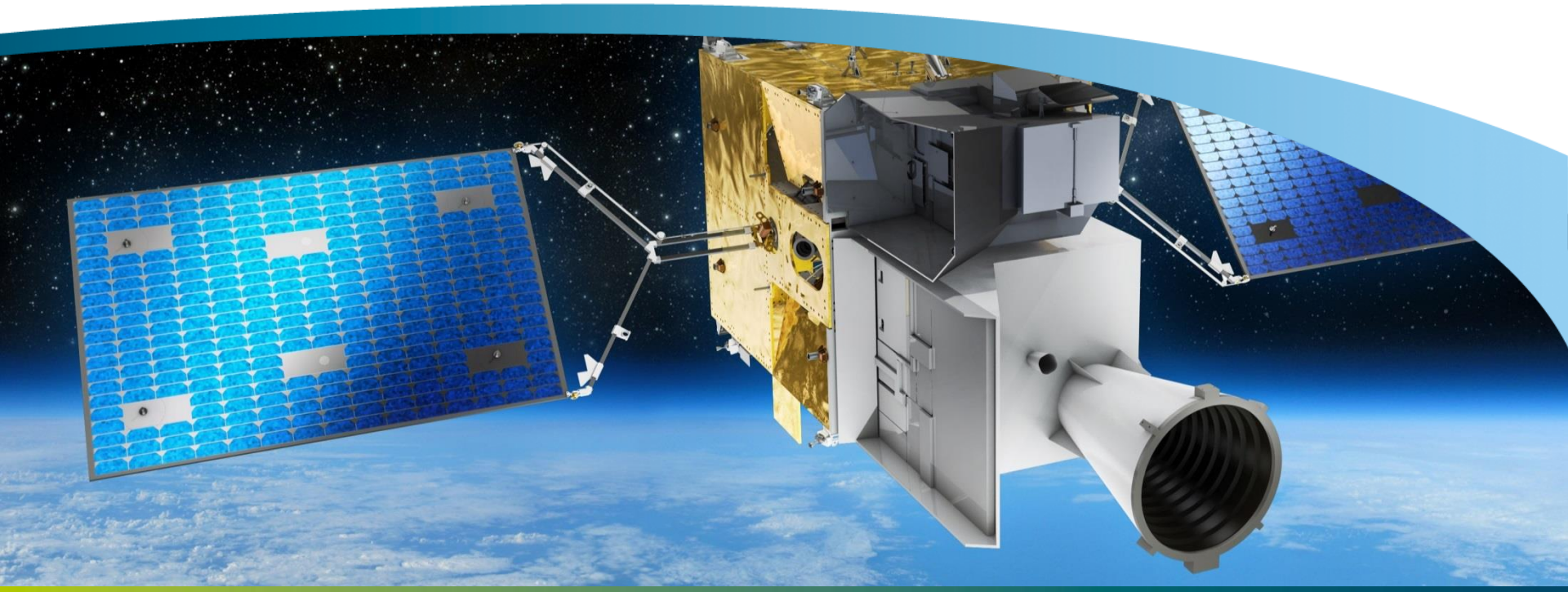
OHB System AG
Dr.-Ing. Holger Michel
12.06.2019, Gothenburg



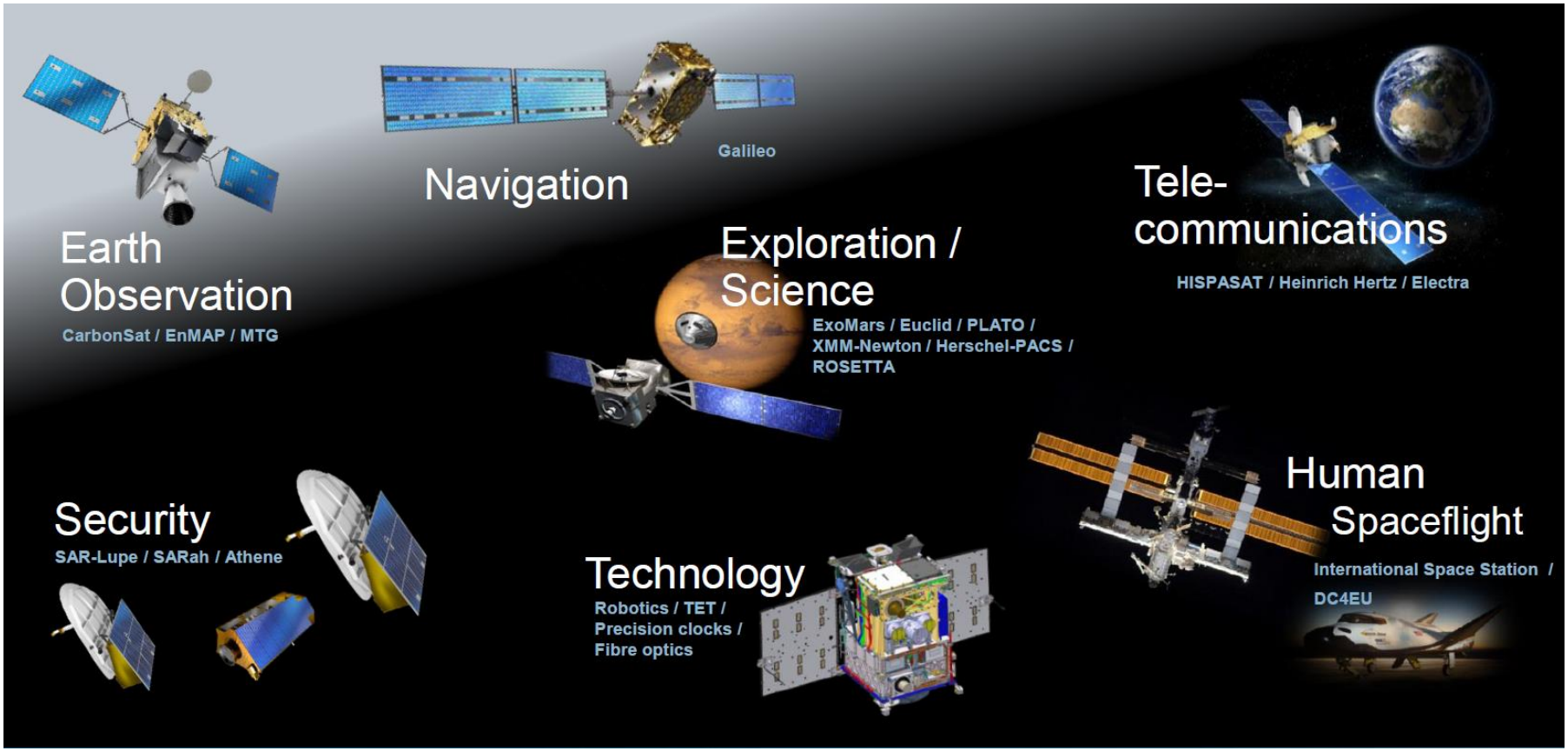
SPACE SYSTEMS

CAN-Bus usage in OHB Satellites

We. Create. Space.

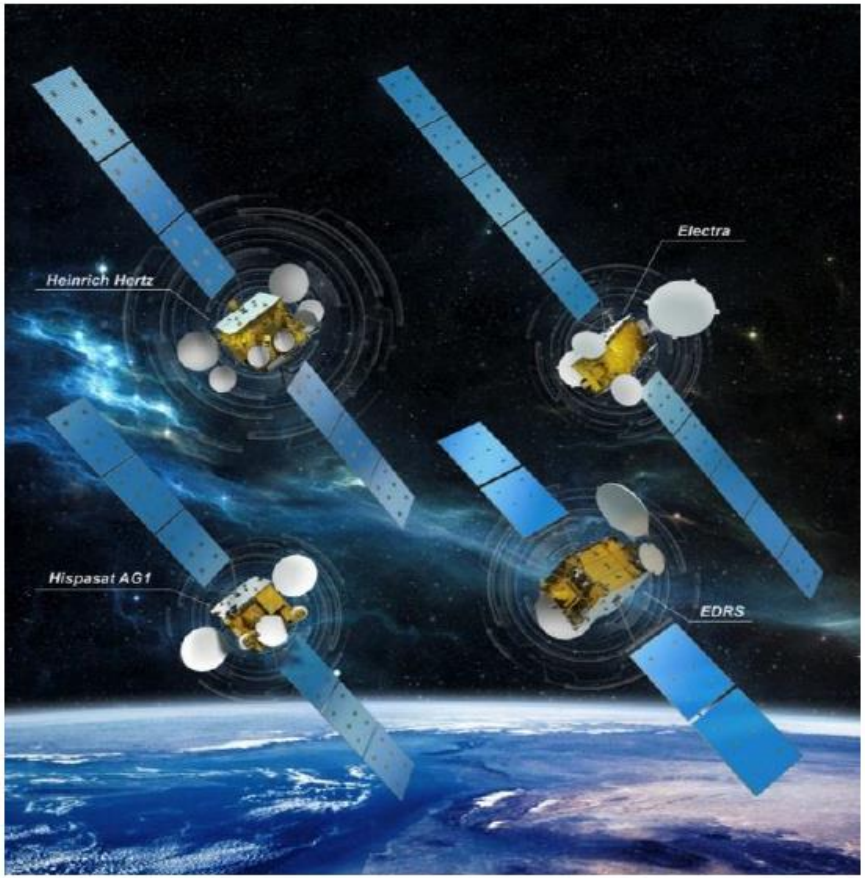
Outline

- OHB System AG (Bremen) and its product lines
- CAN-Bus in telecom payloads
- FDIR
- Reference test bench
- Avionics bus in other satellites
- Conclusion


Earth Observation
CarbonSat / EnMAP / MTG
Navigation
Galileo
Exploration / Science
ExoMars / Euclid / PLATO / XMM-Newton / Herschel-PACS / ROSETTA
Tele-communications
HISPASAT / Heinrich Hertz / Electra
Security
SAR-Lupe / SARah / Athene
Technology
Robotics / TET / Precision clocks / Fibre optics
Human Spaceflight
International Space Station / DC4EU

Programs:

- Hispasat36W-1
  - In orbit; realization under the ARTES 11 program
- EDRS-C
  - ESA ARTES 7: European data relay satellite
- Heinrich Hertz
  - German program: testing innovative communications and platform technologies
- Electra
  - ESA ARTES 33: fully electrical propulsion system

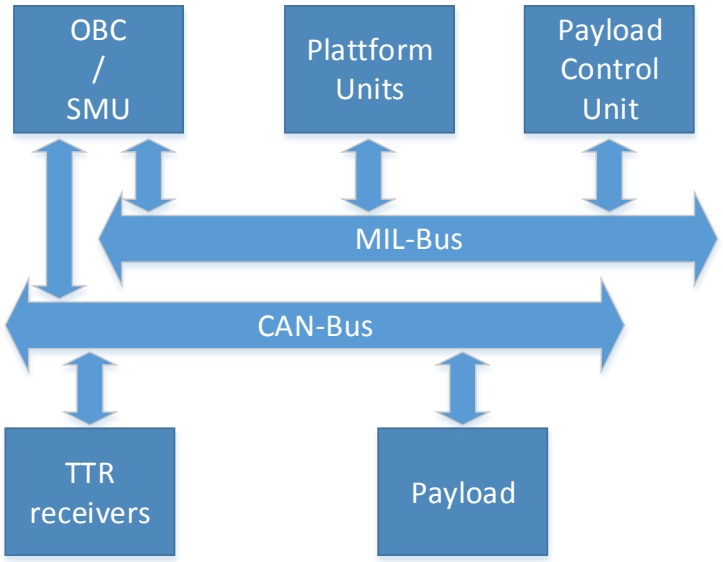


Telecom payloads currently main driver for CAN-Bus implementation:
- Number of addressable nodes
- Availability of units

Electra: CAN as payload control bus directly driven by SMU/OBC

One payload unit on CAN-Bus (limited functionality)

125 kbps



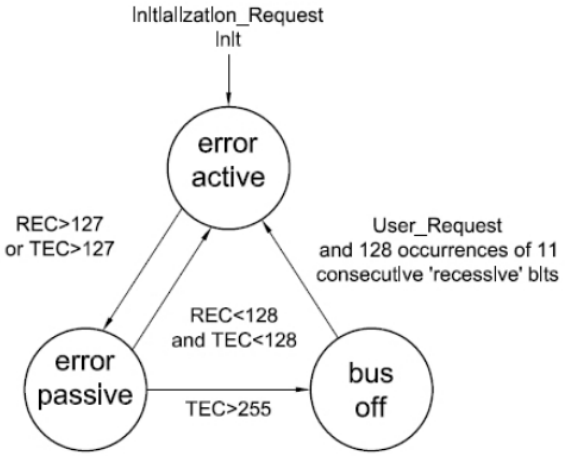
- ISO 11898-1
  - Data link layer and physical signaling
- ISO 11898-2
  - High-speed medium access unit
- ISO 16845
  - Conformance test suite
- CiA (CAN in Automotive) standards
  - Definition of CANOpen protocol
- ECSS-E-ST-50-15C
  - CANbus extension protocol

Tailoring at OHB System:

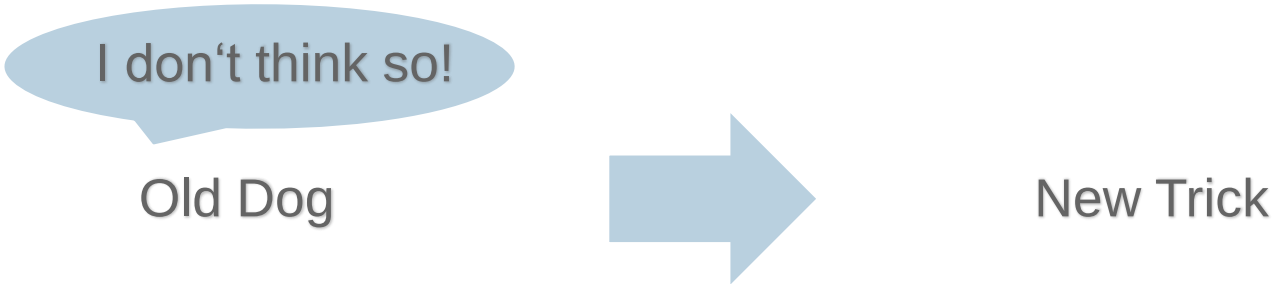
- Node requirements (Available)
  - Single Master
  - CANOpen subset
  - Redundancy
    - Master active switching
    - Slaves with edge detection

- Errors on the Bus detected by CAN
  - Bit monitoring (read-back of the transmitted bit)
  - Bit stuffing (6 consecutive bits of the same level)
  - Frame check (fixed format of some part of the CAN frames)
  - ACK check (all nodes must ACK the correct reception of any message)
  - CRC (15-bit contained in all frames)

- Isolation through CAN-Bus redundancy switching.
- Transition to error passive and bus off



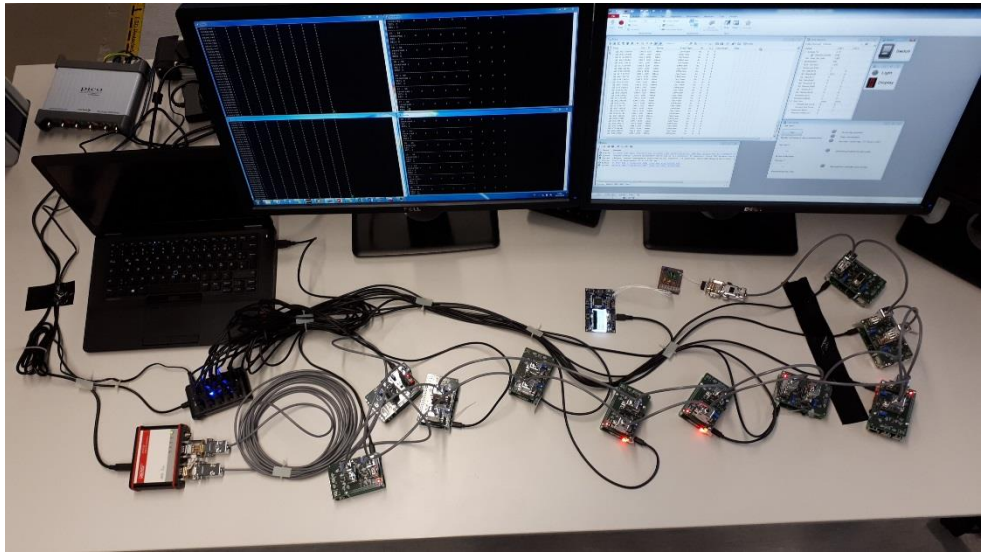
- Some errors in a node‘s CAN controller not directly detectable
- Request reply scheme not inherent to CAN-Bus
  - Needs to move to protocol or node control layer
  - Out of order messages due to arbitration possible
  - Response deadlines hard to define



- ISO 16845 gives good guidelines for node conformance tests

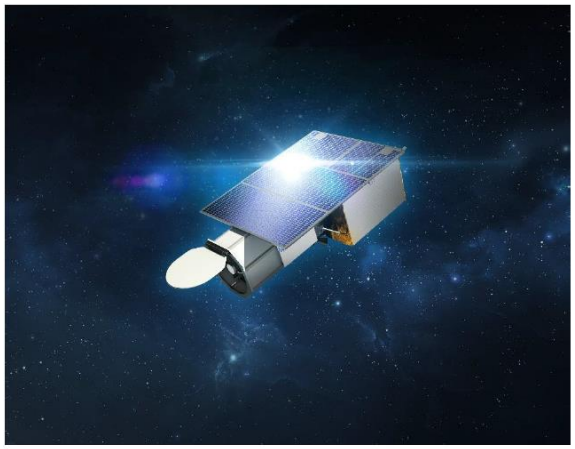
- No standard for system integration interoperability tests and complete bus

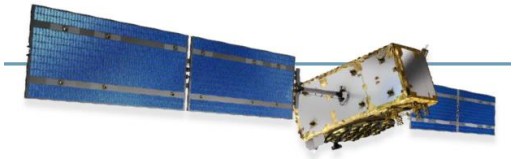
- Topics for system integration test in development
  - Basic Message exchange
  - Overload frames
  - No Acknowledge
  - Status of all nodes (TEC & REC read from nodes)
  - Error Counting in Master (OBC)
  - Babbling idiot
  - Bus switching interaction
  - Failure detection at all participants
  - One Node is not available

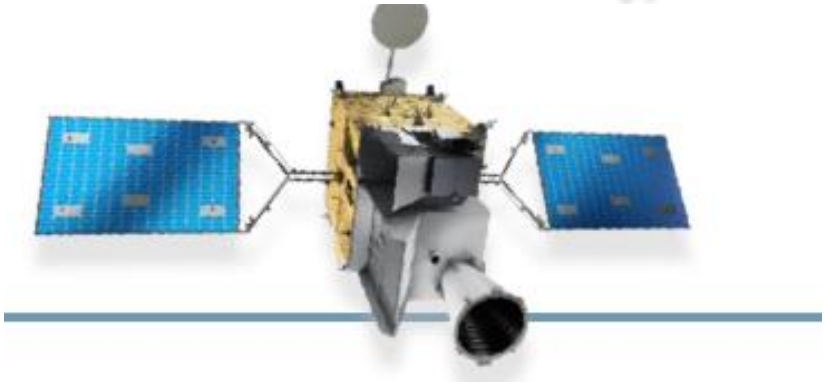


- Zynqberry based low cost slave nodes a single master node
- CANoe analyzer by VECTOR
- Training of AIT
- Software development (Zynq/ARM instead of LEON2)

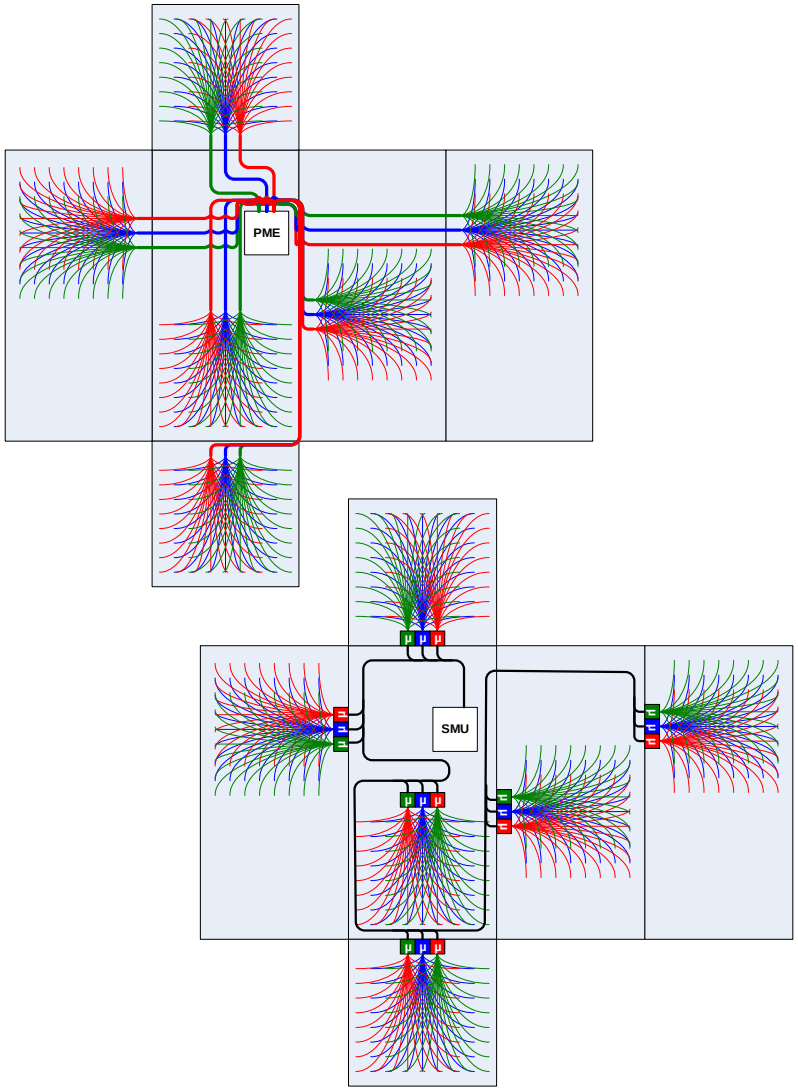
- Navigation
  - Galileo
- Earth observation
  - MTG (Geostationary weather forecast)
- Security
  - SARah (Constellation comprises 3 radar satellites)
  - OPT-SAT (global electro-optical reconnaissance)
- Science
  - PLATO (ESA)







- Harmonization
  - Common units
  - Common architectures
  - Common documentation
- Distributed
  - RTU concept
    - Modular Units
    - TC: HPC
    - TM: ASM, BSM, TSM
    - Dedicated modules
      - Orbit Control Module (Valves)
      - Attitude Control Module
  - AIT advantages
  - MIL-Bus based (CAN considered)
- No further granularization (Not considered)
  - FDIR concerns (ON/OFF TC and TM)
  - Cost of more FPGAs of µControllers



CAN-Bus usage as platform bus

Challenges:

- Real-time
- Data rate (not better than heritage MIL-Bus)
- FDIR and protocol software implementation
- Heritage units

Advantages

- Number of nodes, EMC, Power and weight

- CAN Bus is considered for new data handling system, but currently no advantage is significant enough to convince projects to switch bus system.

- Interest on CAN for platform bus, but concern over FDIR and software maturity overweigh
- New FDIR and software driver/middleware concepts required
- CAN-Bus in telecom payloads and some platform units in development

Thanks for your attention!

Any questions?