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
DPC Overview (reminder)

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
TRL evolution vs. time


Here we are
Current DPC status

DPC enters its latest qualification phase.

ESCC9000 completion planned Oct ‘16.

First Flight Models are in production now.
Space Applications
DRK board: multiple interfaces

Power & Reset
3 x UART
1553
2x CAN bus
Cores IO
Isolated USB to Jtag
DPM test
DPM placeholder
PWM
ADC
DAC
EXT1
EXT2
EXT3
EXT4
EXT5
EXT6

12/06/2016
# Software Toolchain: widely based on Open Source Tools

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

Use of existing building blocks
- Reference PBA design or mezzanine
- CAN interface (HW & firmware) ready
- 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+2xCAN+LCL+dc-dc
DPC in space applications

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

12/06/2016
DPC in space applications

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
Acknowledgements

ESA project team for their great support and many advices in conducting this project: Richard Jansens, Claudio Monteleone, David Sanchez de la Llana, Cesar Boatella, Rok Dittrich, Matthias Gollor, Jesus Rancano, King Lam …. and their colleagues.

IMEC and ICsense development teams.

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.
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