

Porting the ASTRO APS platform from GR712RC to GR740

Olivier Ballereau, GR740 User Day 2022



Exploring new horizons.
We are ready.





Porting the ASTRO APS platform from GR712 to GR740

- About Jena-Optronik and its products portfolio
- The ASTRO APS2 Platform
- The new ASTRO APS3 Platform
- Porting the Software
 - Improvements
 - Added complexity
- Summary

Space for success - Jena-Optronik

- Location **Jena, Germany**
- Employees **~240**
- A subsidiary of **Airbus Defence and Space**
- DIN EN 9100:2018** certified

From space for our world

- As vast as the universe is, there is no space for inaccuracy: **sensors by Jena-Optronik** keep satellites stable and on track.
- Visionary technology in the truest sense of the word: our **space optics & electronics** help to generate crucial Earth Observation data, helping to improve the quality of life.

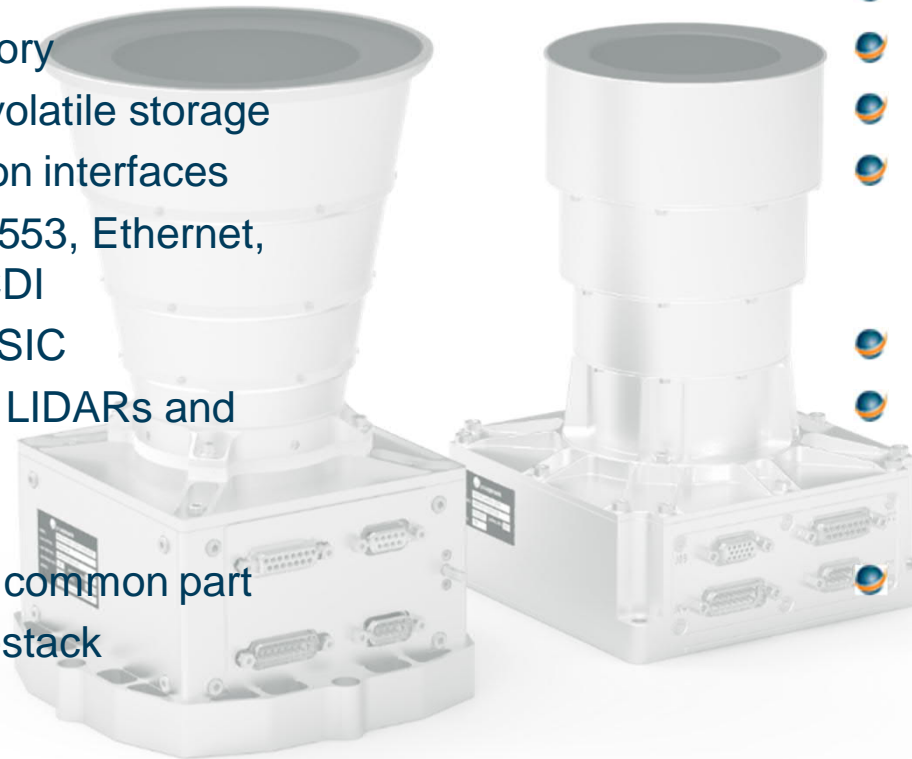


Your mission		Our solution	
	Space exploration		Star Sensors ASTRO® product family
	Human spaceflight		Cameras / Camera systems
	Earth observation		LiDAR RVS® product family
	Telecommunications & Navigation		Space optics & electronics
	Space logistics & Debris removal		Services
	Space Situational Awareness		



A Platform for small devices...

- based on: the GR712RC
- small form-factor
- small amount of memory
- small amount of non-volatile storage
- multiple communication interfaces
 - SpaceWire, MIL1553, Ethernet, UART, HDLC, SCDI
- usually extra FPGA/ASIC
- used in Star Sensors, LIDARs and Navigation Cameras
- modular software
 - large and flexible common part
 - modular protocol-stack

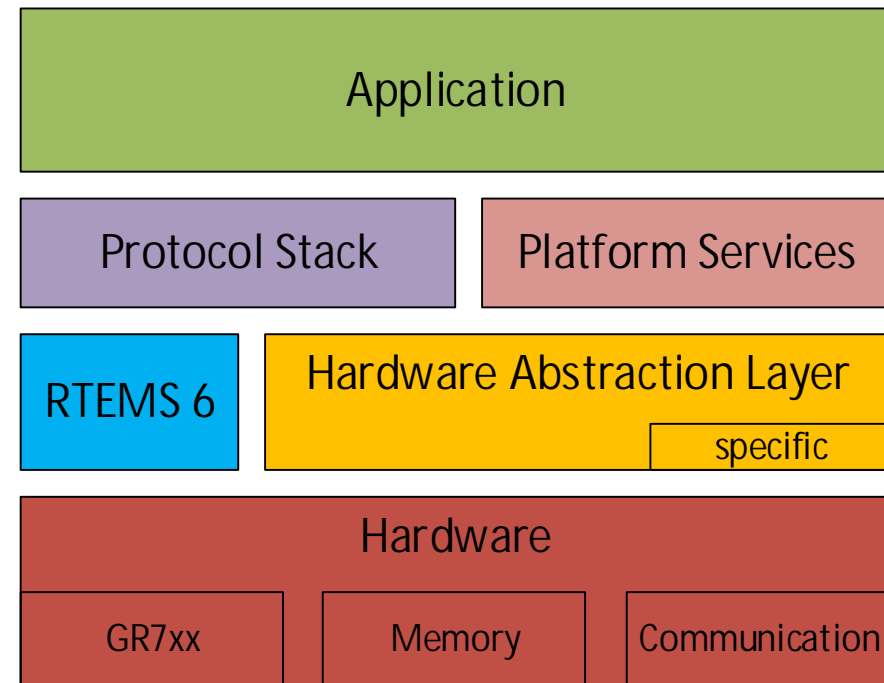


...and its evolution

- based on: the GR740
- smaller
- more memory, yet still on the smaller side
- larger amount of non-volatile storage
- multiple communication interfaces
 - SpaceWire, MIL1553, HDLC, UART...
- optional extra FPGA/ASIC
- uses ESA's Space Qualified RTEMS 6 with Symmetric Multi-Processing
 - more is done in software
- still the same modular software

Modular Software

- Large set of platform services
- Modular protocol-stack
- Hardware Abstraction Layer
 - defines abstract interfaces
 - several implementations
- Port for the GR740
 - GR712RC drivers as basis
 - rest of the software “as is”
 - run the “old” software on the “new” platform
- Flexible test-boards for easy prototyping



The GR740 brings several improvements that are important to us

- Interrupt level re-mapping
 - possibility to assign an internal bus line to an interrupt level
 - possibility to assign a GPIO to an internal bus line
- Interrupt time-stamping
 - precise time-stamping of an event is sometimes necessary
 - (overall) latency complicated to assess
 - possibility to latch the time when an interrupt is asserted
- Level-2 Cache
 - large, shared and unified
 - write-back
 - internal scrubber
 - bridge between memory bus and processor bus

The GR740 brings several improvements that are important to us

- GPIO controller
 - logical OR/AND/XOR for safe manipulation of the output-, direction- and interrupt mask registers
 - the same for the interrupt polarity register would have been nice
- Large number of (improved) controllers
 - SpaceWire, MIL1553, Ethernet, UART, CAN, SPI and PCI
 - pin multiplexing
 - DMA
- SpaceWire
 - more ports and integrated router
 - similar GR712RC and GR718
- SpaceWire Time Distribution Protocol controller

The GR740 brings several improvements that we cannot really use

- SDRAM with more bandwidth
 - for small a platform, either no improvement or too much memory
- Hardware memory-scrubber
 - can scrub a memory area (automatically, repeatedly)
 - too much/too fast for a small platform

The GR740 brings also some extra complexity

- Five internal busses
 - global status and error propagation rules
- IOMMU Bridge
 - either cache coherency problems or complexity if one want to avoid the processor bus
- The GR740 has four CPU cores
 - RTEMS 6 with Symmetric Multi-Processing
 - space-qualified for the GR740 thanks to ESA

The GR740 brings also some extra complexity

- Boot-loader changes
 - PLL setup for System-, Memory- and SpaceWire-clocks
 - SMP start
- Pin multiplexing for the PROM-bus
 - conflicts with MIL1553
 - less address/data bits available
 - using both extra PROM signals and MIL1553 brings in some complications

Updating from the GR712RC to the GR740 is mostly straightforward

- Basic support can be achieved quite easily
- Better tuning for the GR740 is more complicated
 - identifying bottlenecks caused by small changes (e.g. wide accesses on the SDRAM and PROM)
 - using the new features/improvements can make some redesign necessary
- Full conversion to SMP is a large effort in itself

Overall a nice improvement over the GR712RC!

Thank you! Questions?

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