Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface

Contributors:

S. Davy, LESIA, Observatoire de Paris, France (implementation on SORBET instrument)

C. McClements, S. Parkes, Space Systems Research Group, School of Computing, UoD, UK (IP core provider)

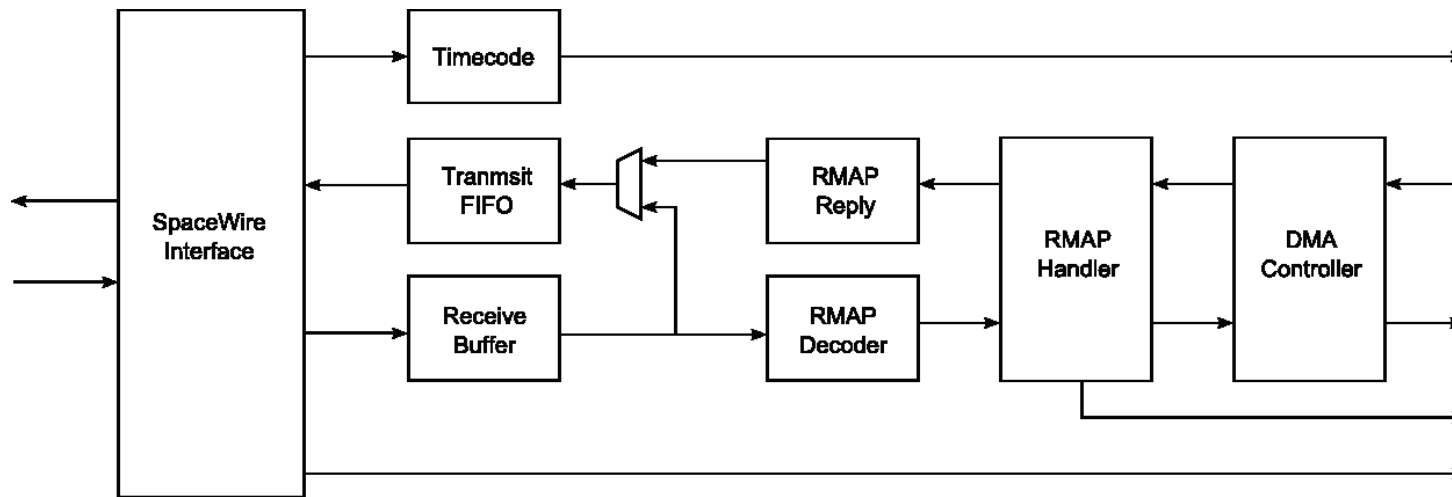T.Takashima, Department of Space Plasma Physics, ISAS/JAXA (MMO contractor)

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Outline

1. IP core description

2. Japanese MDP / Sensor electronics

3. Case study: SORBET instrument

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
IP core: overview

SpW nearly compliant with ECSS-E50-12A; exceptions are:

–   physical layer shields will be removed to save mass

–   capable to boot and run at 2MHz to save power (sucessfully tested in March).

Loopback at SpW Rx/Tx buffer level for debugging purposes.

Partially ECSS-E50-11 RMAP compliant; exception is:

-   implements only 5 out of the 11 possible command types.

Includes a DMA Controller.

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:

IP core: supported RMAP command types

Code	Description	Supported
"0000"	*Not used*	-
"0001"	*Not used*	-
"0010"	*Read single address*	*No*
"0011"	**Read incrementing address**	Yes
"0100"	*Not used*	-
"0101"	*Not used*	-
"0110"	*Not used*	-
"0111"	*Read-modify-write incrementing address*	*No*
"1000"	*Write single address, no verify, no acknowledge*	*No*
"1001"	**Write incrementing address, no verify, no acknowledge.**	Yes
"1010"	*Write single address, no verify, send acknowledge*	*No*
"1011"	**Write incrementing address, no verify, send acknowledge.**	Yes
"1100"	*Write single address, verify data, no acknowledge*	*No*
"1101"	**Write incrementing address, verify data, no acknowledge.**	Yes
"1110"	*Write single address, verify data, send acknowledge*	*No*
"1111"	**Write incrementing address, verify data, send acknowledge.**	Yes

Operation	Write	Verify	Acknowledge	Increment
Housekeeping Read	0	0	1	1
Sensor Read	0	0	1	1
Sensor Write, no acknowledge	1	0	0	1
Sensor Write, with acknowledge	1	0	1	1
Command Write, no acknowledge	1	1	0	1
Command Write with acknowledge	1	1	1	1

Operation Command Codes

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
IP core: provision and status

Available through JAXA (MMO Europeans and UoD to sign NDA).

Source (Xilinx/Actel) and netlist (Actel Block Flow) delivery

Tested on Spacewire USB brick (Xilinx), first delivery in January 2008.
Simulated and Tested for Actel RTAX FPGA, chip programmed last April.

RTAX1000S area occupation:

```
SEQUENTIAL (R-cells)        Used: 1080   Total: 6048     (17.86%)
COMB (C-cells)              Used: 1615   Total: 12096    (13.35%)
LOGIC (R+C cells)           Used: 2695   Total: 18144    (14.85%).
```

5 license agreements signed at present day.

Validated with C.McClements technical support in SORBET instrument digital unit FPGA (both Xilinx/Actel) with Leon3 GPL processor.

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Context: Japanese MDP / Sensor electronics
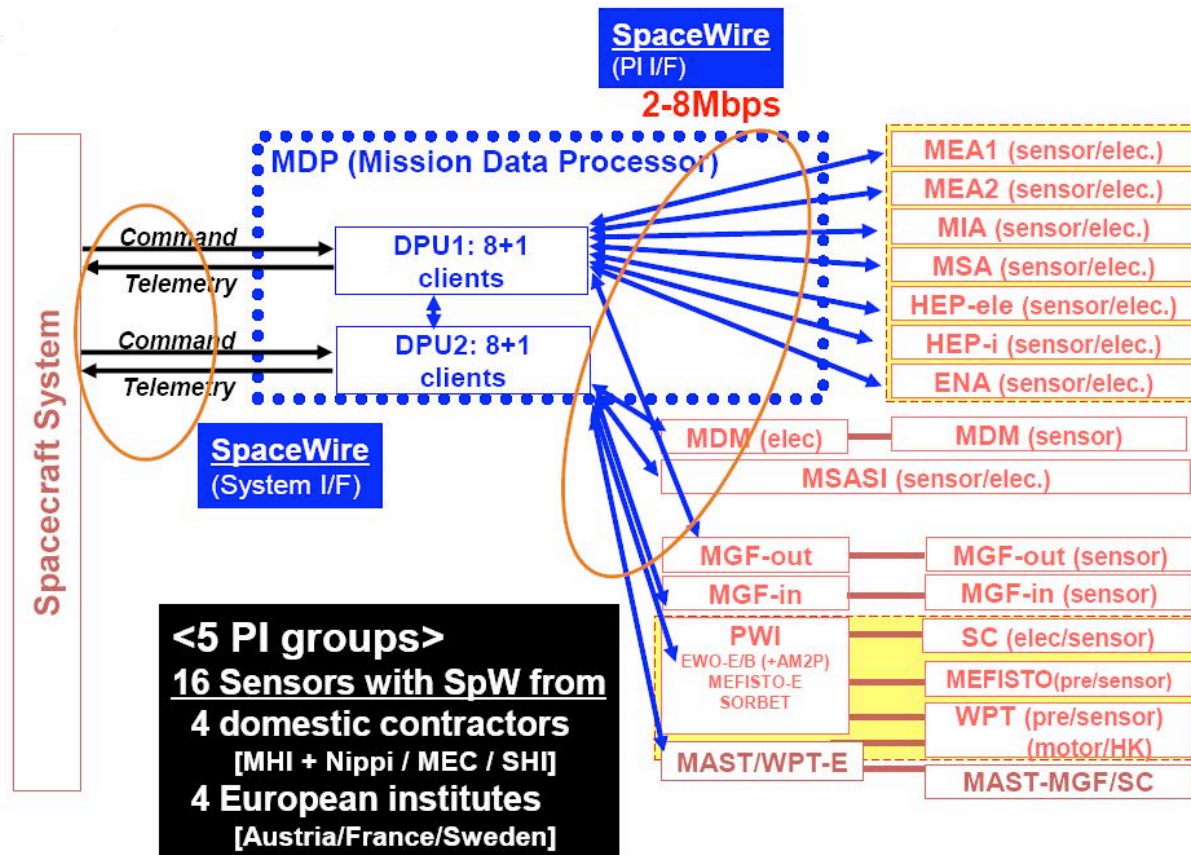
MPPE: particules

-MEA1, MEA2 (e⁻ analyser)

-MIA (ions analyser)

-MSA (mass spectrometer)

-HEP–ele(e⁻), HEP-i (ions)

-ENA (energy neutral)

MDM: dust monitor

MSASI: Na Atm. Imager

MGF : fluxgate

PWI: plasma waves

-EWO, (DC, LFR)

-MEFISTO, (active antenna)

-SORBET (radio receiver)

MAST/WPT

RMAP allows:
• CPU to be free in order to perform other critical tasks
• Homogeneous design regarding sensor electronics

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Case study: SORBET instrument (1/3)

- Thermal noise and HF radio receiver (co-PI: M. Moncuquet; PM: M. Dekkali)
- Digital Unit FPGA: Actel RTAX1000S / Leon3FT (Xilinx for prototyping)
- Purpose: TM (science), TC, HK (voltage, temperature)
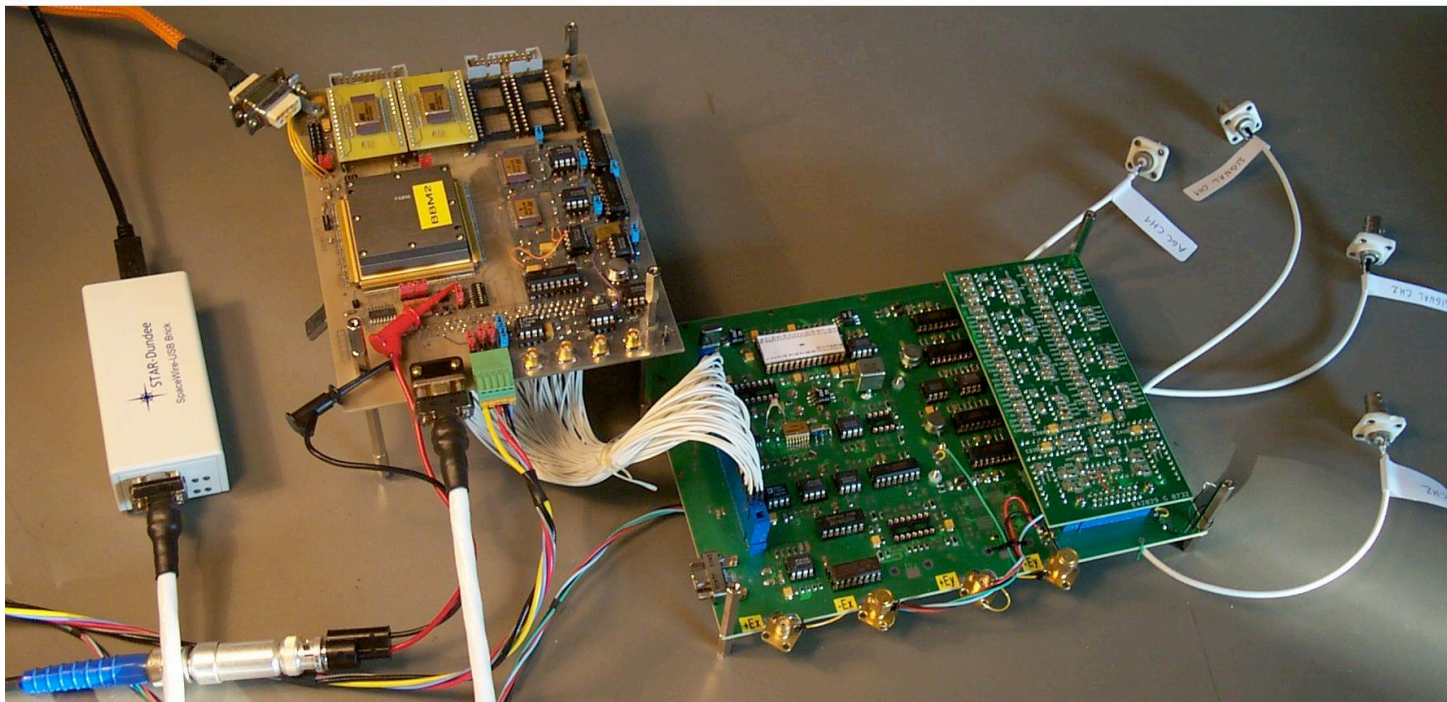
Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Case study: SORBET instrument (2/3)
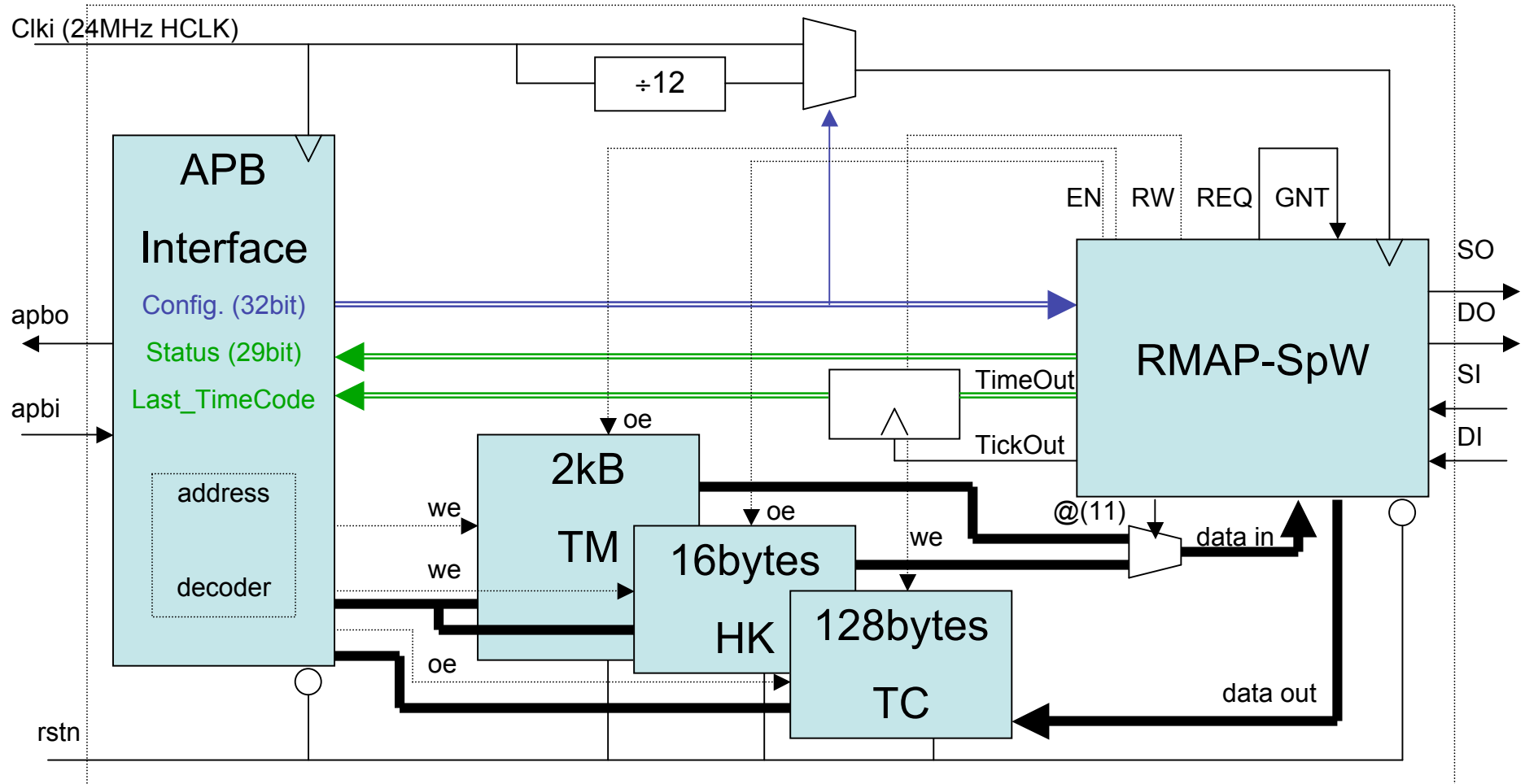
RMAP-SpW IP core in SORBET instrument FPGA

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Case study: SORBET instrument (3/3)

- UoD Validation Software
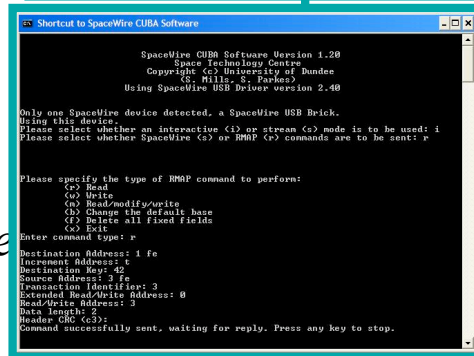
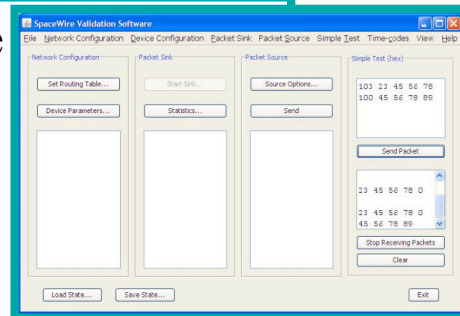- *Link control*

- *SpW Rx/Tx*

- *Time codes analysis*

- UoD CUBA Software

- *SpW stream/interactive*

- *RMAP stream/interactive*

- Custom application using Brick C API
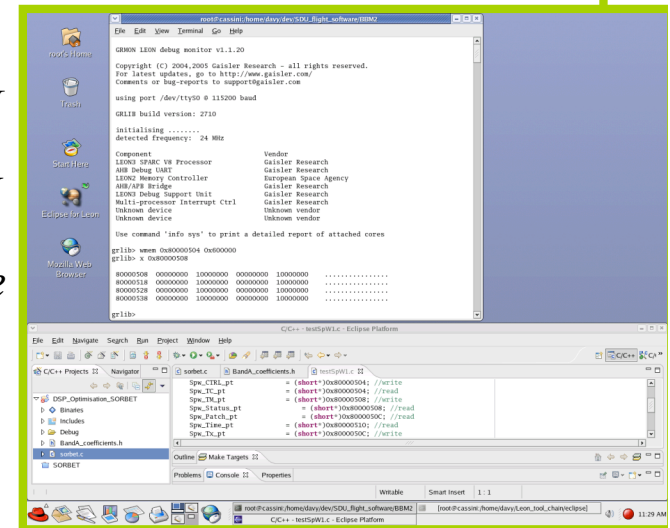
- grmon

- Testbench programs

- *read TC*

- *write TM*

- *write HK*

- *read time*

- *irq*

USB

RS232

USB-SpW Brick

SORBET instrument

DSU Digital

Unit

Spacewire cable

Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface:
Conclusion

- Specific IP core used on MMO in Actel FPGAs

- Validated on Xilinx FPGA

- Validated on Actel AX FPGA, EM Actel AX1000 FPGA under design

- European contributors have to deliver EM with RMAP-SpW in ~4 months

- Flight Model delivery: early 2010.

- Launch: 2014. Turn on for science: 2020.

Complementary information:
« Introduction to SpaceWire Applications for the MMO S/C in Bepi Colombo Mission »
by Y. Kasaba, available at:
http://spacewire.computing.dundee.ac.uk/proceedings/