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# **Smart components and standardization –**

A huge potential for reducing costs and  
development time of satellite projects

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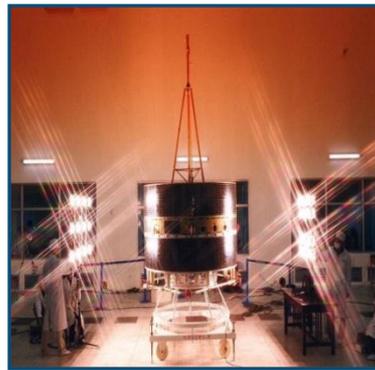
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## **Content**

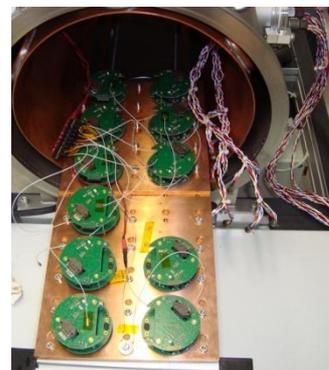
- Introduction
- Overview about standardization in satellite business
- Possibilities of standardization for micro and nano satellite
- Smart components
- RW 90 reaction wheel as example for smart component
- Interaction of standardization and smart components (using the RW 90 as an example)
- Conclusion



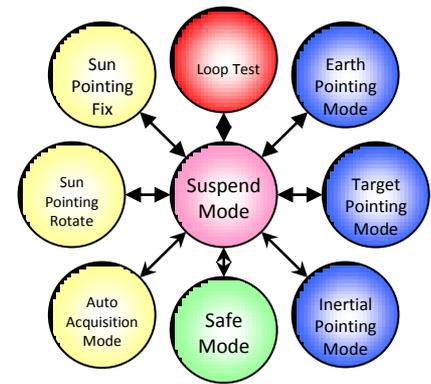
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Structures and mechanisms



Environmental Testing

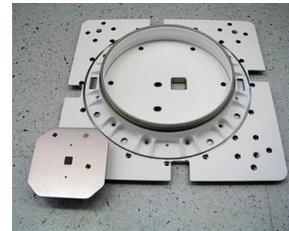


Attitude control systems

## Introduction



Power subsystems

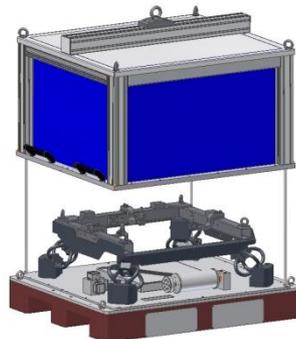


Thermal subsystems



Attitude control  
components for small  
satellites

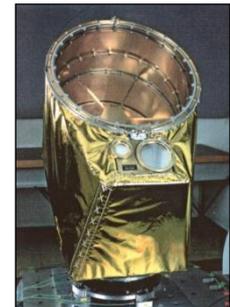
GSE



Small satellite systems



Payloads





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## ***Standardization in satellite business***

### ➤ **Traditional satellite business**

- ECSS, Military stds., NASA handbooks
- Base often on decades old technologies, processes, interfaces

TET-1 satellite for DLR, using tailored ECSS standards, reliability of 0.95 over mission lifetime



### ➤ **Small satellite business**

- Tailored standards of the traditional satellite business
- Company internal standards (depending on customer and mission)

### ➤ **Micro, nano and pico satellite business**

- Nearly no standardization



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## ***Standardization in satellite business***

- CalPoly's Cubesat standard as an successful example for standardization in nano satellite business
- Standardization of size and mass of a pico satellite
- Development of standardized deployment mechanisms like P-Pod, X-Pod, SPL
- Reduction of costs for a cubesat launch



SPL, DPL (and TPL) Cubesat deployment mechanisms



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**Standardization possibilities for micro, nano and pico satellites**

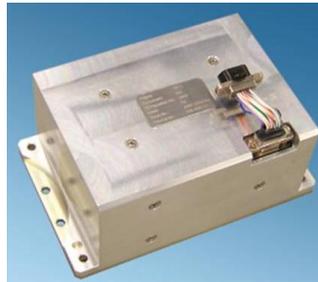
- Standardization of nano satellite sizes and masses
  - Increase launch possibilities
  - Reduce launch costs
  
- Standardization of testing conditions, processes and procedures
  - Make testing more reliable
  - Prevent over-testing
  - Reduce testing costs
  
- Standardization of the satellite bus architecture
  - Especially interfaces and protocols
  - Huge cost saving potential in combination with smart components



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## Smart Components

- Smart components are characterized by following attributes:
  - Digital interfaces
  - Internal monitoring and protective mechanisms
  - Huge data processing capabilities



Examples for smart components AGS-1 (gyro system),  
AGPS (GPS receiver) and RW 90 (reaction wheel)



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***Cost saving  
potential of  
smart  
components***

- Easy integration because of digital interface
- Less engineering and development effort on satellite side because tasks which were hitherto part of the satellite will be performed by the component:
  - Control tasks
  - Monitoring tasks
  - Protection tasks
  - Etc.
- Increased reliability and lifetime of the components and the complete mission



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***RW 90 as an  
example for a  
smart  
component***

## ➤ Digital interfaces

- Allow easy integration of components into a satellite bus architecture
- RW 90 is equipped with RS422/485 interface

Disadvantage:

- Each satellite project has its own interface and data protocol requirements

→ AFW realized more than six different digital interfaces in its reaction wheels according to customer requirements



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***RW 90 as an  
example for a  
smart  
component***

## ➤ Protective and Monitoring mechanisms

- Early identification of upcoming failures
- Giving a good indication about the general health state of the RW 90
- Protective mechanisms like:
  - Latchup protection
  - Temperature monitoring and overheating protection
  - Program flow control

→ Increase of robustness and reliability



RW 90 smart reaction wheel



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**RW 90 as an  
example for a  
smart  
component**

## ➤ Huge data processing capabilities

- Processing tasks which were hitherto part of satellite main system are performed by the wheel
- Model based controllers:
  - Compensating of offsets and time delays
  - Estimation of acceleration reserve
  - Software power limiter
  - etc.

Compensation of displacement offsets using model based controllers





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***Interaction of  
standardization  
and smart  
components***

- Each satellite project has its own interface and data protocol requirements to the components
  - Implementing a new digital interface into components means additional engineering effort, delta-qualification and testing → additional costs
  - Implementing converter circuits in the satellite means additional power consumption and an additional failure source
- ➔ **Standardizing the digital interfaces and data protocols generates a huge potential for cost savings!**



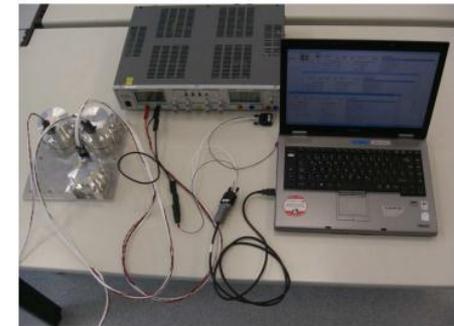
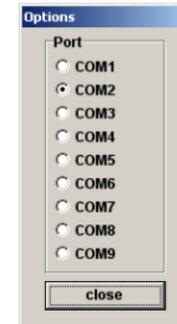
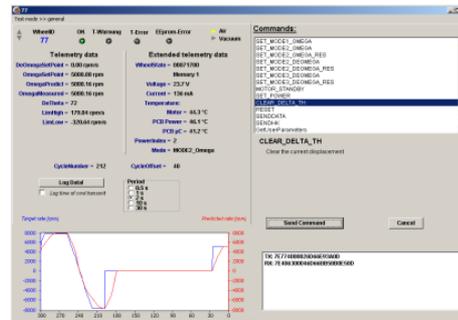
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*Interaction of  
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➤ A look ahead

– Plug & Play satellite

- Comparable to a PC and its peripherals (printer, keyboard, mouse, etc.)
- Just **plug** component to a satellite architecture
- And **play** (operate the component)



**Prerequisite:**

**Standardized interfaces and protocols!**



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## **Conclusion**

- Micro, nano and pico satellites can be a cost effective alternative or supplement to bigger satellites
- There is an additional cost savings potential if these systems would be more standardized
- The use of smart components can generate a further cost savings potential
- **But only in combination with standardization smart components can tap their full cost savings potential**



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**Thank you for your attention!**

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