Radiation tolerant developments: Common Building Blocks

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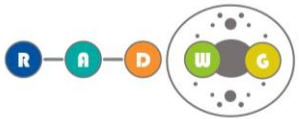
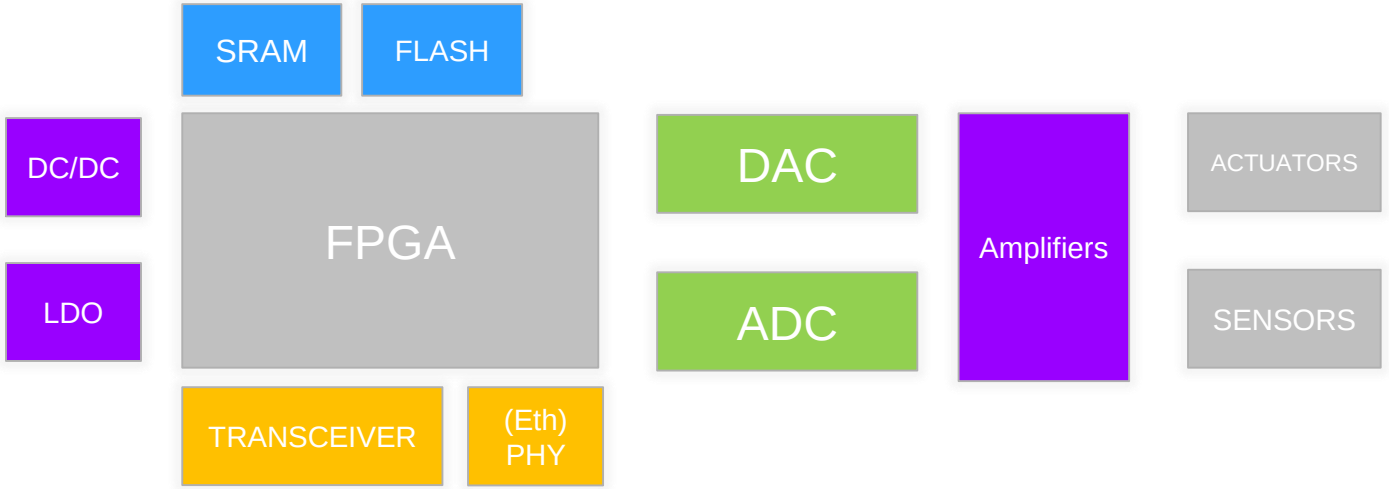


Main Groups Development Activities

Team	Activity	Devices components			System	Type
		Analog	Digital Mixed	Power		
TE/MPE	QPS	x	x		Custom	COTS
TE/EPC	Power Converter	x	x	x	Custom	COTS
TE/CRG	Cryogenics	x	x		Custom	COTS/Rad hard
TE/MPE	Interlock and Kicker	x	x	x	Semi-Custom	COTS
EN/STI	Radiation Monitor	x	x		Custom	COTS
BE/BI	Beam instrumentation	x	x		Custom	COTS/Rad hard
BE/RF	RF Cavities	x		x	Custom	COTS
BE/CO	Control equipment	x	x		Custom	COTS
EN/MEF	Survey	x	x		Custom	COTS
TE/VSC	Vacuum equipment	x	x		Semi-Custom	COTS
IT	IT tools		x		Semi-Custom	COTS
EN/EL	Light, LED	x			Semi-Custom	COTS
GS/ASE	Safety, Alarms	x	x		Semi-Custom	COTS
EN/STI	Radiation test activities	x	X	x	-	-

- Components
  - Analog → everyone
  - Digital → everyone
  - Power → increasing interest in different groups
- COTS components for RadTol Systems
  - Not all COTS are RadTol

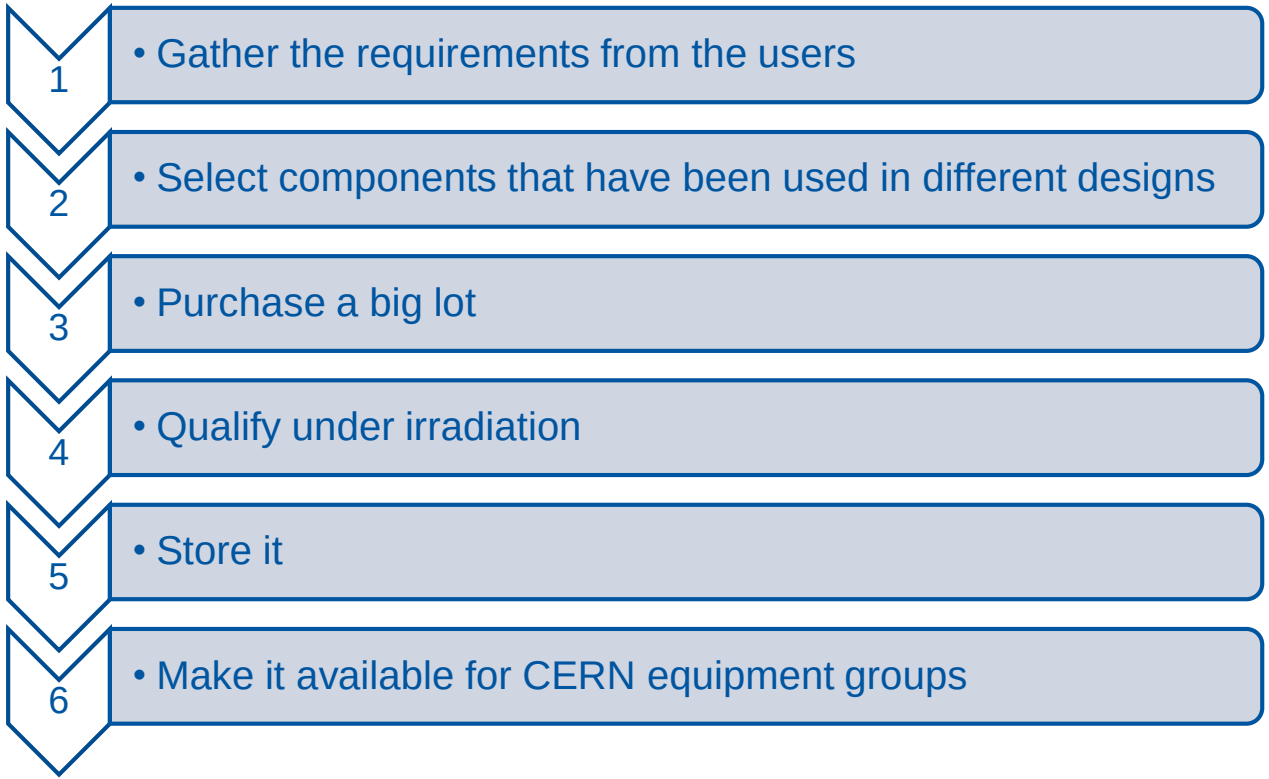
Typical System Architecture



Common Building Blocks - Developments

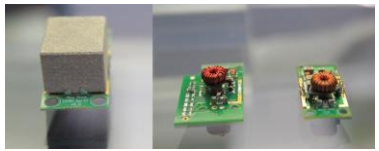
- What are common building blocks?
  - Components that are of general use and can be found in many systems
  - ADC/DACs, FPGAs, µControllers, voltage regulators etc.
- What are common Developments?
  - Solutions made to serve a specific application, but can be easily adapted to more global solutions
  - R2E assures communication that allows common developments

Strategy for common building blocks



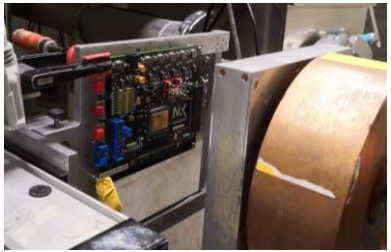
Common Blocks Status

- Currently several solutions are investigated by the R2E project and other groups that will serve the common interest
  - Catalogue of qualified parts that groups can use to pick up components
- FPGA is flagship of common blocks as it is a key component for both the Accelerator Sector and Experimental Physics Department
  - a lot of work around new COTS FPGA (SmartFusion2)
  - Investigation on radhard SRAM-based FPGAs NanoExplore
  - Investigation on µControllers
- ADC/DAC solutions
  - In search of different resolution/speed solutions that are robust for CERN environment
  - Several parts that can fit the needs of everyone
- Power supplies
  - FEAST is already a common building block from EP that serves the entire CERN
  - Voltage regulators → plethora of references to cover all requests



Common Blocks Candidates

- Strong interest from A&T in rad-hard/Rad-Tol FPGAs
- Preventive approach for characterization needs
  - Work ahead of our time
- Mostly used and most complex block of a design
  - It takes months and a lot of effort to characterize an FPGA
- NanoExplore -> BRAVE FPGA NGMedium/NGLarge
  - Full European, ESA/CNES/Airbus/TAS supported
  - TID > 3kGy
  - Solution for all groups at CERN (i.e also EP for the ELMB++)
  - Organized an hands-on training session in January



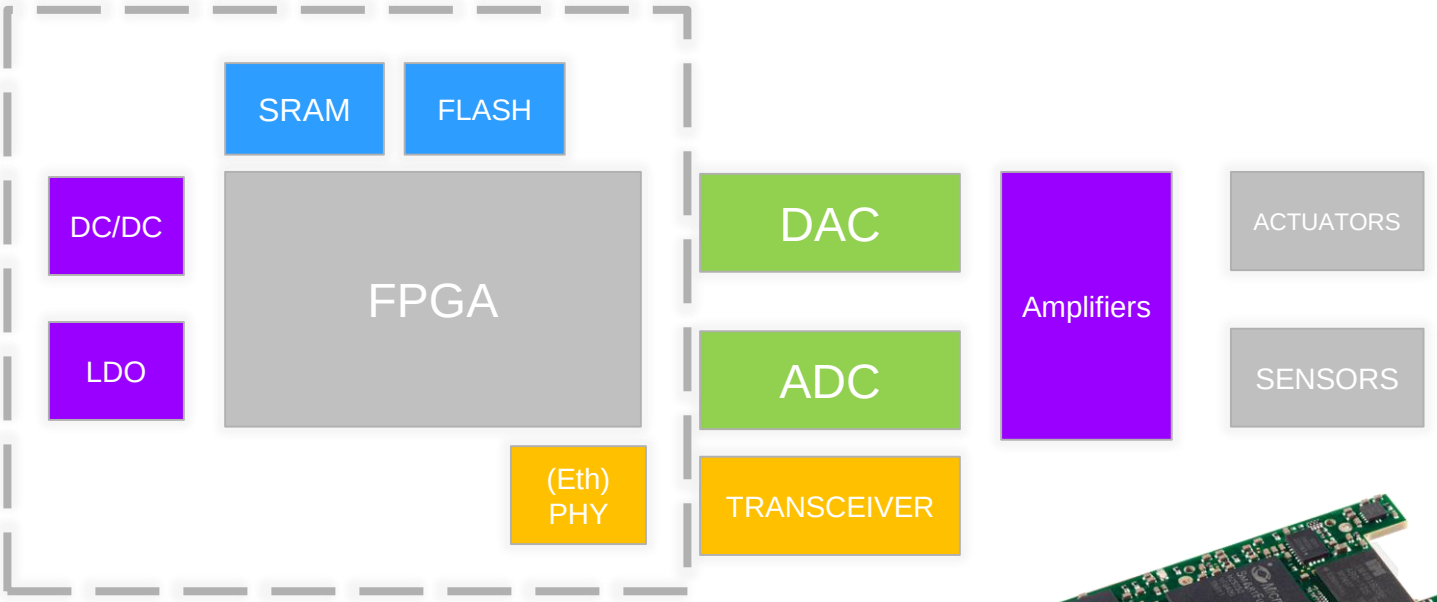
Common Blocks - Components

- Throughout 2018 we tested several components for the common blocks that the A&T can profit
- 65nm Cypress SRAM memory with embedded ECC
- Several FLASH memories with SPI for FPGA reconfiguration but not only (target 500Gy)
- 12-bit SPI ADC and above (PSI)
- DC/DC and AC/DC converters (tests at CHARM)
- Optocouplers
- MOSFETs (NMOS, PMOS)

Selection started

Reference	type	edms report	TID (Gy)
LT1236A	Voltage reference	1319268	500
MAX5541	16-bit DAC	1380070	1000
ADS1281	24-bit output ADC	1380069	1000
ADS7852Y	12-bit ADC	1387205	500
THS4130	Differential Amplifier	1581959	500
TPS7A4901DGNT	linear voltage regulator	1752855	500
TPS7A3001DGNT	linear voltage regulator	1752855	500
OPA2192	rail to rail amplifier	1839551	750
NanoExplore NGMedium	RadHard FPGA		3000

System On Module common building blocks



Two SOM:

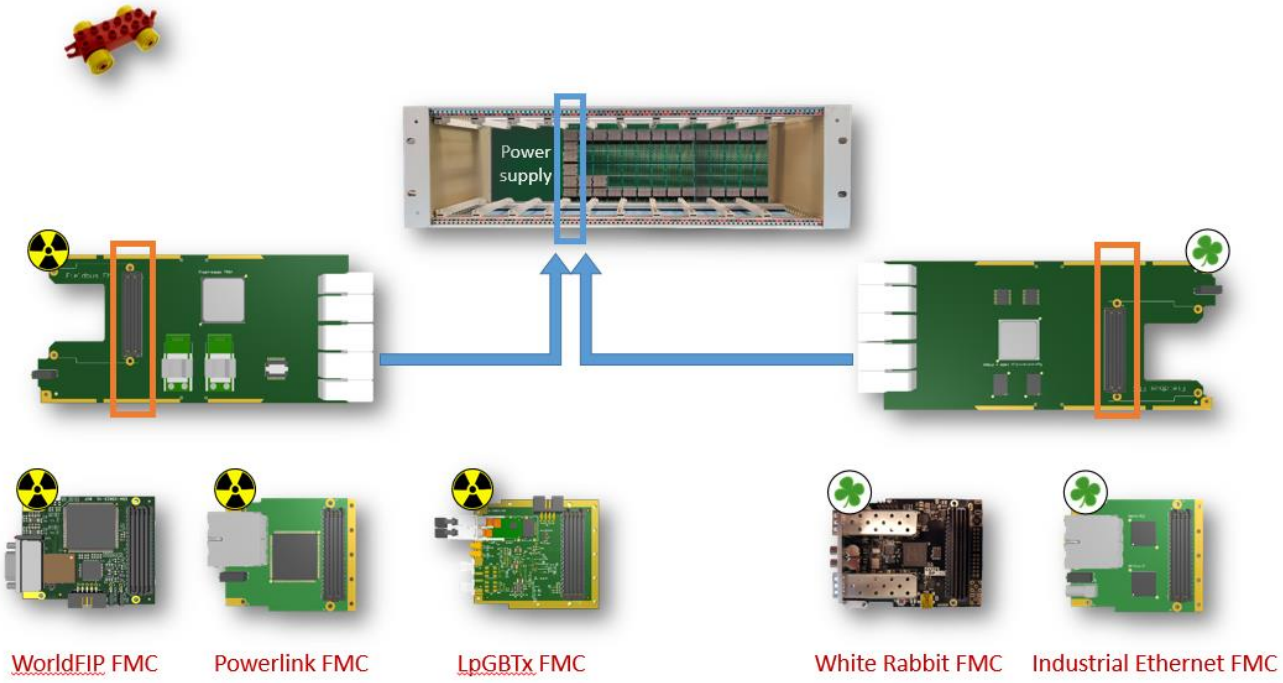
- With NGMedium radhard FPGA
- With SmartFusion2

Developments Status

- GEFE developed by BE-BI for front end electronics readout
  - New versions are coming forward
- Power supply for CompactPCI Serial by BE/CO
  - In-depth characterization of the FPGA
- Low current measurements
  - LogAmp circuit developed by TE-VSC
- 4-20mA reading developments by TE-VSC
  - Transceiver for any apps using RadTol PLC
- Communication solutions from EP, BE-CO, BE-BI
  - VTRx+ BE-BI
  - LpGBT for high speed link solution in the LHC
  - Field bus Ethernet developments
- Purpose → to make such developments common for different groups
- Not necessarily funded directly via R2E
  - R2E plays the role of communicator

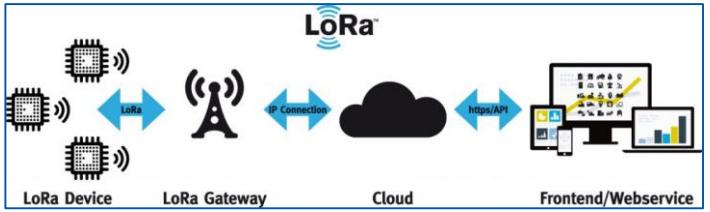
GEFE Board, M. Barros Marin, A. Boccardi

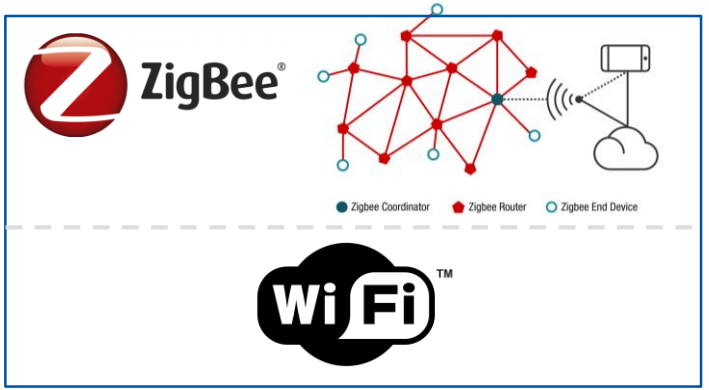
BE/CO development as a kit for the equipment

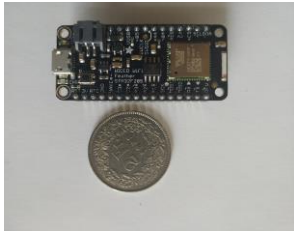


The proposal
for a common wireless solution

- **Proposal :** The radiation tolerant wireless Internet of Things (IoT) platforms for on-field sensor data acquisition
  - Two platforms:
    - Long-Range/Low Baud rate (LRLB)
      - LORA (km range, heavily shielded areas)
    - Short-Range/High Baud rate (SRHB)
      - ZigBee, Wifi (kb/s up to Mb/s)
  - Common solutions
    - Miniaturized to make it embeddable in any other system
    - Multipurpose
    - Availability of several on-board peripherals
    - User configurable
    - Based on commercial components
    - Low cost <100CHF
    - Low power development (can run on batteries)
    - Tested under irradiation
    - Components to be selected for radiation hardness and low power
  - Provide to the users/companies two wireless platforms independent from any application
  - Easy of installation
  - Support different wireless standards







Current Collaborations for a common development

- Link between the developments
  - Promoting developments that can be used by everyone
  - Sharing radiation expertise and providing support to the developments
- Inter CERN
  - BE-BI → high speed communication link
  - BE-CO → high speed Ethernet
  - EP → VTRx single mode
  - EP ELMB++
  - TE-VSC
  - TE-CRYO
- External
  - TRACO -> DC/DC (TE/EPC)
  - NanoExplore → RadTol FPGA
  - MicroChip → RadTol microcontrollers
  - Cobham → rad/hard microcontroller

Future Steps

- Maintain knowledge and centralize efforts at RADWG
- Promote and apply strategy to all groups and experiments
- Be preventive in component selection for most critical components
- Plan LS2 -> follow up as many developments as possible to provide support
  - Push for common developments
  - Provide support to collaborations for intern and extra CERN developments
- Focus on key components that can be bottleneck for many designs
  - FPGA has to become a flagship of the efforts of the project and become a common goal for everyone
  - Provide as diverse as possible solutions to the equipment groups for common blocks to minimize time and money of finding appropriate components
- Purchase and qualify large quantities of components
- Store them and make them available for the CERN community