Generic GNSS function in SAVOIR

Avionics, Data, Control and Software Systems (ADCSS)

Presented by J. Rosello (EOP-ΦMT , EO Future Missions)
Co-authors : W. Gasti (TEC-EDD, OBC & Data Handling)
T. Hult (RUAG Sweden)

(17-Oct-2017)

GNSS function

Facts today :

- GNSS offers **continuous** availability of Position, Velocity, Time (PVT), mainly in the Earth Orbit
- Multiple GNSS Space **Applications**, mainly in LEO, but also in Transfer and GEO orbits:
  - Absolute & Relative Navigation
  - Scientific Instruments (Radio Occult: MetOp-SG, SAC-C/D, … + GNSS-R: UK TDS-1, CYGNSS, …)

➔Space GNSS Receivers are a **key technology** for different type of space missions + applications

Consolidated trends :

- **More signals** from new GNSS constellations (modernized GPS, Galileo, Beidou, Glonass)

➔ increase in robustness (e.g. less loss of tracking, faster reacquisition) & a bit better accuracy

- **Miniaturisation** in electronics enables further integration of avionics
  - → more room for instruments → mission outcome increases
  - reduction of development/integration (cost and time)

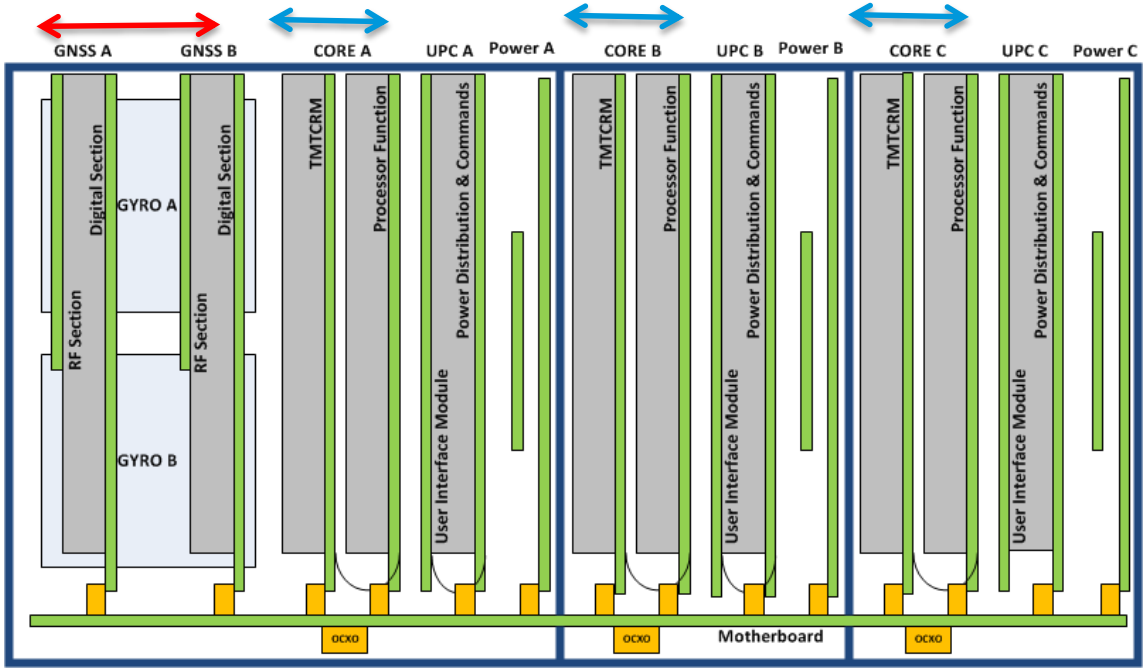
Therefore :

- In practice, GNSS functions are already being integrated in the OBC Units.
- HW architectures and SAVOIR need to adapt accordingly

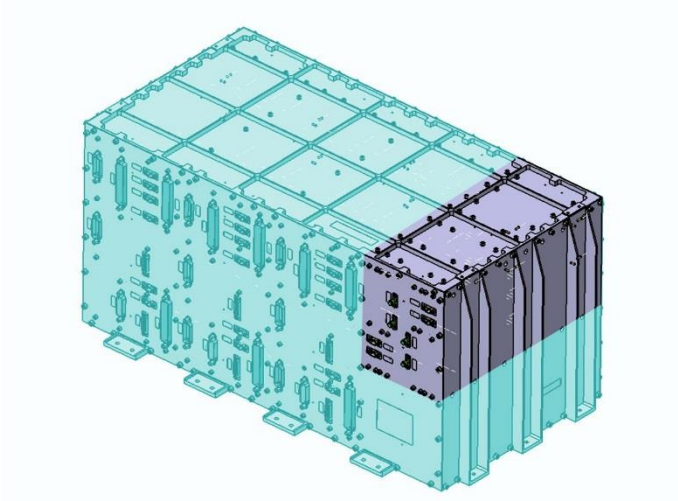
Example-1: TAS-I integrating GNSS in OBC

Done for Telecom Satellites

- Artes 5.1 , "Feasibility of AGGA-4 inside the central computer", ESA Contract C4000108120)
- followed-up for Neosat



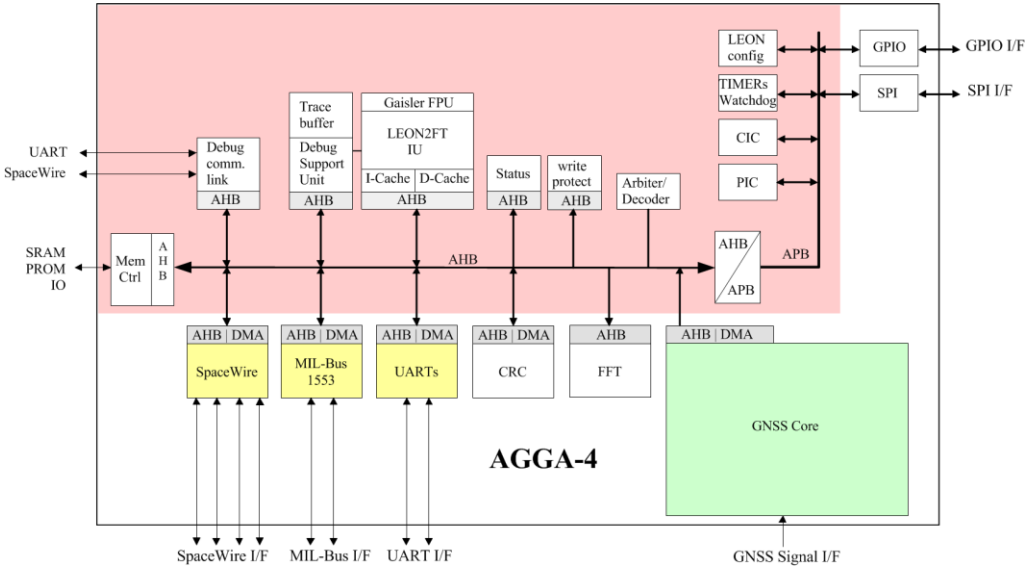
- **Triple** Redundant SMU
- **Dual** (N+R) GNSS Functions

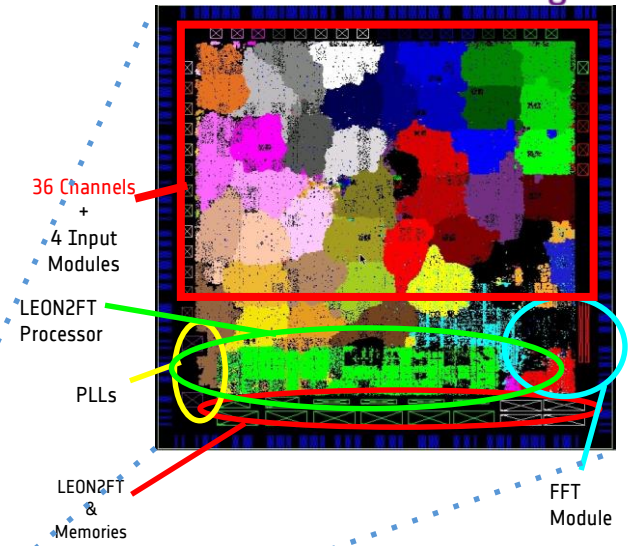


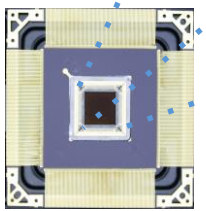
Pictures Courtesy of TAS-I,
Extract from: AGGA-4 days (27-Sept-2016)

AGGA-4 (Advanced GPS-Galileo ASIC)

Floorplan







GNSS core : 2.7 Mgates

LEON2FT + GSFPU: 428 + 122 k gates = 0.55 Mgates

Clocks + I/Fs+ backend : 1.35 Mgates

Design : 4.6 Mgates

Pads+others : 1.4 Mgates

Total : 352 pins CQFP and 6 Mgates

(Die size 13x13 mm, incl. Pads)

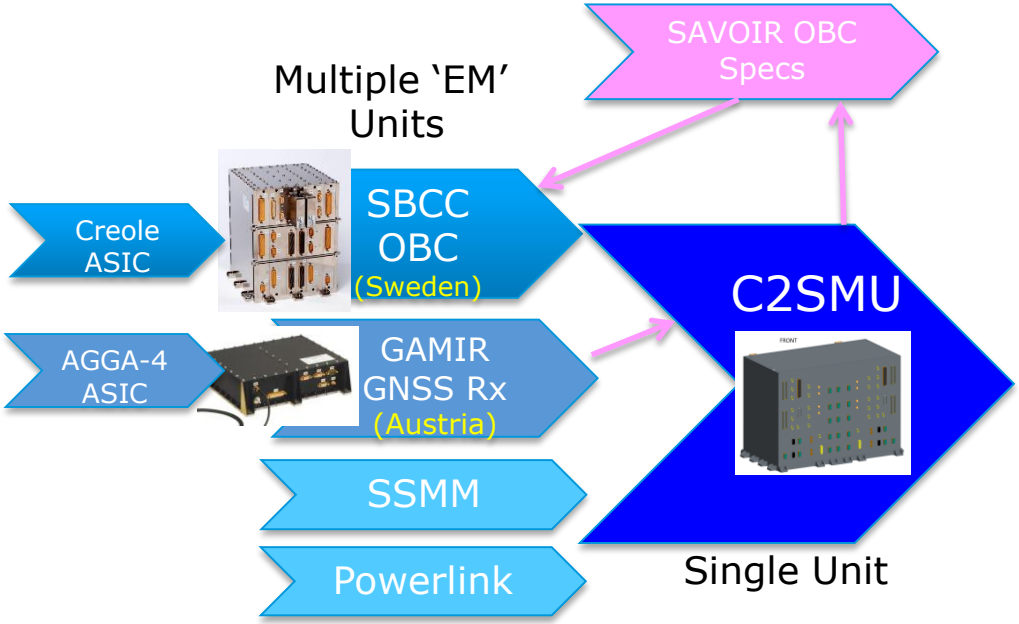
Designed by Airbus GmBH

Available as ASSP from ATMEL since 2014

Study Definition and Breadboarding of C2SMU

ESA Contract 4000118320 with RUAG Sweden (KO in 3Q-2016)

C2SMU = Complex & Complete SMU



C2SMU Feasibility and BB Study
- Requirements + Architectural Design
- Integration + Analysis/Testing key modules
- Development Plan

Development in follow-up study in 2018
(funding TBC)

C2SMU contract content

Four tasks and reviews:

- Consolidation of preliminary requirements
- Analysis and Architectural design of the C2SMU
- Breadboarding of integrated key functions in a demonstrator and validation ➔ Nov. 2017
- Overall results Analysis and recommendation for the new C2SMU

Deliverables

- C2SMU Specification
- Architectural Design report
- Demonstrator description
- Test plan, test procedure, test report
- Development plans for Demonstrator and full C2SMU

Background for C2SMU

The SAVOIR OBC specification has been elaborated over a couple of years and is now used at least as reference document in ESA programmes (PLATO)

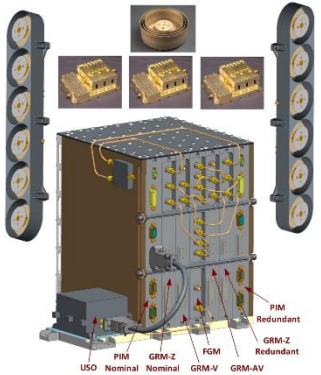
The following extensions have been discussed within RUAG:

- Handling the CCSDS File Delivery Protocol also on the S/X band link
- Providing additional capabilities for planetary missions (ADCSS 2016)
- Integrating a GNSS receiver handling the Time Reference and Position Sensor functionality

RUAG has two studies related to the extensions:

- Miniaturized Integrated Avionics for Planetary Landers (MINAVIO)
- Compact and Complete Spacecraft Management Unit (C2SMU)

plus the experience of integrating four GNSS GAMIR boards (from RUAG-Austria) into the GNSS Radio Occultation Instrument for MetOp-SG

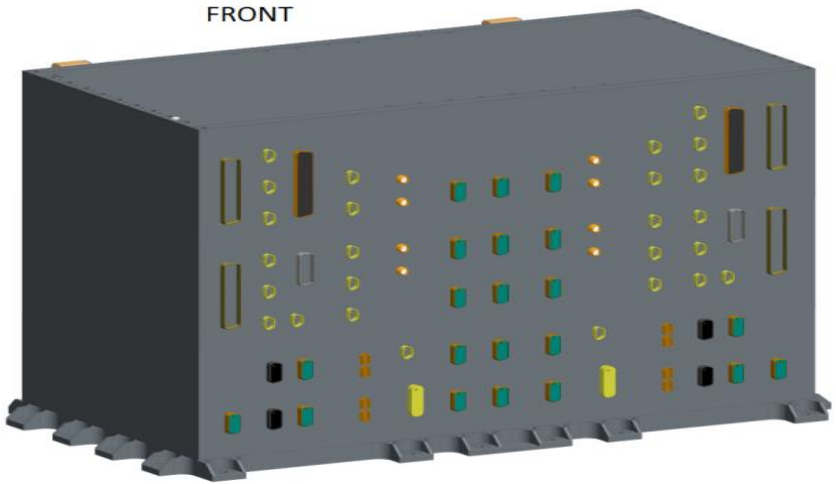


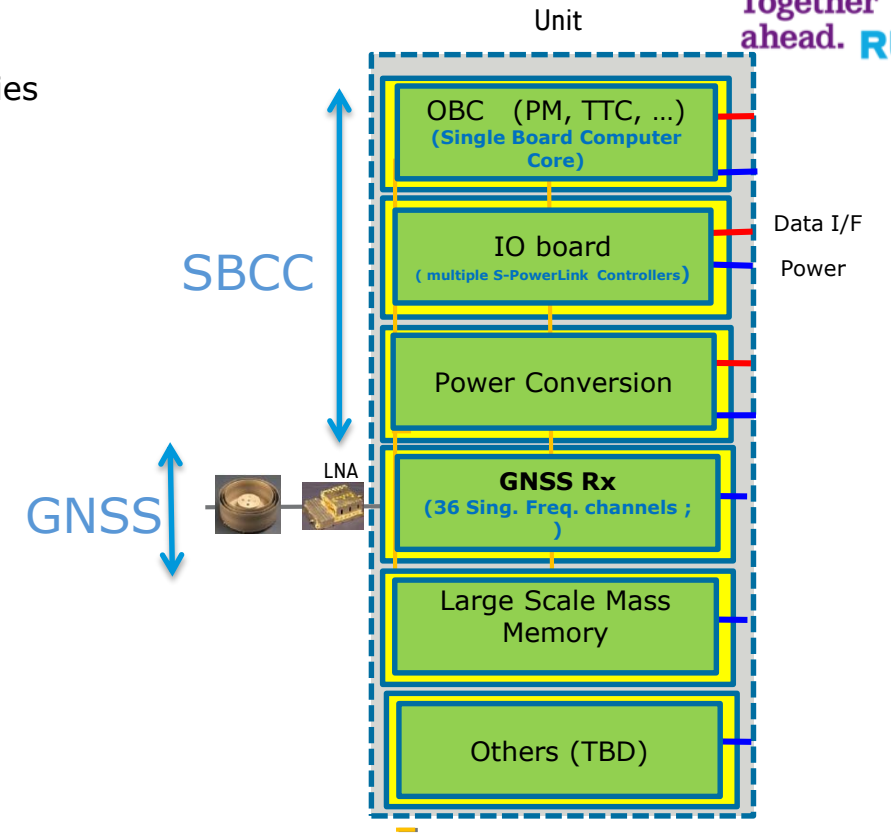
C2SMU study – ESA Contract 400118320

Integrating

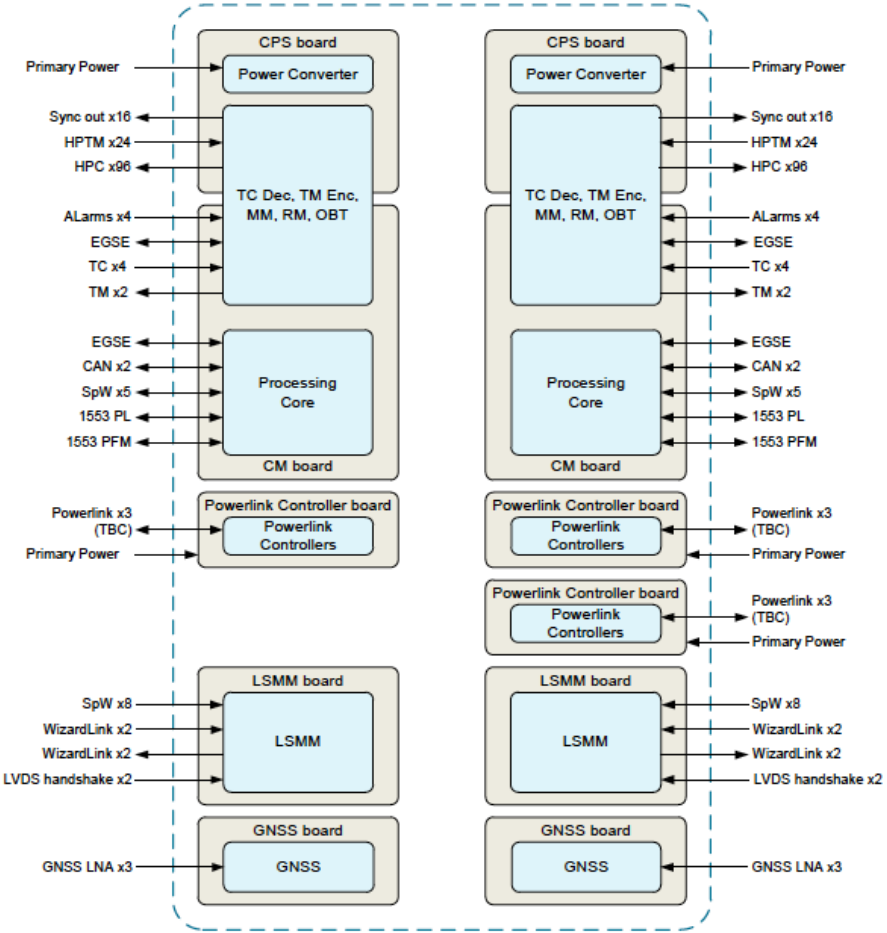
- OBC + Reconf.Module + IO board from earlier studies
- GNSS receiver from RUAG-A (GAMIR)
- Large Scale Mass Memory

+ Anticipating PowerLink for RTU functions





C2SMU preliminary architecture



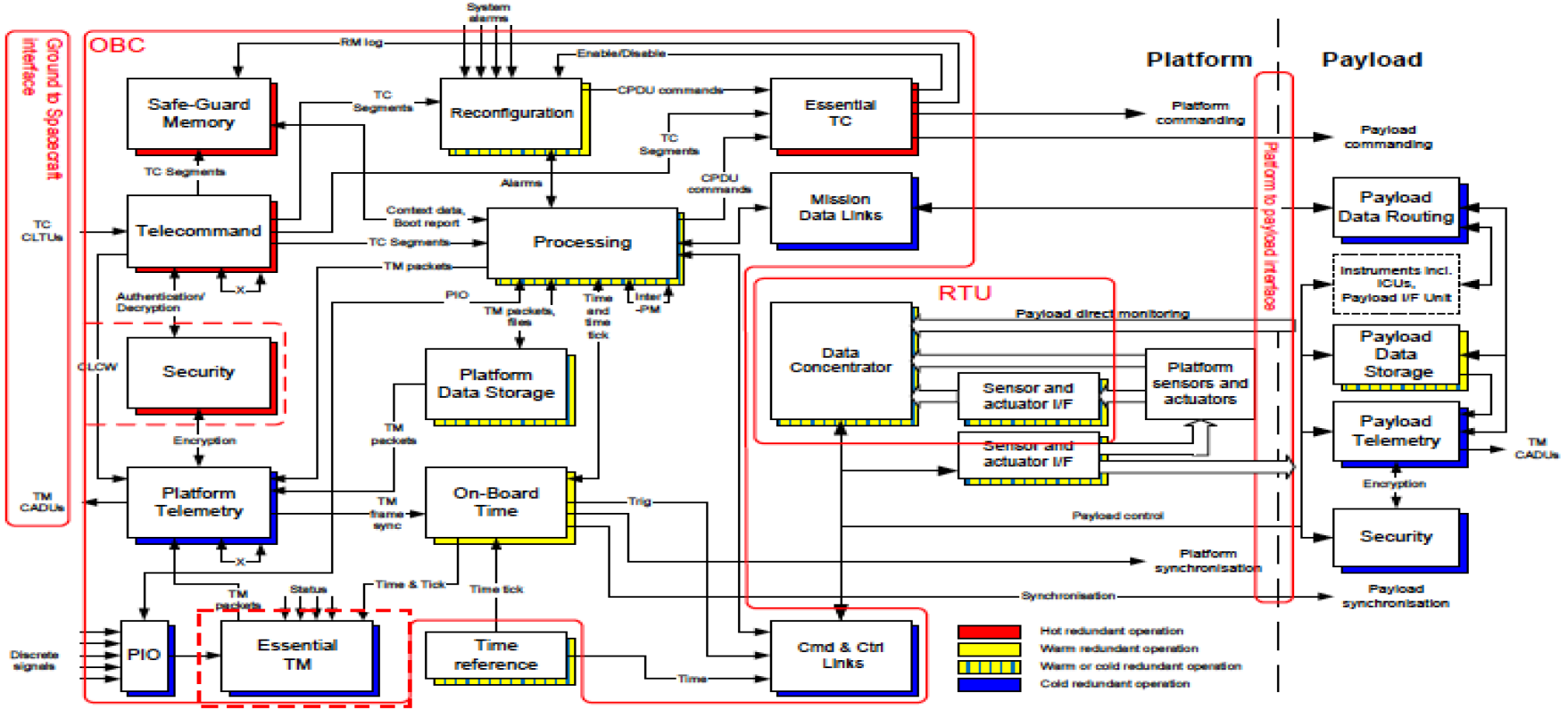
C2SMU feedback to SAVOIR

Recommendation for SAVOIR-SAG

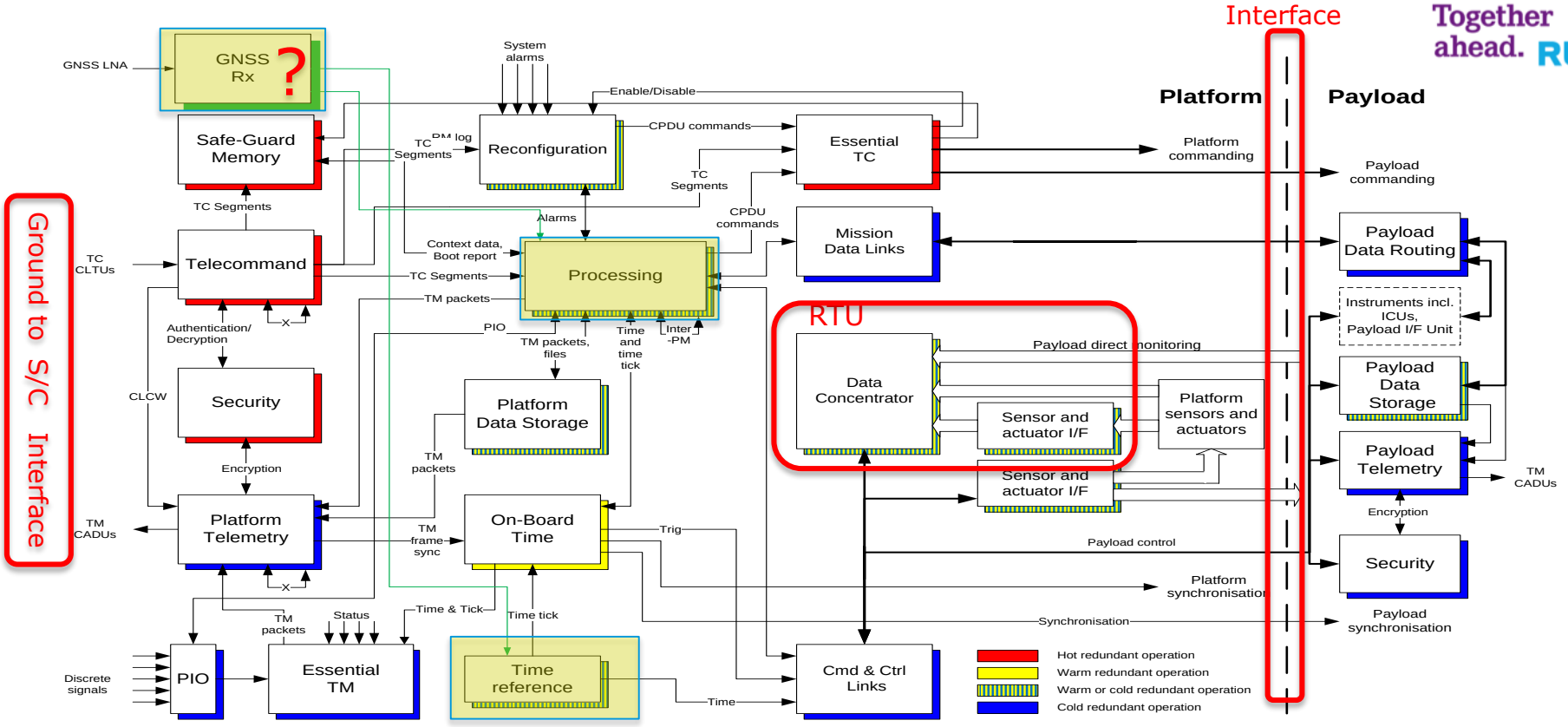
GNSS Receiver a **new optional** function (mainly for Earth Orbiting) to be added to SAVOIR OBC Spec.

- **When** the GNSS Receiver function is integrated in the OBC , then to be specified and interfaced in accordance with the two already existing functions in the SAVOIR OBC:
  - » **Time Reference** Function with extra input from the GNSS Receiver function
  - » **Processing** Function to perform the position… etc. function

Current SAVOIR Reference Architecture



Update of SAVOIR Reference Architecture



Process for GNSS function into OBC SAVOIR spec.

Should be similar to what has been done for earlier SAVOIR work

The main stakeholders prepare the updates in a consensus mode

- Reviewed internally at ESA
- Updates
- Public review
- Updates
- Publication

Suggested additional requirements for GNSS

- To provide position only or position and attitude
- To support single or dual frequency (GPS L1/L5, Galileo E1/E5), up to 24/18 satellites tracked with requirements on how tracking is configured and performed
- To provide support for Precise Orbit Determination
- Requirements on parameter modifications
    - Acquisition, tracking, TM sampling, PVT solution
- Diagnostics requirements on patching and dumping

Performance requirements

- Reference clock accuracy
- Signal C/No minimum levels for acquisition (autonomous and guided) and tracking
- PVT accuracy, GPS or Galileo only
- PVT accuracy, GPS and Galileo in combination
- Pseudorange measurement errors
- Carrier phase measurement errors
- Time To First Fix

Conclusions

- GNSS is well established in all Earth orbiting satellites.
- Miniaturisation enables integration of OBC and GNSS functions into just one Unit

➔ GNSS Receiver a **new optional** function to be added to SAVOIR OBC Spec.

- **When** the GNSS Receiver function is integrated in the OBC , then to be specified and interfaced in accordance with the two already existing functions in the SAVOIR OBC:
  - » **Time Reference** Function with extra input from the GNSS Receiver function
  - » **Processing** Function to perform the position… etc. function

- Should be similar to what has been done for earlier SAVOIR work

  The main stakeholders prepare the updates in a consensus mode