RTU presentation

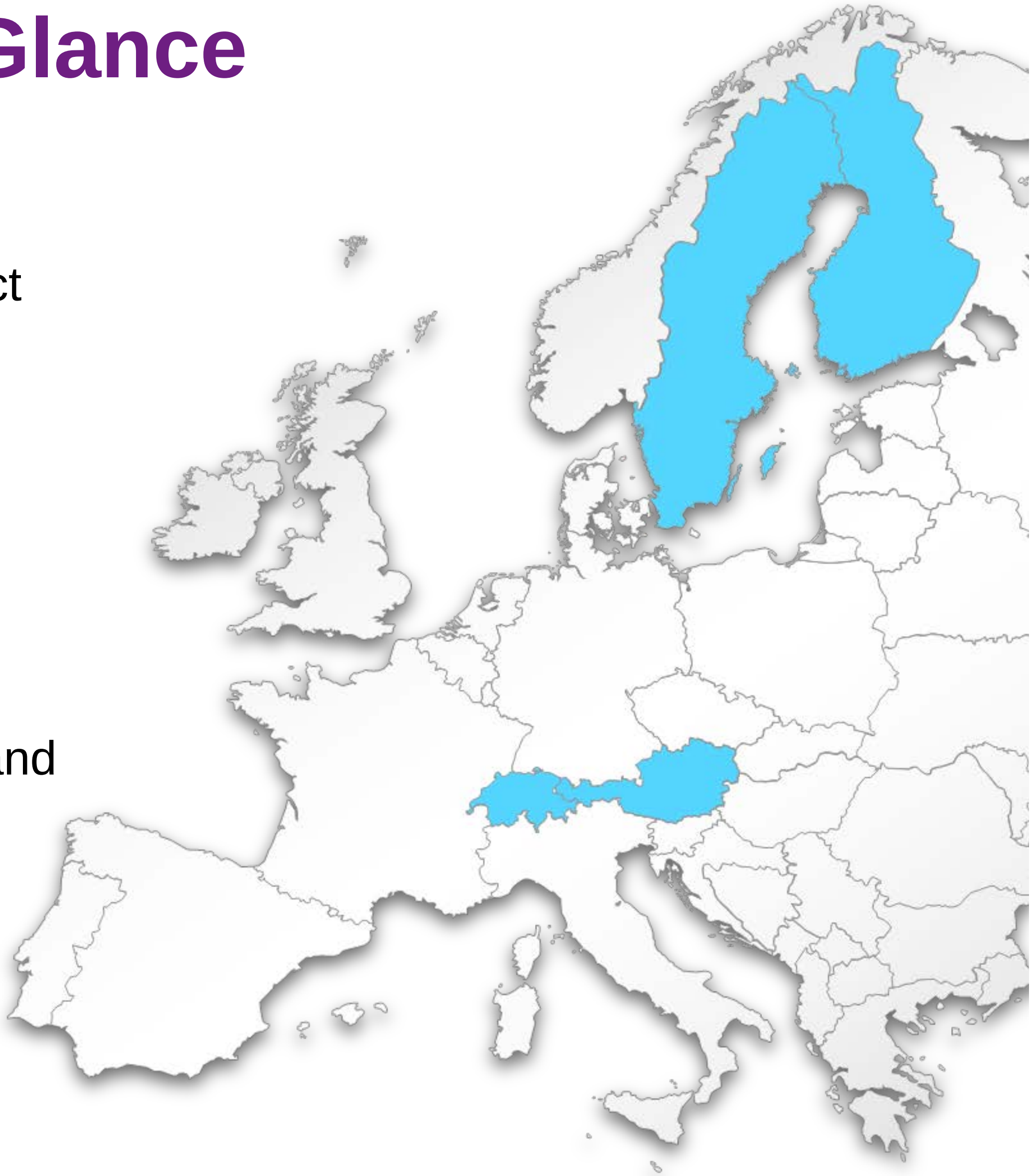
Torbjörn Hult
Chief Engineer, Digital Products
RUAG SPACE

ADCSS 2015, ESTEC
2015-10-22

Together ahead. RUAG

RUAG Space at a Glance

- Leading European space product supplier to the industry
- Acquisition of Saab Space and Austrian Aerospace (2008), Oerlikon Space (2009), Patria Space (2015)
- Eight sites in four countries (Switzerland, Sweden, Finland and Austria)
- US office in Denver, Colorado
- 1160 employees
- Total revenues (2014): 265 M€
- Headquarters: Zurich (CH)

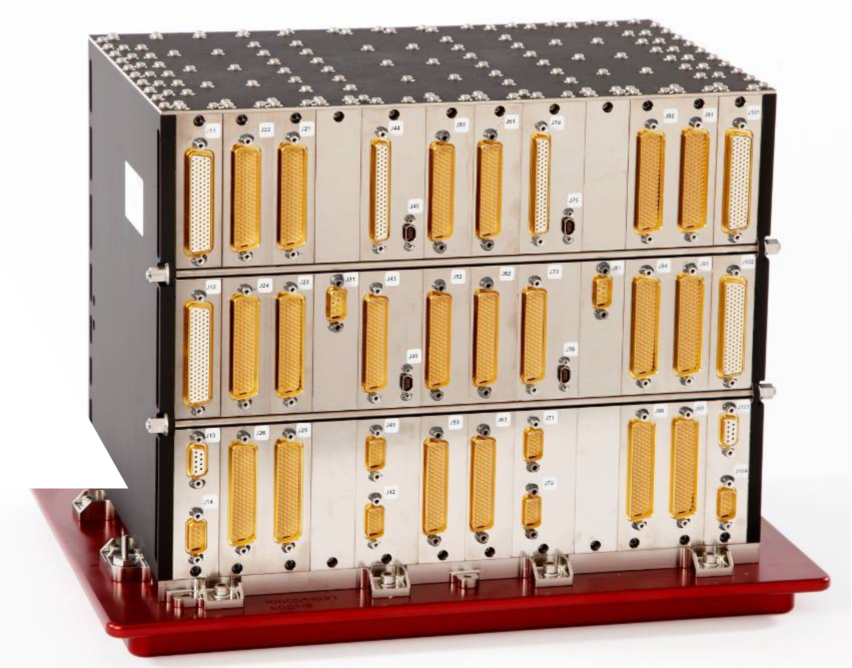


Together ahead. RUAG

Satellite Management Unit (SMU) OBC + RTU in the same unit

Ongoing:

- Galileo (14 + 8); OHB
- EDRS-C; OHB
- MTG (6); OHB
- Sentinel-3 (2); TAS-F
- ExoMars Orbiter; TAS-F
- ExoMars Rover; AD&S-UK
- Euclid CDMU, TAS-I



Future:

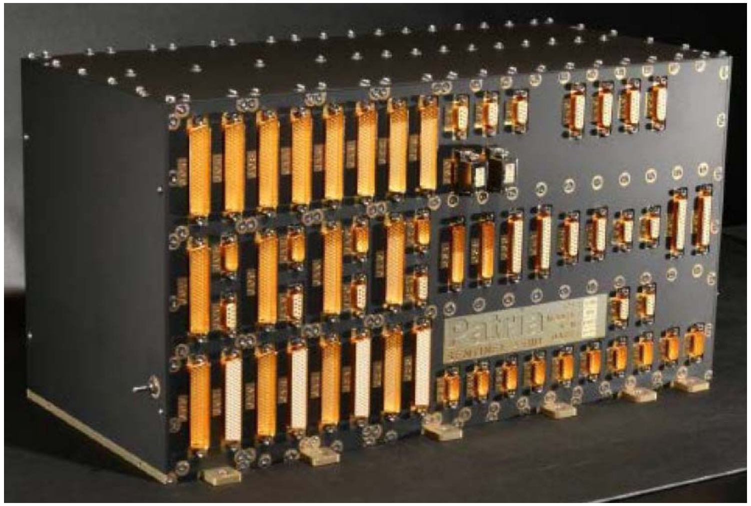
- Sentinel-3 C&D; TAS-F
- (Biomass), EOEP-8, ATHENA, L2, Mars Explorer

Together ahead. RUAG

Standalone RTU/RIU

Ongoing:

- Sentinel-2 (2); AD&S-DE
- EarthCARE; AD&S-DE
- Solar Orbiter; AD&S-UK
- Jason-CS (2); AD&S-DE
- Iridium Next PLIU (81); TAS-FR



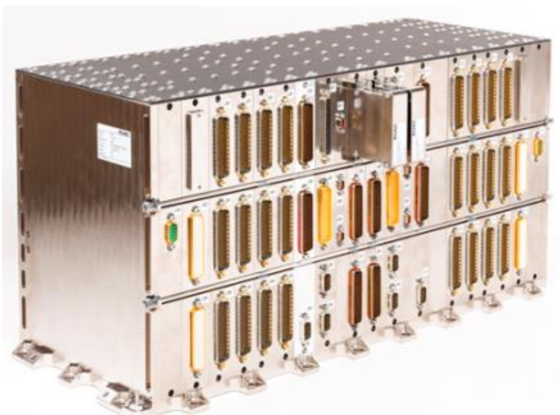
Future:

- Metop SG (6); AD&S-FR
- Sentinel-2 C&D; AD&S-DE
- Biomass, EOEP-8, Juice, ATHENA, L2, Mars Explorer

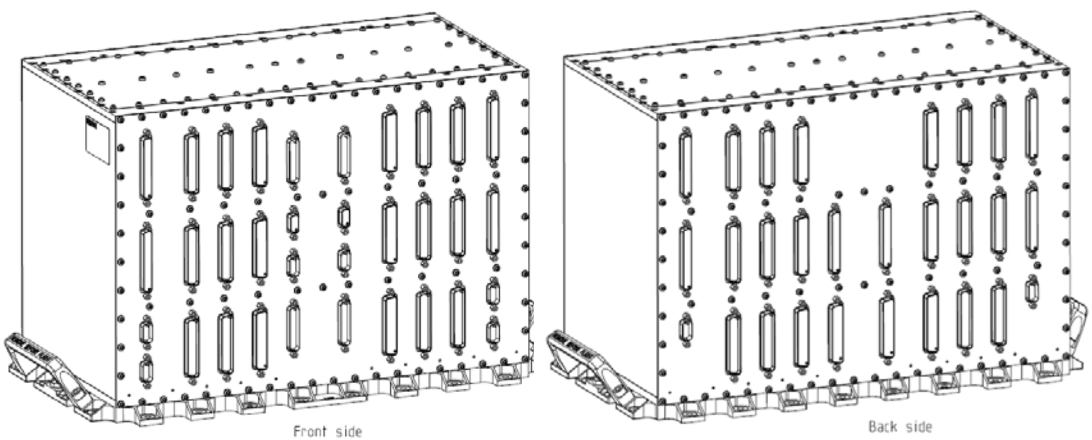
RTU evolution

Increasing number of inputs, mainly thermistors on ESA spacecraft

→The box becomes larger and larger unless something is done

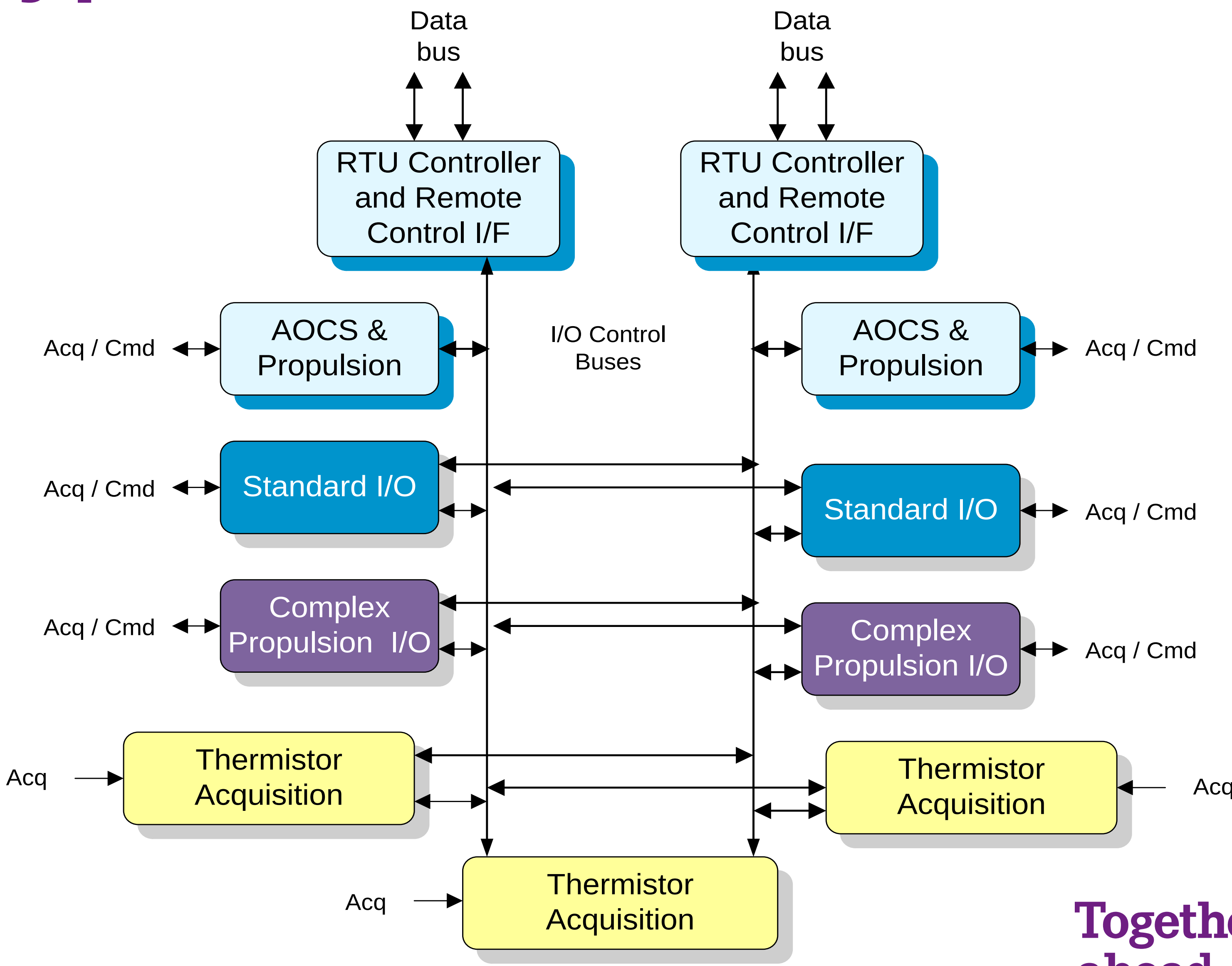


MTG SMU
(30 RTU connectors)



Metop SG RIU
(reduced size with connectors on two faces, 52 RTU connectors)

Typical RTU architecture



Together ahead. RUAG

Redundancy aspects

- The current specified RTU functional architecture assumes full cross-strapping between all RTU functions. This would be an overkill for small RTUs or RTUs for short missions as cross-straps always result in extra hardware.
- Cross-strapping of external inputs/outputs to the RTU is also important. Three concepts can be identified:
  - Sensors/Actuators have a single output/input and a number of these devices are connected to a small I/O group in the RTU. This I/O group is then controlled by a pair of redundant User Interface Control functions (Type A)
  - As for type A but the I/O group is controlled by a a single User Interface Control function (Type B)
  - Sensors/Actuators have a dual output/input and a number of these devices are connected to a larger I/O group in the RTU controlled by a a single User Interface Control function (Type C)
- Type A and B have typically 16-64 I/O signals while type C can have several hundred I/O signals.

Operability concept (1)

- Details on internal states and state transitions can be specified but is not really necessary, it should be sufficient to define that the RIU shall be fully operational for the required mission configuration within a certain time after power-on.
- TM acquisition lists are good, as is the capability of validating that the acquired data really belong to a certain acquisition start event. However, details on how this validation is done should be left to the designer.
- Ensuring that the acquired data is correct should also consider the probability that the data is incorrect →No need to chase error cases that are in the order of a few fits, i.e. >10000 years MTBF.
- The operation concept could change with the data bus used (1553, CAN, SpaceWire) but should be kept the same irrespective of the bus selection.

Operability concept (2)

- Commanding with both direct and delayed (or fixed relative some event) actuation capability is good. Command lists are not necessary.
- Resetting output commands by a watchdog mechanism in case there are no new commands from the OBC is vital for propulsion and recommended for other commands. Note however the general requirement 5.7.2f in ECSS-E-ST-70-11C:
  ” The ground segment shall be capable of overriding any on-board autonomous function.”
- Monitoring of internal RTU status is vital. As a minimum internal redundancy configuration, supply voltages and detected errors must be monitored. Other monitoring of the operation is less vital as there is normally a system end-to-end check that commands are executed.

Modularity

- Modularity is not a real need but rather a possible means for the individual RTU supplier to become competitive.
- Competitiveness <u>may</u> need modularity and capability to include modules from different subcontractors
- Competitiveness may also be reached by other methods like efficient development processes and management procedures.
- Lack of general principles for location of connectors on space units
- Modularity also requires fixed external interface specifications that do not vary from mission to mission or from prime to prime.

What prevents reuse between different suppliers?

- Lack of suitable module mechanical standards
- Lack of suitable backplane standards (connectors, I/F, protocol, …)

Together ahead. RUAG

Building blocks and technology

- FPGA or ASIC technology to implement the RTU Controller functionality.
  - Includes suitable memory technology for both volatile and non-volatile memories.
  - Includes suitable IP-blocks and interface circuitry for the selected control interfaces.
- Point-of-Load converters with built-in on-off capability, overvoltage protection and current limitation
  - Ensures that the RTU is not generating excess overvoltages on its outputs.
  - Ensures that the power dissipation in case of failure is kept to a reasonable value
- Mixed ASIC technology
  - Already used but higher performance (speed, accuracy, resolution) expected for the future

Functional chains handled by the RTU

- The RTU is mainly a simple gateway between sensors/actuators and the OBC. This far no RTU has been equipped with functional local control loops (control loops to set magnetorquer currents, output voltages etc. etc. are of course included).
- Functional expansion is sometimes provided:
  - Micro-stepping. RTU receives the number of full steps to perform during a S/W cycle and generates the sine wave outputs to the motors.
  - Automatic motor stop when reaching an end-point
  - Generation of alarms (Rate Sensor, temperature, …)
  - Data processing: Averaging and filtering of acquired data
  - Switch-off of outputs when receiving the EQSOL signal
- Possible future capabilities:
  - Simple heater control (thermostat type)
  - Integration of sensors could be possible. First choice would be accelerometers and MEMS gyros.

Thank you for your attention!