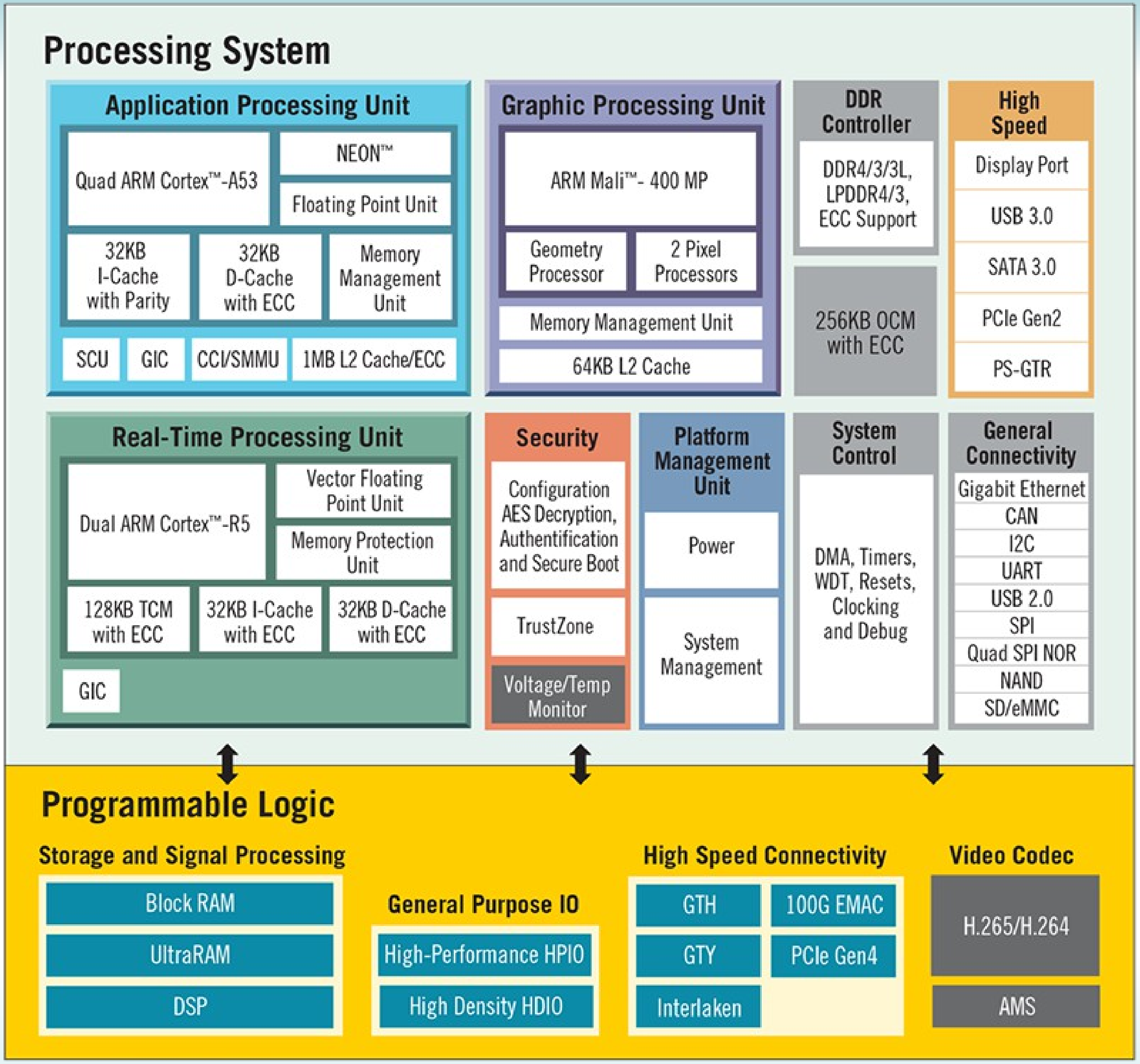
ESEMPIO DI TESI MAGISTRALE (2013)

Implementazione di un controller per Solid State Disk (SSD) su architettura Zynq AMP (Linux + bare metal)



What's next: Zynq UltraScale+™ MPSoC



Note: Illustration not drawn to scale.

Stay hungry, stay Foolish

S. Jobs

Detto in maniera meno altisonante:

- avere 20 anni capita una volta nella vita (Einstein ha pubblicato la teoria della relatività ristretta a 26 anni!)
- siate curiosi e assorbite più che potete!

Trieste Mini Maker Faire

FABLAB UDINE

CV di un vostro “concorrente” indiano:

- 26 anni
- Bachelor of Engineering Electronics and Communication Engineering
- C, C++, Assembly, Java, RCP, Android, Shell, Batch scripting
- German (basic), English (fluent), French (intermediate)
- Master of Science: Control and Embedded Instrumentation, ESIGELEC, Rouen (France)
- Master of Science: Embedded System and Instrumentation, Manipal University, Manipal (India)
- **Internship at Texas Instruments GmbH, Munich (Germany)**
- **Internship at Texas Instruments GmbH, Nice (France)**

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CONTATTI

stages@dave.eu

Q&A

DAVE S.r.l.

Via Talponedo, 29/A
I-33080, Porcia (PN) Italy

Tel +39 0434 921215
Fax +39 0434 1994030

www.dave.eu
info@dave.eu
wiki.dave.eu