CAN in Space Workshop: CAN backplanes and DPC ASIC

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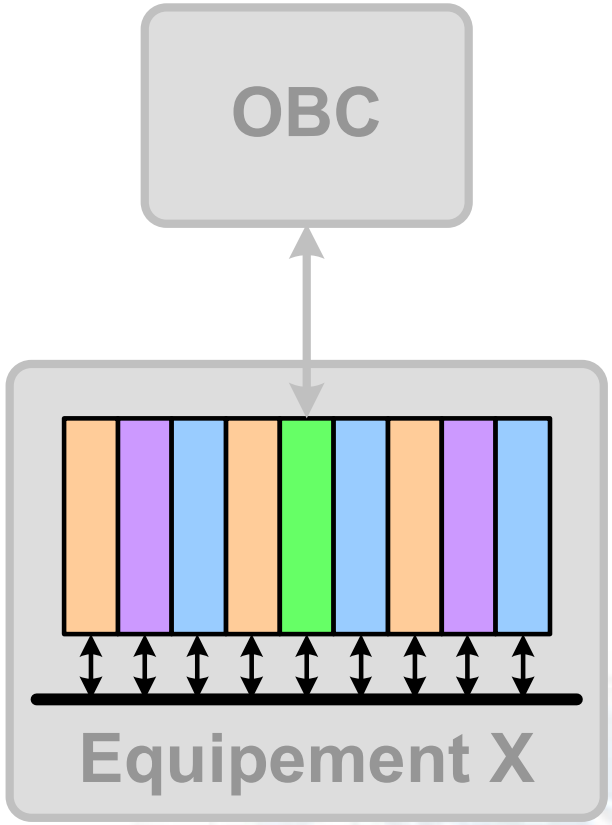
What are the needs ?

- **TM/TC exchange on a bus**
  - Reliable
  - EMC friendly
  - Simple & low cost
    - Development & recurrent cost
  - Low power consumption
  - Modularity
    - Multicast feature
    - Synchro & time distribution feature
  - Interoperability



Why CAN ?

CAN has won the trade-off (CAN – SpaceWire – UART – SPI – I²C …)

Reliable	Widely used in automotive – good supply chain
EMC friendly	Slow physical layer
Simple & low cost	Simple physical layer – only 2 wires
Low power	Slow physical layer (ex: 20mW)
Modularity	Layered protocol approach: no need of unused feature
Multicast feature	✔
Synchro & time distribution	✔
Interoperability	Standardized – Well supported by commercial tools

CAN is not perfect: limited 1Mbps bitrate, no galvanic isolation

CAN useful features

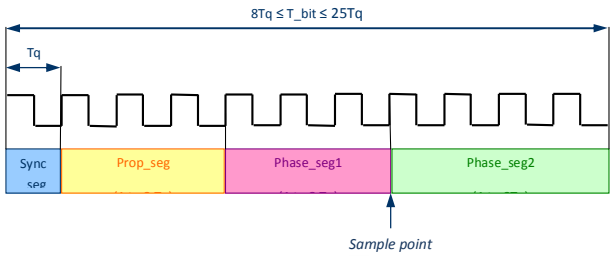
- Layer organization
  - Mandatory features available off-the shelf
  - Only implement useful services

OSI Model Layer	Function	Relevant services
7. Application	Access to the services	TC transfer TM acquisition
6. Presentation	Data management	Object Dictionary
5. Session	Communication management	CANOpen SDO
4. Transport		Expedited Domain transfer Block Up/Download
3. Network	Access to modules	Framing
	Acceptance filtering	
2. Data Link	Data encapsulation Frame coding (stuffing) Acknowledgement Specification variation (STD/EXT)	CAN ISO 11898-1
1. Physical	Bit Encoding/Decoding Synchronization CAN High Speed	Physical transport

Mandatory

CAN useful features

- **The PHY layer**
  - Variety of standard **off-the-shelf** transceivers
  - EMC friendly – smooth waveform transitions
  - Simple:
    - 2 wires
    - Accurate impedance control & connectors not required
  - Differential – high common mode rejection
  - Asynchronous
    - ±1% ~ ±3% node clock deviation allowed
    - Crystal oscillator not mandatory



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CAN useful features

- **The data link layer**
  - Variety of standard **off-the-shelf** IPs
  - Take care of the message transmission & error handling
- **The service layer « CANopen » (optional)**
  - Up to now, TAS-B has used:
    - Object dictionary
    - COB-ID for service addressing
    - PDO/SDO messaging protocols
    - SYNC for TM/TC synchro between modules
    - TIME for TM time stamping

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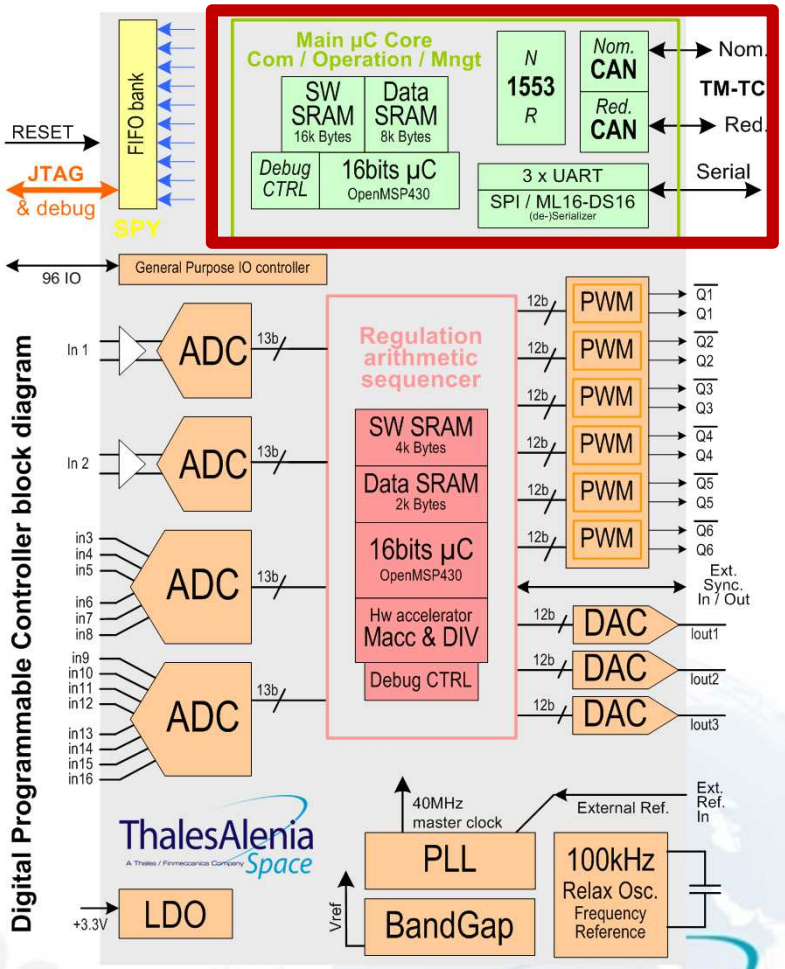
CAN backplane implementation with the DPC ASIC

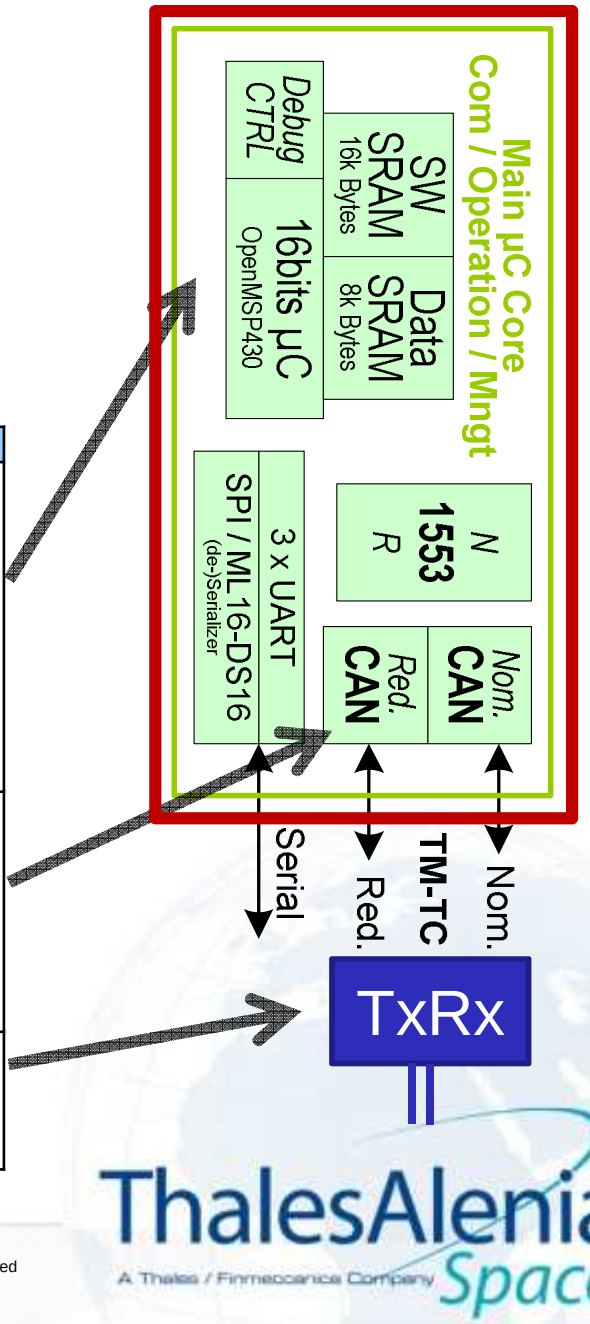
- DPC micro-controller ASIC :
  - 3 x 16bits OpenMSP430 CPUs
  - 42kB memory
  - RC oscillator + 120MHz PLL
  - LDO +1.8V – Accurate Vref
  - 4 x 12 bits 1Msps ADCs + input MUX
  - 4 x 12 bits 1Msps DACs
  - 6 x dual PWM generators
  - Support for **CAN**, 1553, SPI, I²C, UART
  - Radiation hardened
  - US export constraint free



CAN backplane implementation with the DPC ASIC

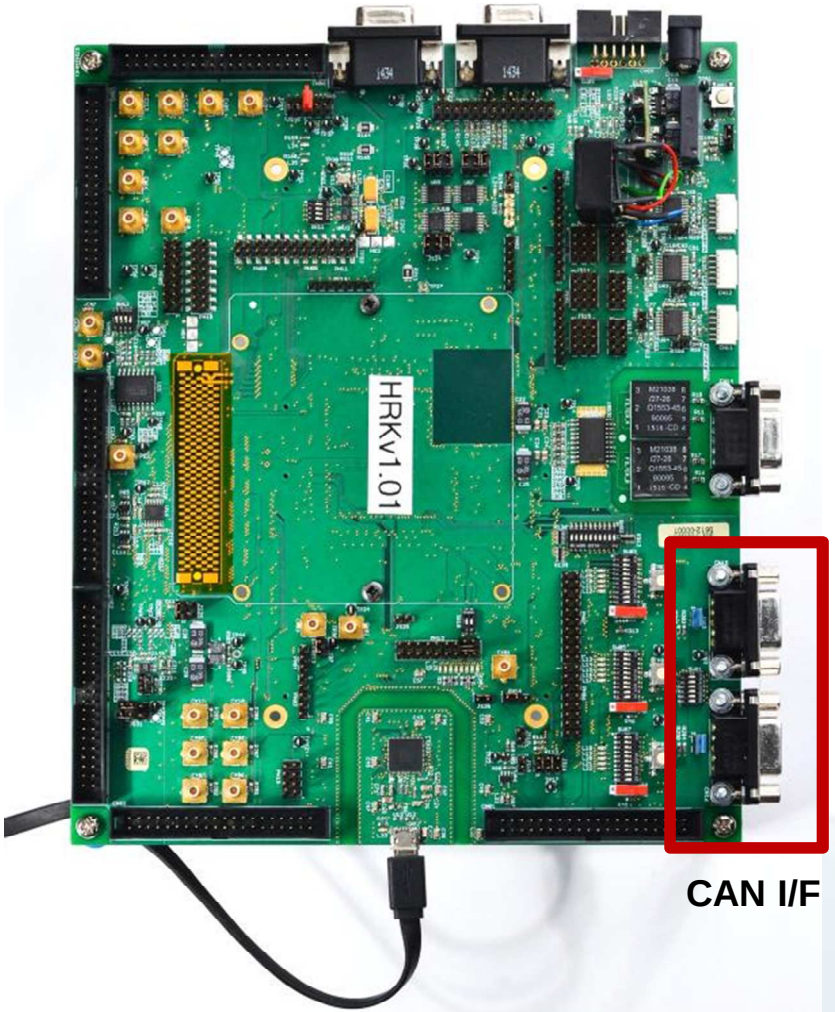
- Off-the-shelf transceiver
- Hardwired CAN IPs (2x)
  - Supervised error handling – Used in master-slave
- CANopen in firmware
  - Re-usable code

OSI Model Layer	Function	Relevant services	Implementation
7. Application	Access to the services	TC transfer TM acquisition	Firmware
6. Presentation	Data management	Object Dictionary	
5. Session	Communication management	CANOpen SDO	
4. Transport		Expedited Domain transfer Block Up/Download	
3. Network	Access to modules	Framing	
2. Data Link	Acceptance filtering Data encapsulation Frame coding (stuffing) Acknowledgement Specification variation (STD/EXT)	CAN ISO 11898-1	DPC CAN IP
1. Physical	Bit Encoding/Decoding Synchronization CAN High Speed	Physical transport	CAN transceiver 1Mbps



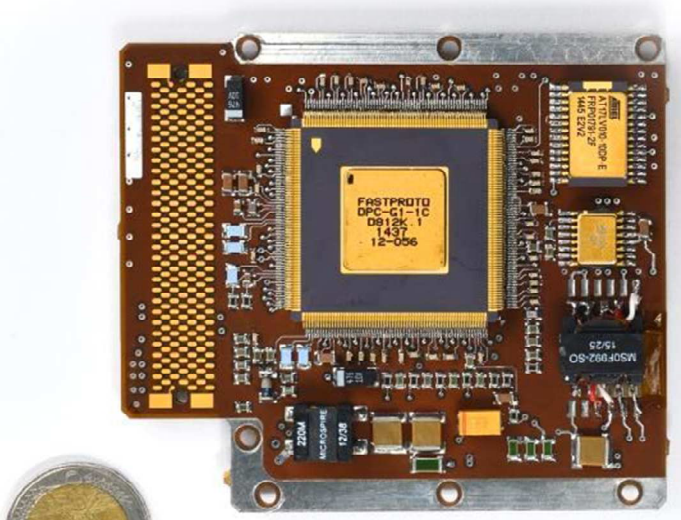
Fast prototyping & FM development process

- Prototyping means
  - HW: reference kits ready-to-use:
    - DPC ASIC
    - CAN transceivers (x2)
    - Access to all DPC features
  - Firmware: tool chain
    - Tool chain framework
    - Re-use of CAN communication controller
- Fast prototyping
  - Focus on the new application
  - CAN interface (HW & firmware) ready



After prototyping: FM design

- Use of existing building blocks
  - Reference PBA designs 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 upload & validation at DPM level
  - Easier teaming agreements
  - **Risk management**

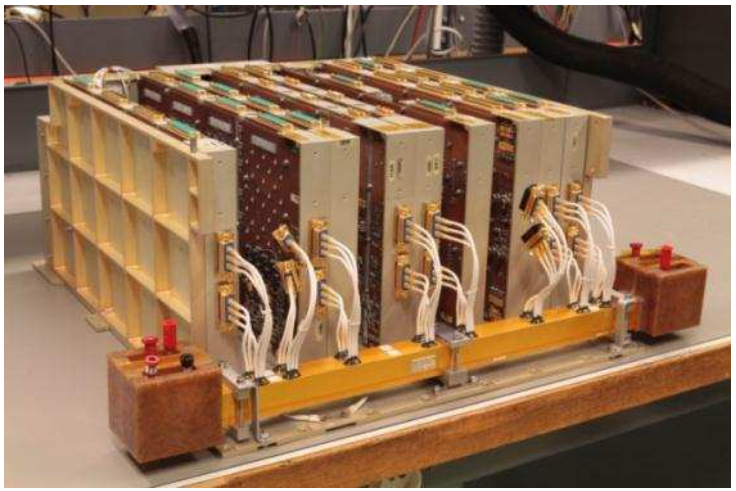


DPM = DPC Plugin Module

Example of existing modules with CAN interfaces / backplanes

HIGH POWER AVIONICS

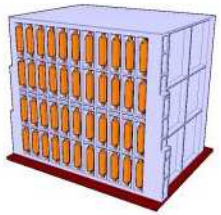
- Modular PLDIU & PFDIU for SB NEO
- Full power distribution and avionics
- CAN backplane bus
- DPC based solution

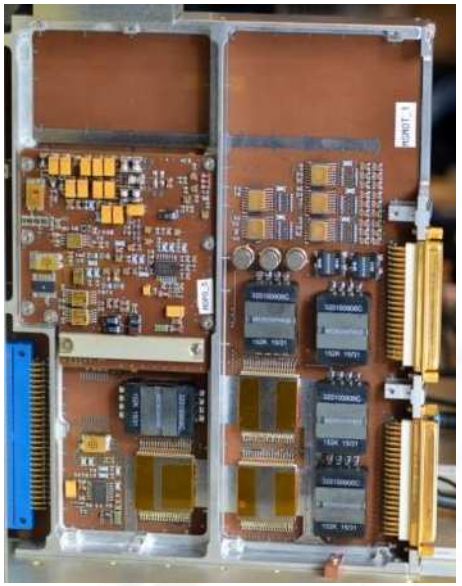


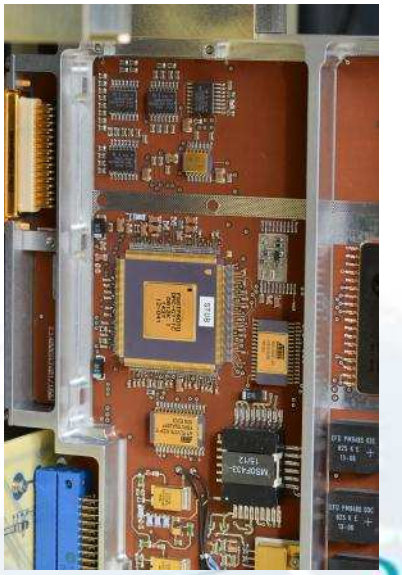
Qualif foreseen Q4'2016

MEDIUM POWER AVIONICS

- Application programs:
  - CERES & SWOT
    - With partners
  - Exomars CRTU
    - With partners
  - Others







Summary

- The CAN perfectly fulfil backplane TM/TC needs
  - Flexible
  - Simple – Low cost – Low power
  - EMC friendly
- Versatile programmable building blocks available
  - Including development means (HW & SW)

- Thanks !