ADCSS-2014 workshop Day 3

ESTEC – October 29, 2014

WE LOOK AFTER THE EARTH BEAT

PL interfaces
MTG-I Architecture

23/10/2014

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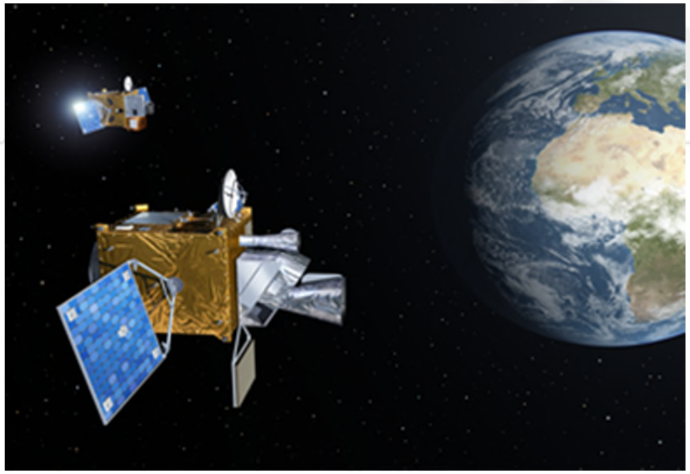
MTG-I architecture - Introduction



- PF/ PL architecture
  - Avionics diagram
    - Focus on Fine Pointing Mode
    - With PL and PF avionics interactions
  - Command-control data-Handling diagram
    - Focus on PL control by PF and by ground
  - Mission data-handling diagram
    - For PF acquisition of PL mission data to be downlinked to ground
    - For PL configuration with mission scenario
- FDIR strategy for managing PL Failures
- Criteria driving architecture & interfaces choices
- Lessons Learned in between PDR & CDR

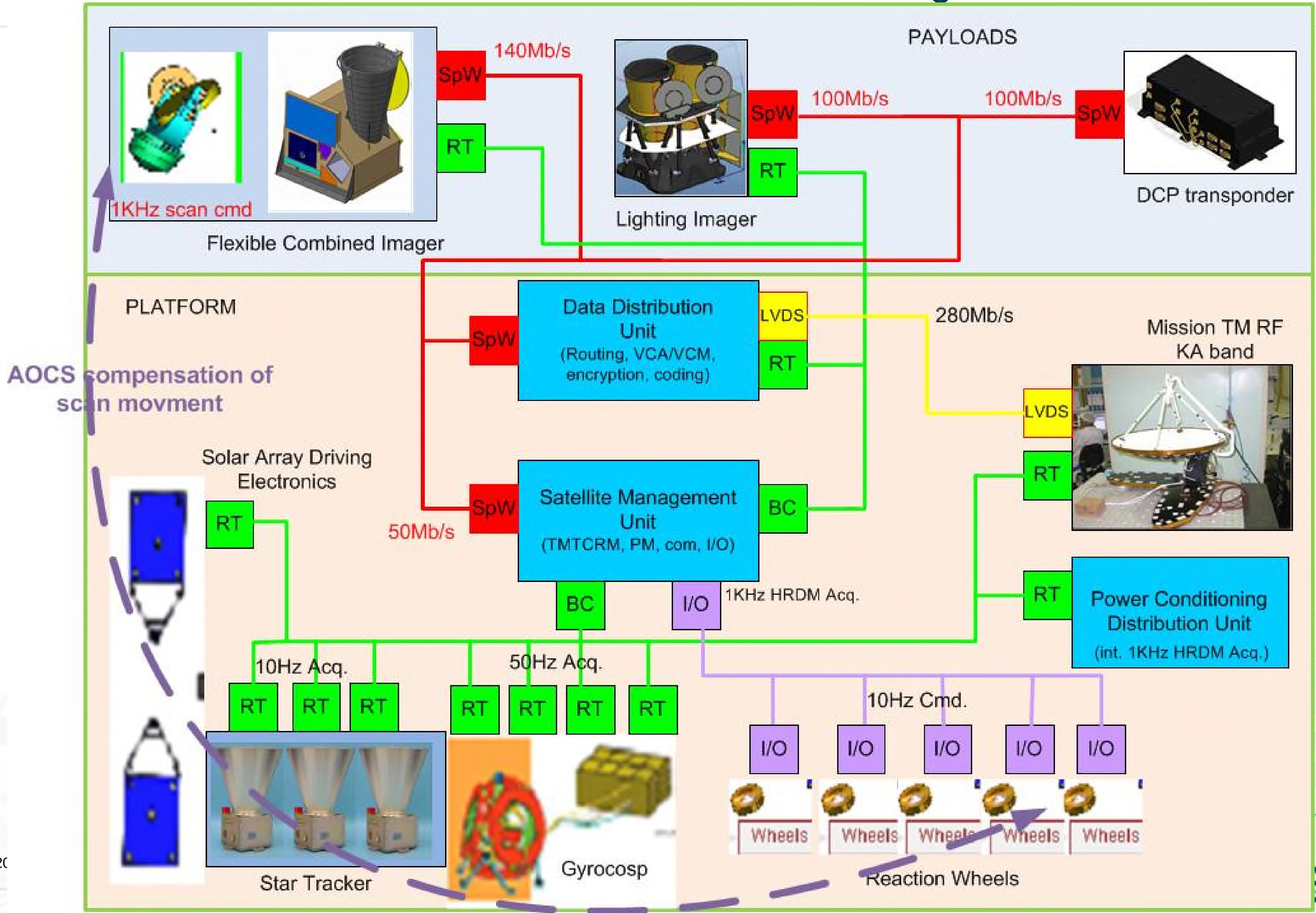
MTG-I architecture - Avionics architecture drivers & choices

- The Driver is Fine Pointing Mode performance (APE 100µrad)
  - FCI scan is controlled at 1KHz, perturbation on PF pointing stability
  - AOCS compensation by reaction wheel commands at 10Hz

- Architecture defined to relax real time constraints and CPU loads
  - With A-priori AOCS compensation of FCI scan movement
  - Based on pre-defined scan and AOCS compensation
  - Available in PF MM through 2 lockup tables per scenario (~200KBytes)
    - One for instrument configuration with scan law at 1KHz
    - One for platform AOCS commands to 5 RWs at 10Hz
  - Fast transfer through SpW network, already existing for mission data

- Allows to remove
  - PL/PF interface for scan movement feedback to PF
  - Hard real time IF and AOCS constraint
  - Minimize CPU load and simplify software complexity and validation

MTG-I architecture – Avionics architecture diagram



MTG-I command/control architecture, drivers & choices

- Command/control drivers
  - Commonality of PL/PF IFs, 4 instrument’s to be developed
  - A common multi-missions PF for 6 satellites (4 imaging, 2 sounding)
  - Industrial organisation requires for uncoupling the PLs and PF developments (HW & SW)

- PL/PF CC Data-Handling architecture based on
  - PL Command control with dedicated 1553 PL/PF bus
  - PUS TM/TC packet formatted exchange between PF/Ground and PLs
    - in line with ECSS standard with QoS 1 “verified data lenght”
  - 1553 bus profile allowing to limit SW interaction between PLs and PF
  - PUS library is provided by Prime TAS
    - To both PF and PL sucontractors
    - To enhance standardization
    - To minimize development effort on both PF and PL sides

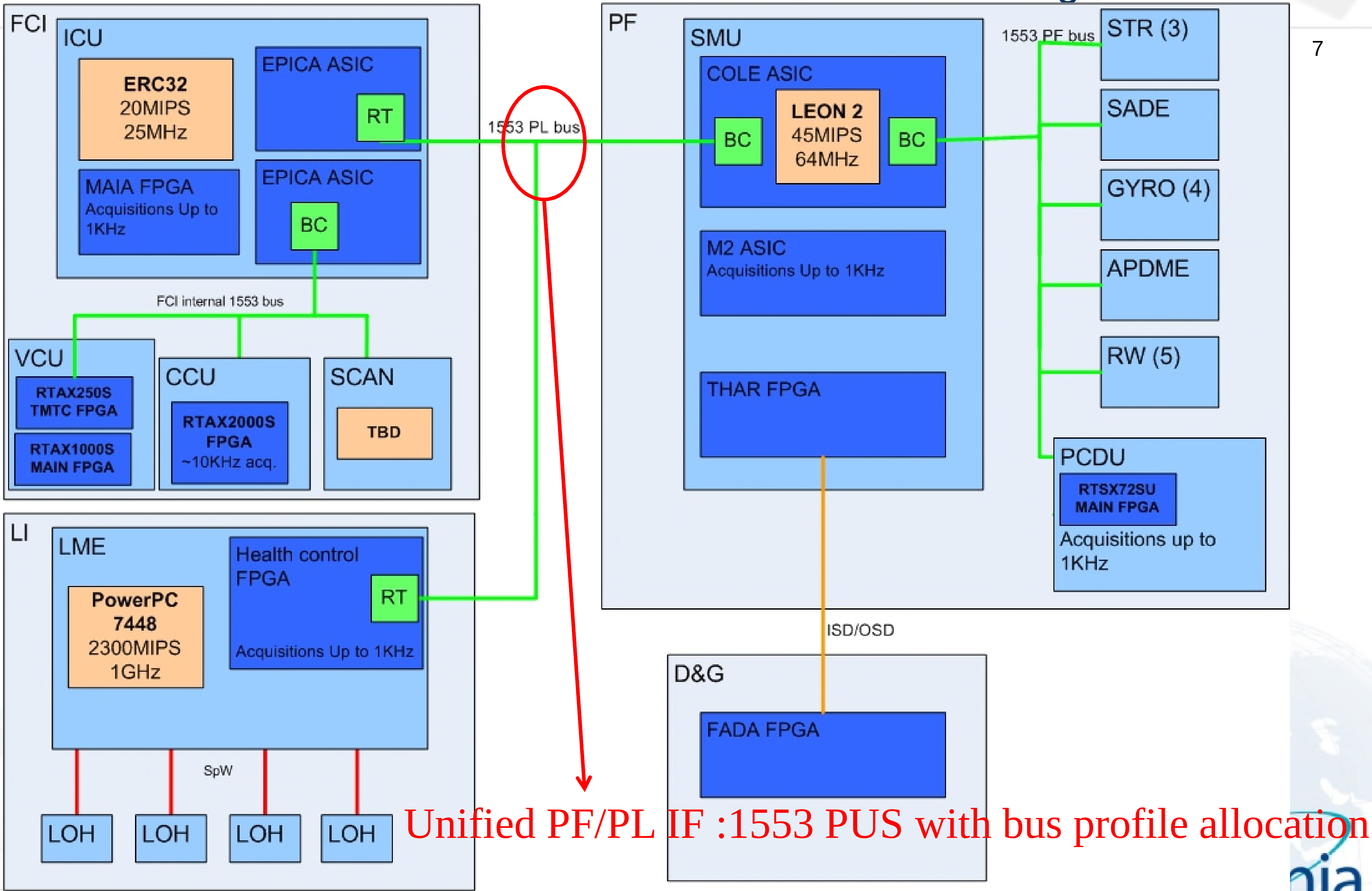
MTG-I architecture – PF/PL FDIR strategy

- FDIR strategy defined to
  - Limit mission outage in case of PF level-3 reconfiguration (SMU)
    - FCI instrument put in WAIT mode with protection against sun
    - Normal mode maintained for all other PLs and PF
  - Reduce PL and PF interaction
    - with parallel and independent FDIR

- Instrument's internal FDIR
  - From level-0 up to 2 performed by instrument SW itself
    - Only 2 PL event packets monitored by PF for thermal aspects
  - In case of instrument's ICU failure
    - switch-off request triggered by watch-dog through discrete interface
    - PF will switch failed PL into survival mode with sun protection

- PF is ensuring instrument survival thermal control and its FDIR

MTG-I architecture – command-control architecture diagram

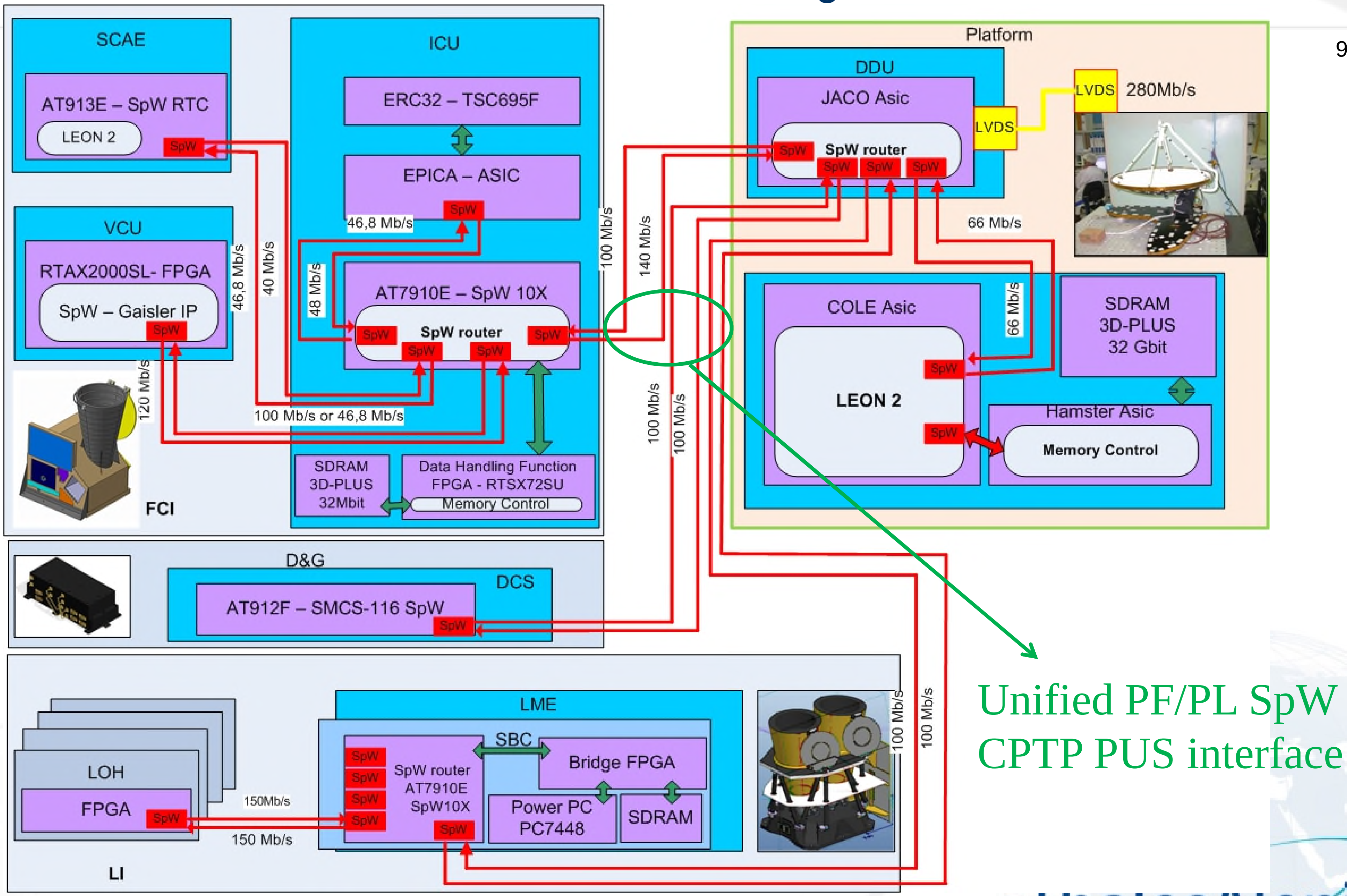


MTG-I mission data architecture drivers & choices

- Mission data-handling drivers
  - Commonality of PL/PF IFs, 4 instrument's to be developed
  - A common multi-missions PF for 6 satellites (4 imaging, 2 sounding)
  - Industrial organisation requires for uncoupling the PLs and PF developments (HW & SW)
  - Same link for data acquisition and configuration
  - Capability to address directly an instrument scan unit
    - Without intermediate data acquisition and re-sending (PF→ICU→SCAN)
      - Dynamic Routing capability
    - For fast scan law configuration

- Mission data on a SpW network
  - with data flows segregated between sources to decouple development as well as performances such as latency, buffering…
  - From 50Mb/s up to 160Mb/s pending on data source
  - Recurrent PF Data Distribution Unit configured with mission link rates

MTG-I architecture – Mission data handling architecture



MTG-I architecture – special care on SpW validation

- Special care to be paid on SpW link electrical performance

- Validation with estimate of SpW auto disconnect-reconnect
  - Any disconnect-reconnect within a packet transmission
  - Will cause the loss of the packet (no storage, no retry in std)

- Negligible with high margin on link usage with BER at >E-12
  - Nevertheless SpW “BER” could impact the mission availability

- Requires robustness test to verify it is actually negligible
  - SpW time skew/jitter measurement and LVDS output eye diagram
  - SpW “BER” measurement over mission period for mission data
    - to assess impact of packet loss vs mission availability
    - If NC, link quality shall be improved or retry protocol to be introduced.

MTG-I architecture – Distribution of SAVOIR functions

SAVOIR Function	MTG-I implementation
Time management	master time OBT in PF SMU, distributed at PPS on 1553 to synchronize PL local time LOBT (PL 1553 & discrete PPS)
Active thermal control	in normal mode, each platform and instrument perform its own operation thermal control OTC and FDIR; when an instrument is put in survival mode its survival thermal control STC is performed by PF for regulation & FDIR
Payload mission (scheduled) operations	PL full autonomy after configuration performed by PF for scan law
Payload contingency operations	PL full autonomy for its own FDIR levels 0 to 2 PL switch-off request discrete line triggered by watch-dog for PF isolation by switching PL into survival mode PL maintenance performed by ground through PF services
Payload mission data management	PL provides mission data in PUS packets to PF for encoding and download to ground into a dedicated VC of mission TM TF
Payload-in-the-loop	PL scan perturbation compensated by PF AOCS by a-priori RW command based on pre-defined lookup tables stored in mass memory, in line with mission scan law (also stored in MM); this approach allows to not have PL in the loop
Platform housekeeping telemetry	all PF HKTM copied and downlinked into mission TM allowing fastest download of high rate diagnostic at 1KHz, dump report... This copy is transferred to mission SpW network with VC0,1 and 2 allocated to PF data (HK, async report and PF mission data)
Onboard security services	TC autentication in PF SMU AU (similar to S3 one) and mission TM encryption based on AES FIPS-PUB-197 with 128 bits key size in PF PDD

MTG-I architecture – PL control IF & protocols

Link type	Units	Protocol	Link speed	Usage
SpW	PF -> FCI	CPTP + CCSDS	100Mbps	Scan laws
	FCI -> PF	CPTP + PUS	140Mbps	Mission data
	LI -> PF	CPTP + PUS	100Mbps	Mission data
	D&G -> PF	CPTP + PUS	100Mbps	Mission data
	LI FEE -> LI LME	Raw data	150 Mbps	Raw Mission data
	FCI VCU -> FCI ICU	CPTP + PUS	120Mbps	Mission data
	FCI Scan -> FCI ICU	CPTP + PUS	40Mbps	Mission data
	DDU -> SMU	CPTP + CCSDS	66Mbps	A-Priori Compensation
1553	PF – FCI/LI	PUS+1553	1Mbps	C/C
	PF – Gyro/STR/RW/SADE/APME	1553	1Mbps	C/C
ISD/OSD	D&G <-> PF	Status & Cmd	250kbps	C/C
Discretes (ASM/BSM/TSM)	PF <-> all payloads	No	N/A	CC & FDIR

MTG-I architecture – Lesson learn

- Pros ☺ :
  - Early specification of 1553 PF/PL bus profile
    - Reduces PF and PLs software dependency
  - Standardized PUS TM/TC exchange for instrument through PF
    - Ease parallel development without strong PF/PL relationship
  - Specification of SpW time skew&jitter allocation (Tx,Rx, harness)
  - FPM scan/AOCS APC based on lookup tables in MM
    - Minimize OBSW complexity & development and space/ground upload

- Cons ☹ :
  - Clearly specify duration for averaging for data rate allocation
  - If not, PLs continuously increase amount of data to be acquired
    - With higher peak over a lower period
    - Leading to difficulties to size counter-part buffer, with the risk that buffers are oversized for unrealistic limits based on link max capability

Questions ?