Reduction of the Harness
The One Interface Illusion

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Picture: Space Passive Component Days 2013 Session 4 - Malagoli – Courtesy of ADS

Why change – It was always like this

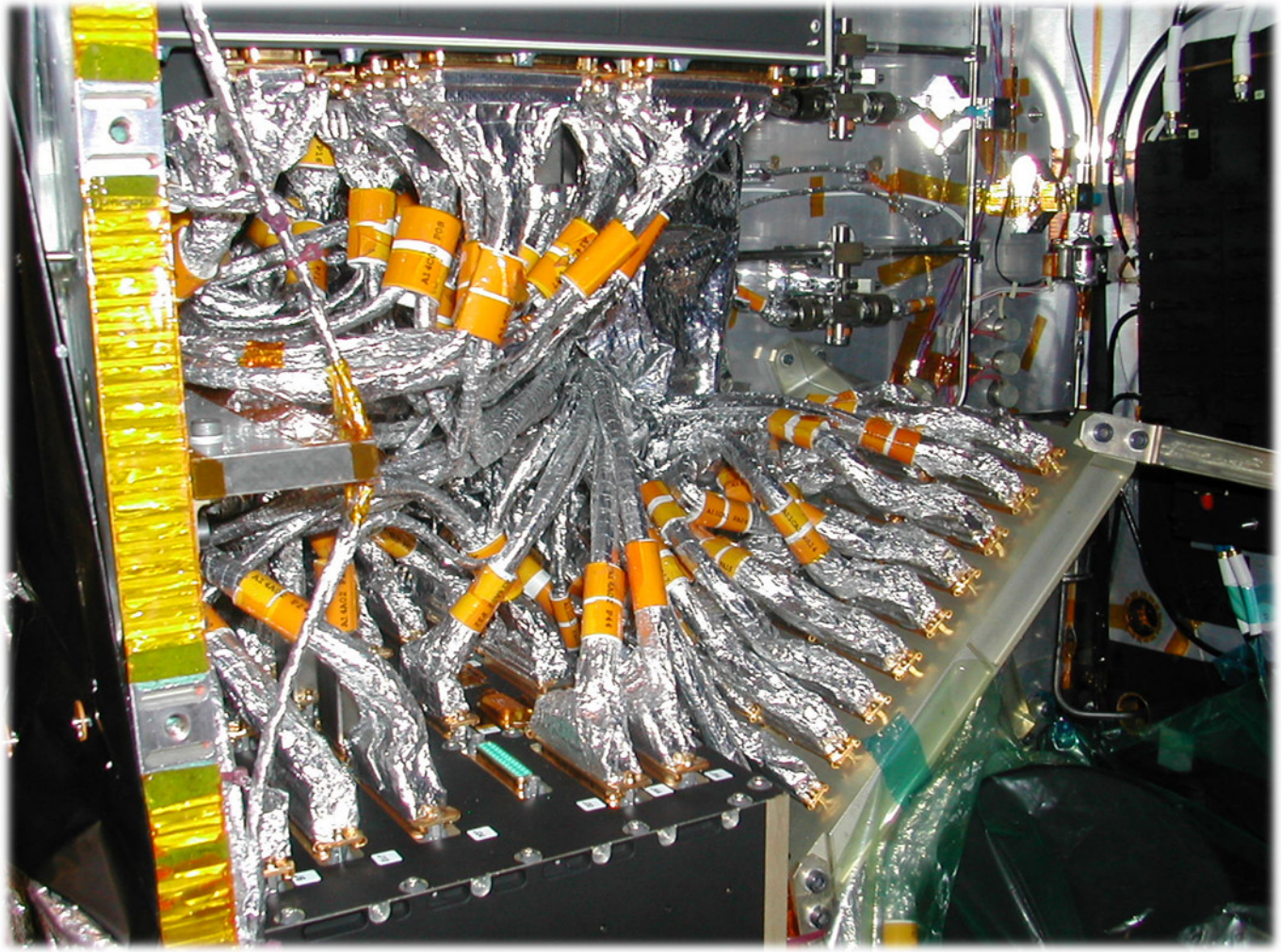
- Harness reduction is a recurrent topic, but
- Evolution on the topic seems to be difficult

"I'm involved in missions for 20 years and did not see a significant change on this over the years"

- Nevertheless it seems to make sense to think about it
- A huge satellite has (SPCD 2013 – Malagoli)
  - 50.000 connections
  - 1.000 connectors
  - 20.000 meters of wires
  - harness mass exceeding 100kg

Picture: Courtesy of ADS - SPCD 2013

Why change – Because it is like this



Picture: Courtesy of ESA - MarsExpress

What can be done

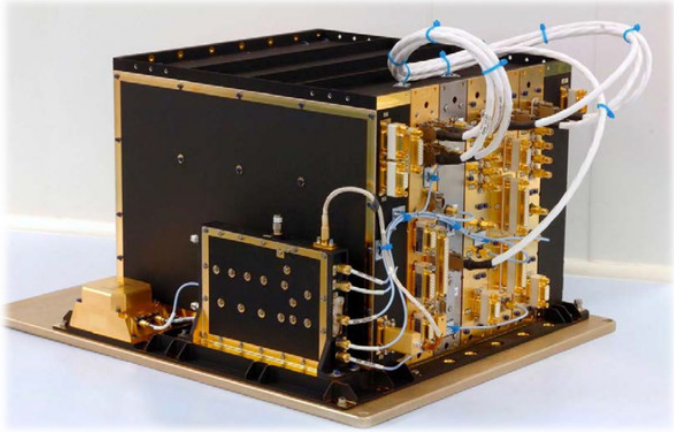
- Harness based
  - Cable length/ volume/ mass

- Architecture based
  - Assessment of current solutions
  - Reducing the number of interfaces
  - Combining functions

Picture: Courtesy of ESA – Seosat RTU

Payload Interfaces

- Science Data
  - SpaceFibre, WizardLink, SpaceWire
- Command & Control
  - SpaceWire, CAN, MIL-1553, UART
- Discrete Signals (ECSS-E-ST-50-14C based)
  - Digital: Switch operation, Status detection
  - Analog: Power/Temperature telemetry
- Timing
  - 1 Pulse per Second synchronization
- Survival
  - Heaters
  - Temperature sensors

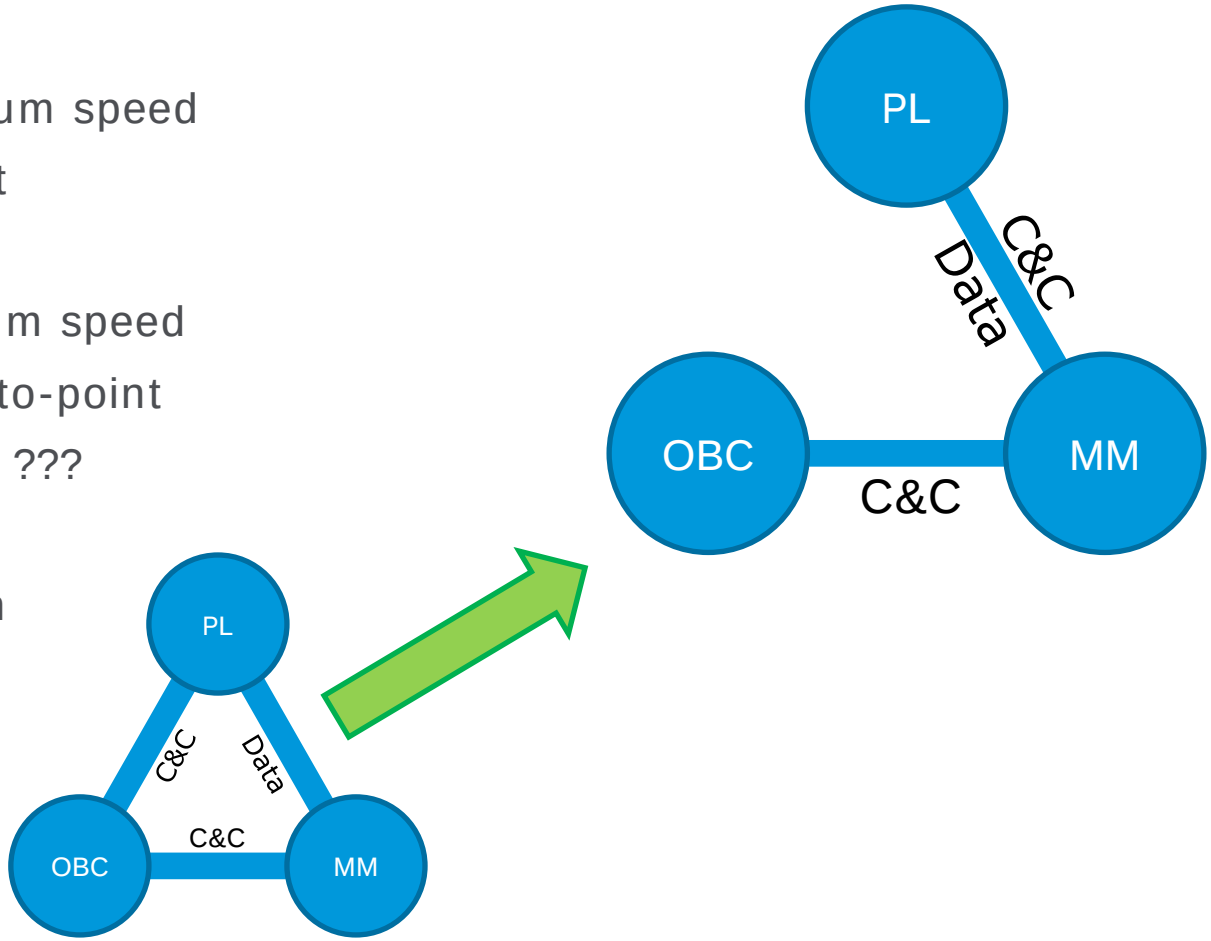


Picture: Courtesy of ESA – Sentinel1 SES

Instrument Point of View (1/3)

- Science Data
  - High to medium speed
  - Point-to-Point
- C&C
  - Low to medium speed
  - Bus or point-to-point
  - Deterministic ???

Approach: Combine them



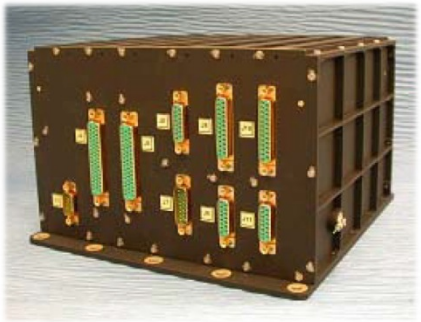
Instrument Point of View (2/3)

Discrete Signals

- ON/ OFF telemetry and command

  Approach:

  - LCL/ Switch in Power Distribution Unit
  - WoC – Wake-on-C&C
  - TC-OFF via C&C

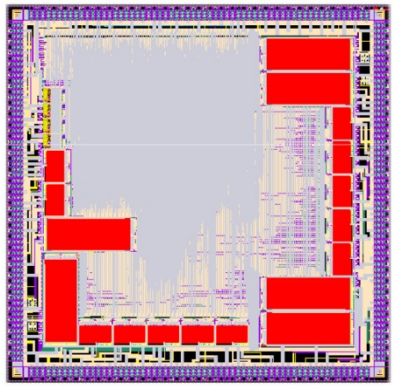


Picture: Courtesy of TAS - PCDU

- Analog telemetry, status detection

  Approach:

  - Sensor circuitry (ADC) included in instrument
    - ✓ Mixed-Signal ASICs & uController
  - Telemetry via C&C



Picture: Courtesy of Tesat - KNUT

Instrument Point of View (3/3)

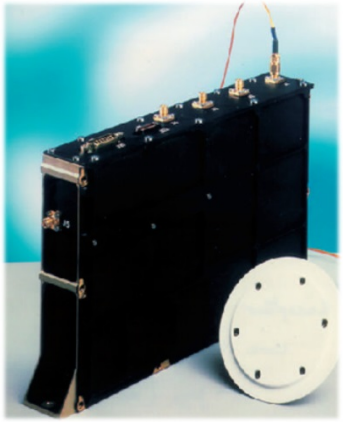
Time Synchronization

- Mission needs define synchronization performance
- 1PPS gives best results, but may be better than needed

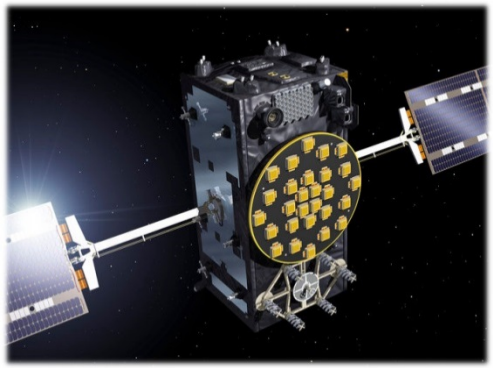
Approach:

- via C&C interface => SpaceWire time codes

Picture: Courtesy of ESA



Picture: Courtesy of Alcatel

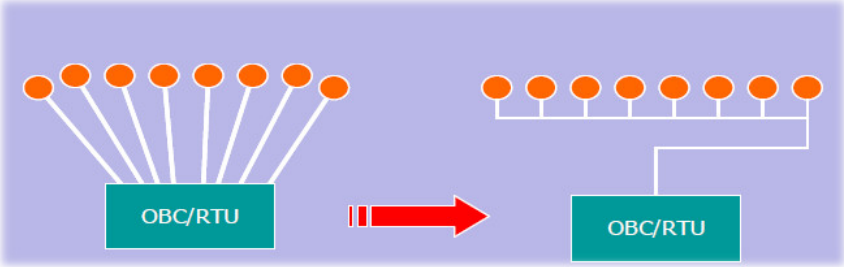


Picture: Courtesy of ESA

System Point of View

Independent payload thermal control

- Survival Heaters
- Temperature Sensors



Picture: Courtesy of G. Furano

Approach: Sensor Bus

- SPI/ I2C
  - reduces number of interfaces ☺
  - additional bus ☹
- Combine with TM/TC ???? - difficult

Why all of this

- Synergy effect on Payload and Platform side
- Simplifies architecture, reduces harness
- Harmonization of Platform and Payload bus
- Scalable architectures
- Sensors with higher data rate for Payload in the loop
- Overcomes the MIL-1553 “Heritage” barrier

- Refer also to ADS presentation at SpW Conference 2014:

  SpaceWire 2: Needs and Evaluation Metrics

  O. Notebaert J. Lachaize, R. Clavier, A. Fueser, H.J. Herpel, G. Montano, L. Planche

Summary of the ideas

- Combine C&C and Science data bus
- Time synchronization via suitable C&C interface protocols
- Discrete Signals to be replaced by functions integrated in PF and PL
  - TC ON/OFF =>LCL/ switch in PSU, WoC
  - PL digitized analog signal telemetry via C&C bus
- Connect sensors/ actuators for PF managed PL control via sensor bus
- Corresponding standards to be written or updated

Comments welcome to get the round table discussion started

☺

Another Interface Challenge – Coming Soon

Thanks for your attention