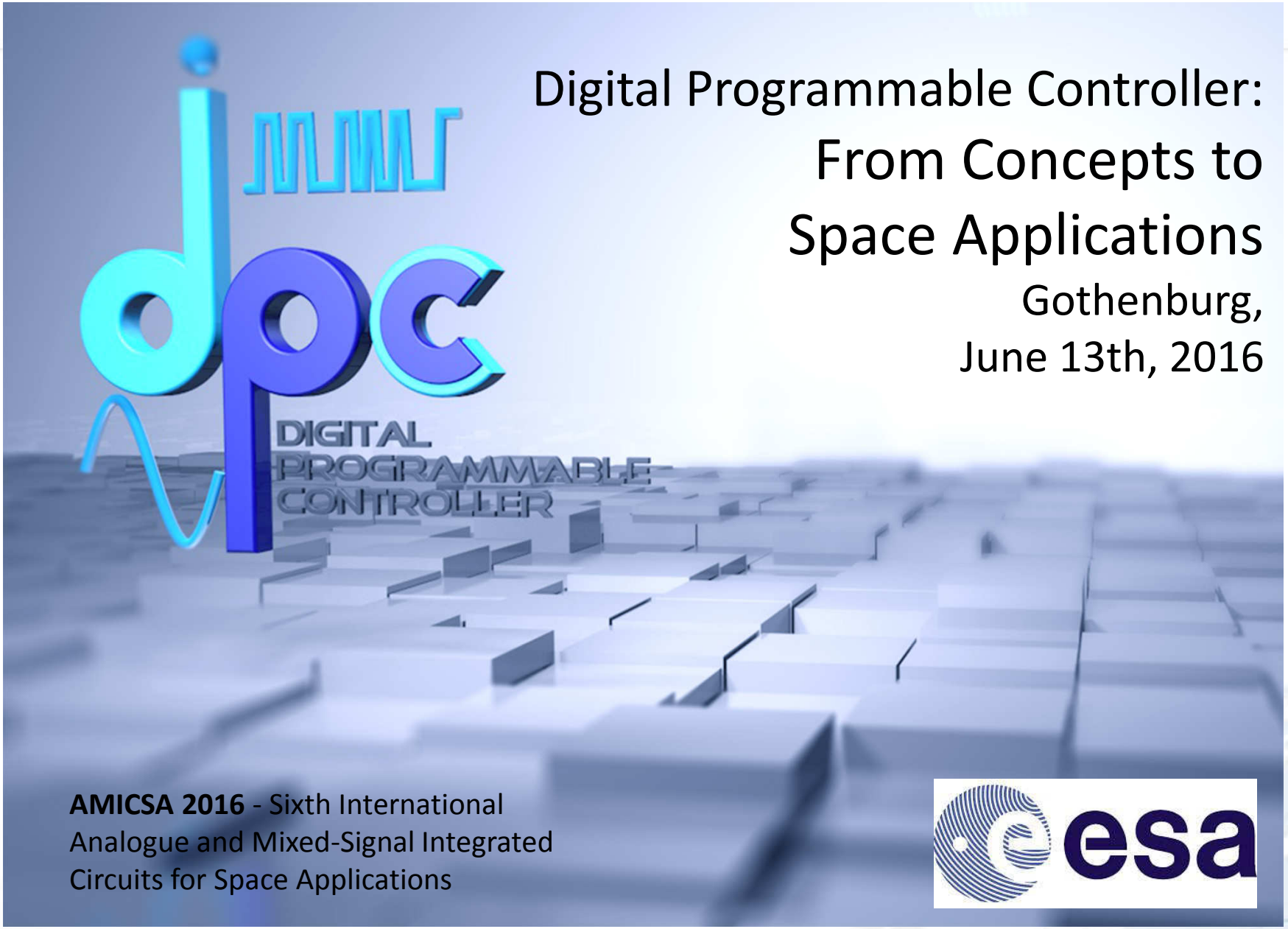
Digital Programmable Controller: From Concepts to Space Applications

Gothenburg,
June 13th, 2016



AMICSA 2016 - Sixth International Analogue and Mixed-Signal Integrated Circuits for Space Applications

esa

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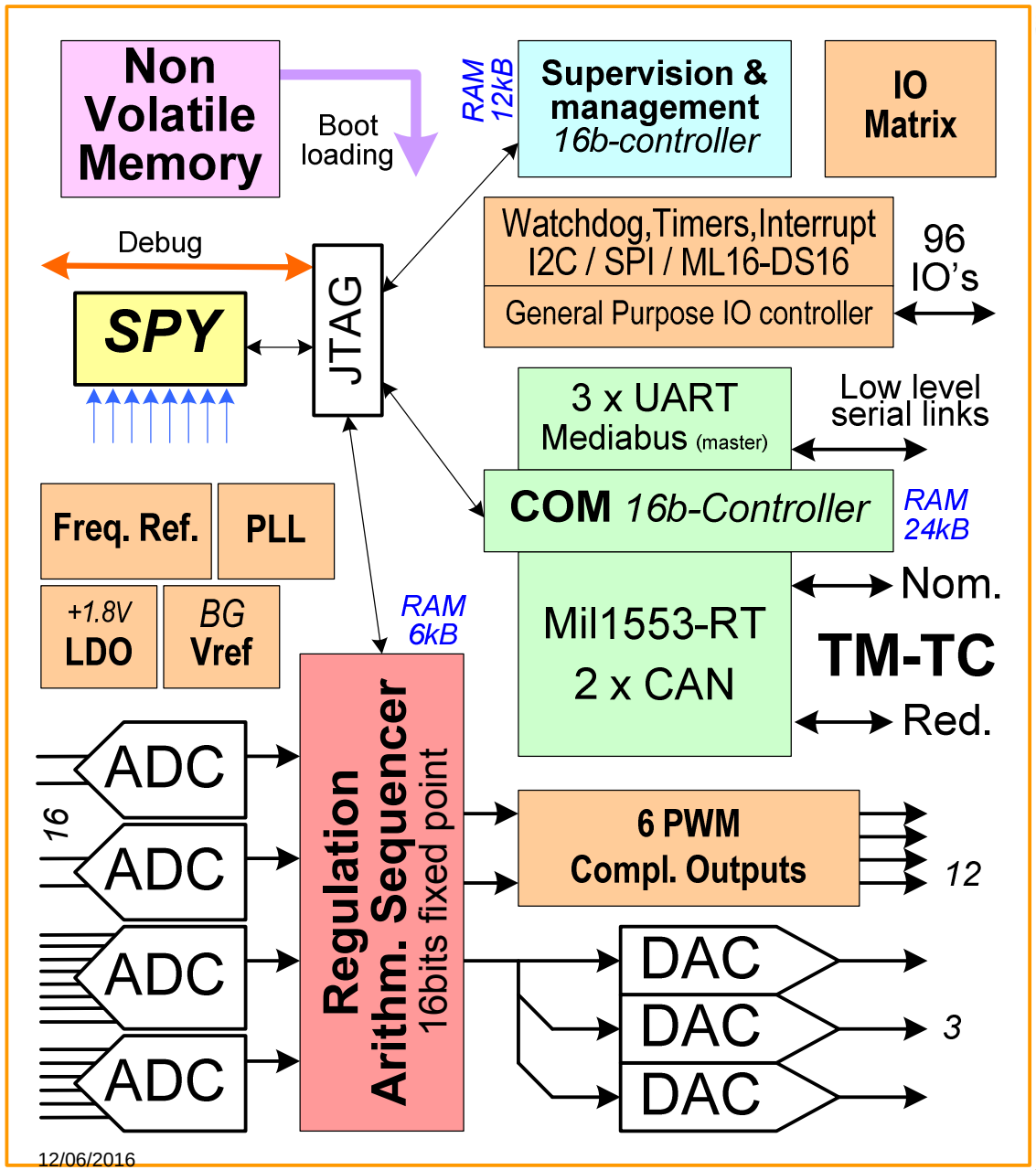
DPC Overview (reminder)



12/06/2016

On chip :

- 4x CPU 16bits OpenMSP430
- No OS / One CPU = one task
- 42K memory
- RC oscillator + 120MHz PLL
- LDO +1.8V
- Bandgap
- 13bits ADC + input MUX
- 12 Bits DAC

Off Chip:

- E2prom
- +3.3V regulator

DARE on UMC 0,18µ

CQFP 256 pins

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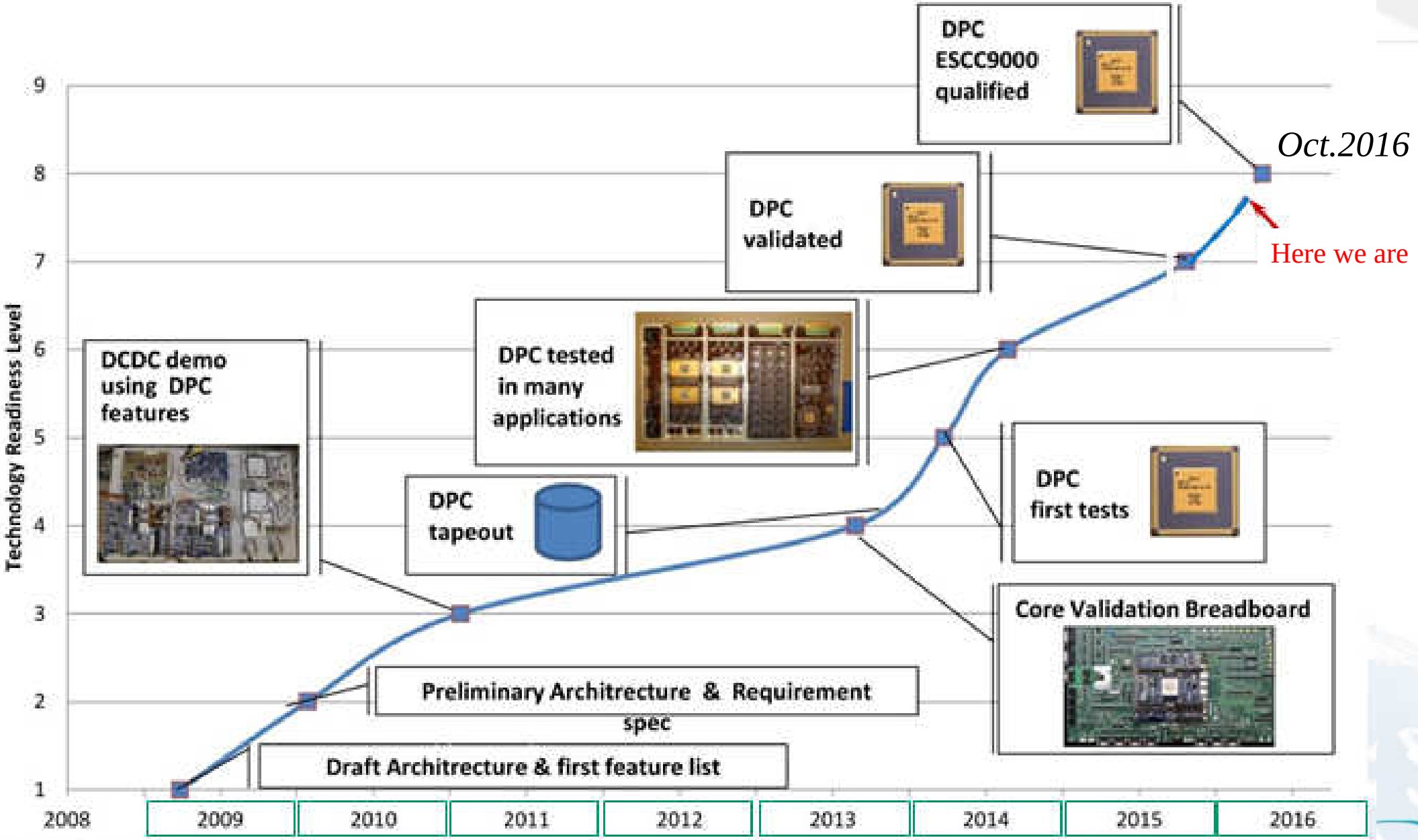
TRL evolution vs. time



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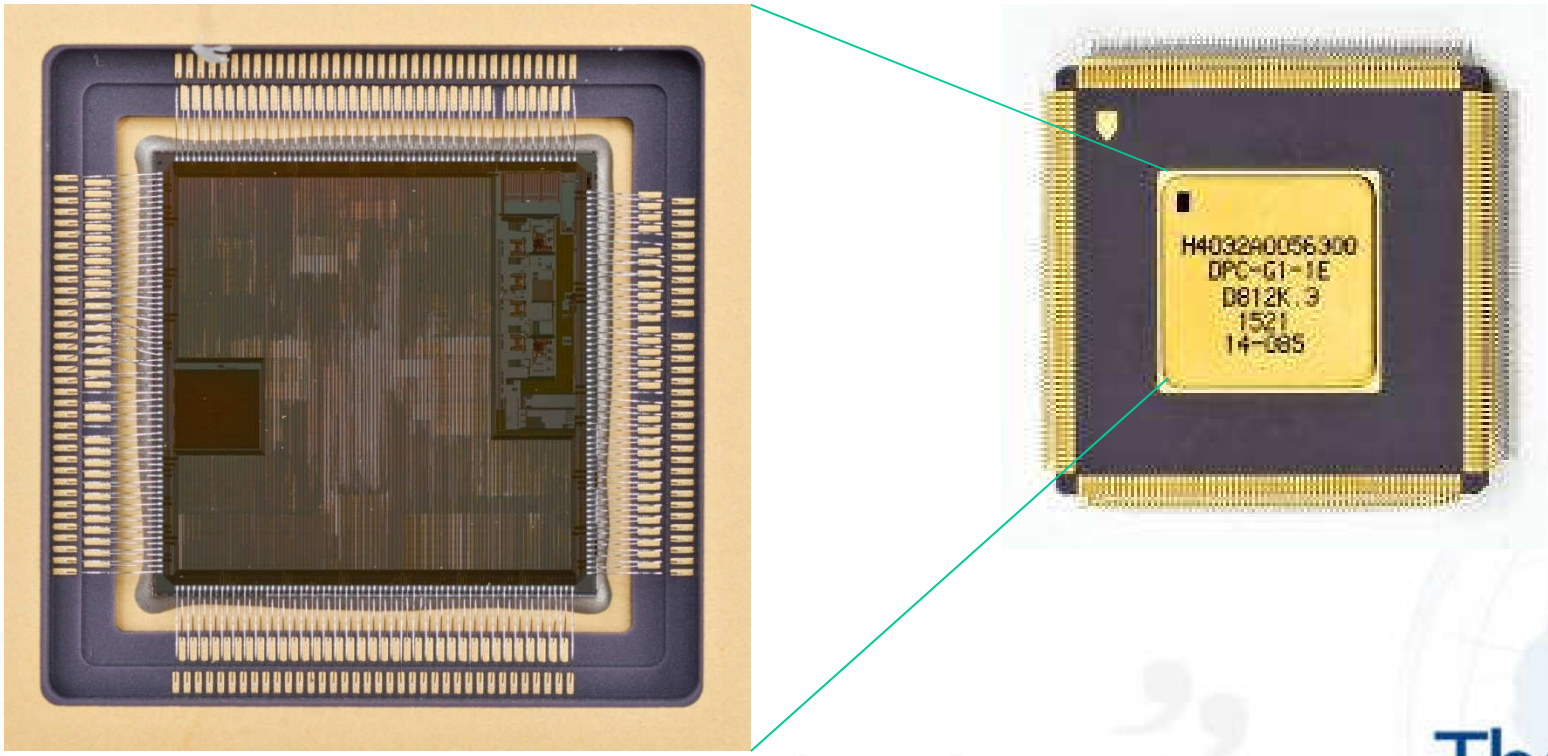
Current DPC status

- DPC enters its latest qualification phase.
  - ESCC9000 completion planned Oct ‘16.

- First Flight Models are in production now.



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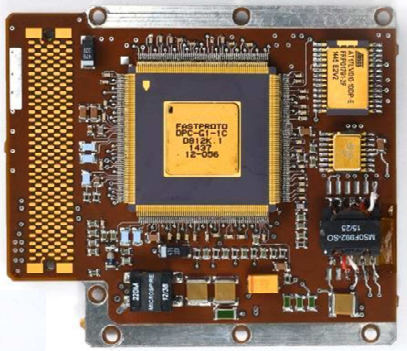
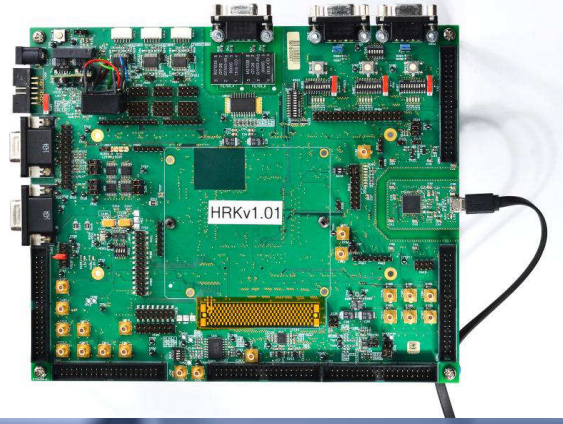
Space Applications

DIGITAL PROGRAMMABLE CONTROLLER





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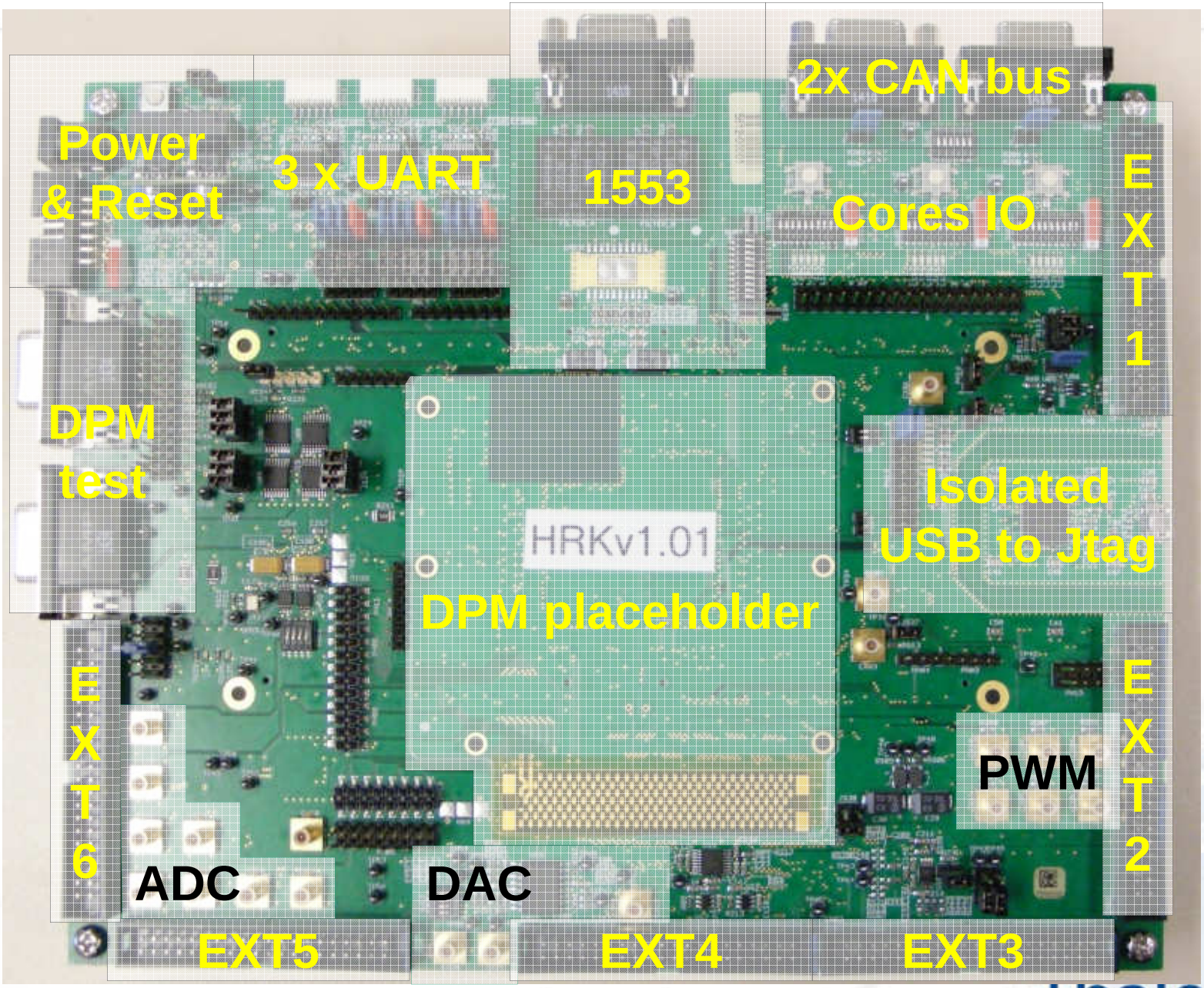
DRK board: multiple interfaces



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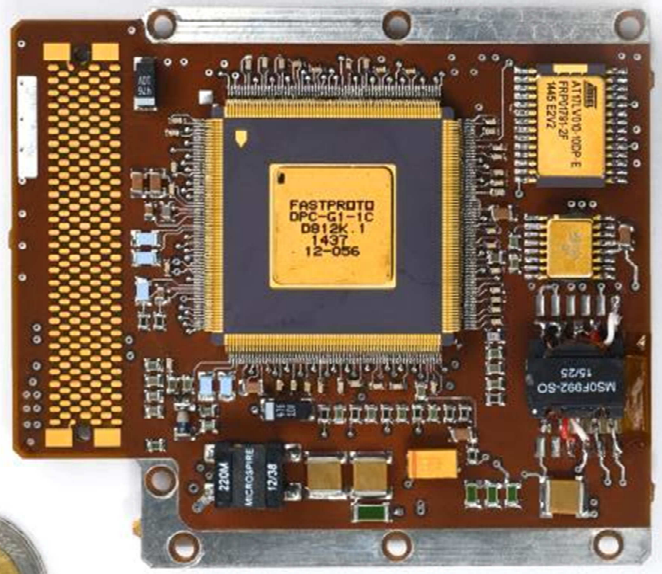
Software Toolchain: widely based on Open Source Tools

Tool Name	Function
msp-gcc	Open source tools for MSP-430, including: • compiler: msp430-gcc • Linker: msp430-ld • Object dumper: msp-objdump • Debuggers: msp430-gdb • Instruction simulalor: msp-debug • Size analysis: msp430-size
dpc-minidebug	Hardware-oriented graphical interface tool enabling simple interaction with the DPC openMSP430 cores. Allows examining and patching registers and memory, setting breakpoints, halt, run and step by step execution.
dpc-gdbproxy	Provides the proxy function for GDB. Replaces the msp430-gdbproxy provided by the mspgcc toolchain.
dpc-pkt	Transforms .elf file in a format compliant to the packet definition.
dpc-gdbproxy	Provides the proxy function for GDB. Replaces the msp430-gdbproxy provided by the mspgcc toolchain.
dpc-pkt	Transforms .elf file in a format compliant to the packet definition.
dpc-programmer	NVM programmer tool and global loader. Writes hardware configuration and program packets in the NVM or loads them directly in the DPC and cores memory through the boot manager.
dpc-configuration	Hardware configuration packets editor.
dpc-crc16	Utility to compute and check the CRC on hardware configuration and programming packets.
Mspdebug	Used in DPC as a MSP430 simulator.

DPM = DPC Plugin Module

- Use of existing building blocks
  - Reference PBA design or mezzanine
  - CAN interface (HW & firmware) ready

DPC+2xCAN+LCL+dc-dc



DPM

  - Focus on new applications
  - No re-design
  - Standard & stable back-plane I/F
  - Stable routing of complex function
  - Firmware validation at DPM level
  - Easier partnerships

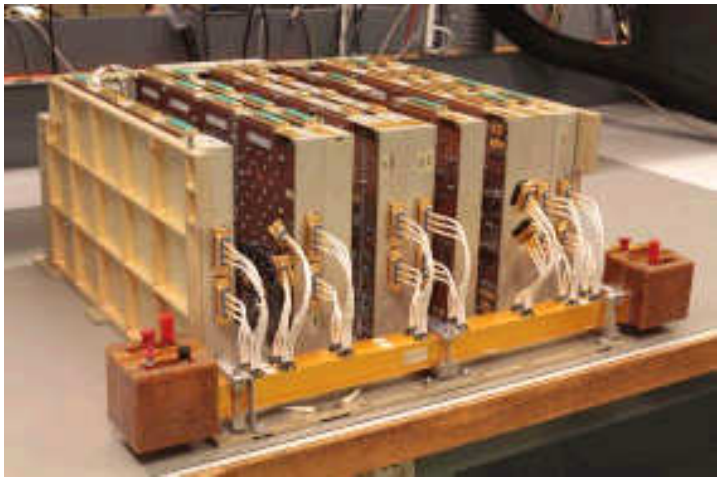
- Available Q4-2016

DPC in space applications

2014

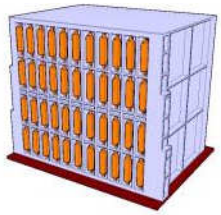
HIGH POWER AVIONICS

- Modular PLDIU & PFDIU for SB NEO
- Full power distribution and avionics
- CAN backplane bus
- 1 DPC per board



MEDIUM POWER AVIONICS

- Application programs:
  - Science & observation
  - Exploration



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DPC in space applications

Miscallaneous equipment

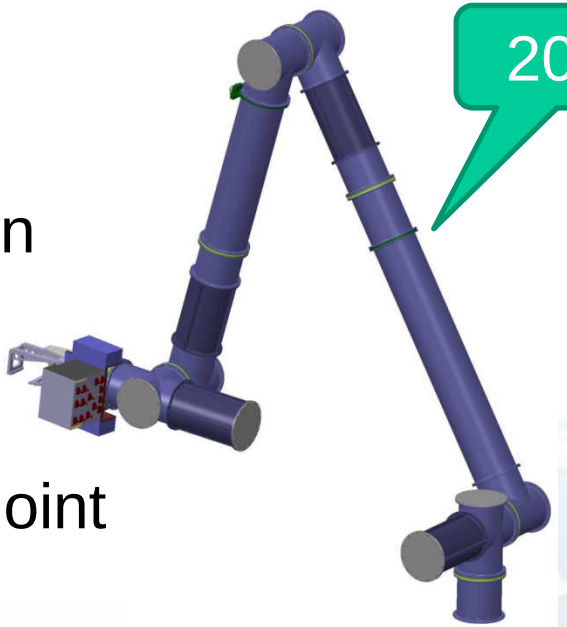
2016

ONERA
THE FRENCH AEROSPACE LAB

- ONERA: Gyroscopes
  - Stimuli, acquisition, processing & reporting

- DLR: robotic arm
  - BLDC Motor Control
    - local power supply with latch-up protection
    - motor power inverter
    - communication and control unit
    - joint torque and position sensor for each joint
    - motor commutation sensor

2016



DLR

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- Olivier Girard , who spent hours in the design of the openMSP430 core and has finally posted it in free BSD licence available to anyone's usage on internet
- M. Durvaux for its clever guidance in the selection of this processor, the top-level chip architecture.
- ONERA and specially Dr Jean Guerard for the feedback he provided as "customer using the DPC" that helped us to improve the efficiency of the DPC development tools.
- Mr. Hans Juergen Sedlmayr from DLR for his kind support in publishing this preliminary information on testing the DPC in a robotic context.

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Conclusions

DPC ASIC status

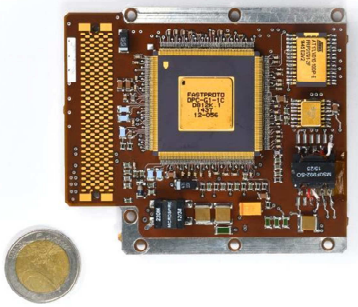
- DPC enters its latest qualification phase. ESCC9000 completion planned Oct ‘16.
- First Flight Models ASICs are in production now.

DPC-based applications

- Many DPC-based applications are already in lab validation, not only in Thales.
- External parties have already developed their own application with the DPC

Availability

- Lab Evaluation boards (DPC Reference kit DRK) are available now.
- DPC Plugin Modules (DPM mezzanine) will be available Q4 2016.
- DPC public data sheet available very soon on ESA website



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