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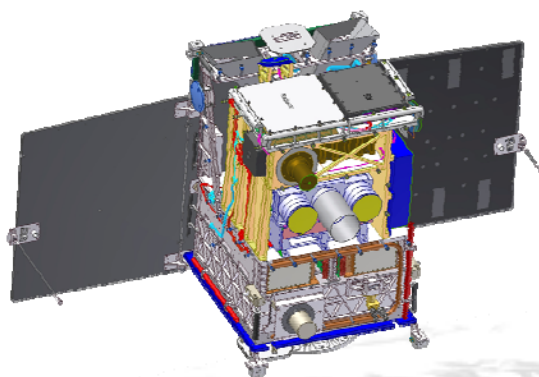
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From Earth to Space - and back



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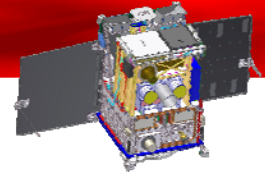
2nd TET Customer Day

TET User Manual

Munich, 05.07.2010

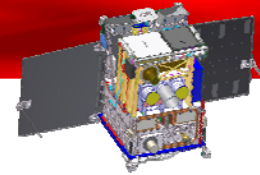
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Motivation

- Provision of condensed information for payload suppliers:
 - Overview on mission concept and its elements:
 - TET Space Segment (satellite)
 - TET Ground Segment (mission control)
 - TET Launch Segment (launcher)
 - TET Mission Phases (launch, LEOP, commissioning, operation, disposal)
 - Description of payload concept / Payload Supply System
 - Requirements for payload accommodation:
 - Interfaces between Payloads and Payload Supply System
 - Payload verification
 - Deliveries
 - PA Requirements
 - Annexes with TET-1 details

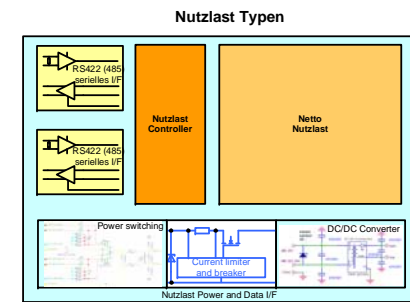


Payload Concept

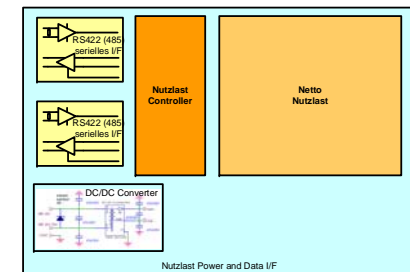
■ Payload candidates are categorized into 4 payload types with different demands on TET accommodation:

- **Type 1:** Fully autarkic, with own power switch and fusing >>> primary power, relay commands and UART I/F
- **Type 2:** in contrast to type 1 no power switch and fusing implemented
- **Type 3:** like type 1 but lacks of internal payload controller >>> needs simple controlling support from NVS
- **Type 4:** no power supply and controller implemented >>> needs full support from the NVS (e.g. solar cells)

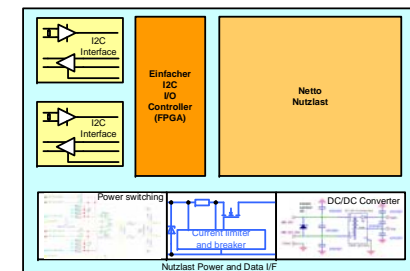
■ Note: NVS provides current limiter / breaker to each payload, thus type 2 will be standard.



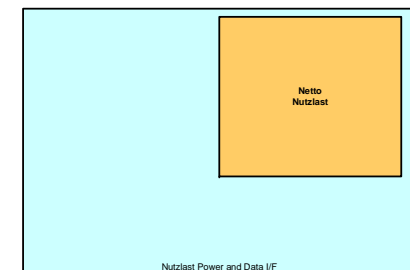
Nutzlast Typ 1



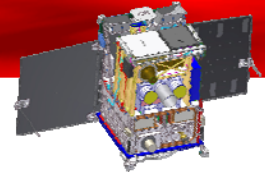
Nutzlast Typ 2



Nutzlast Typ 3



Nutzlast Typ 4



Model Philosophy

Three payload models shall be provided:

■STM (Structural and Thermal Model)

Used for structural/thermal verification of the overall TET design on system level

>>> identical to PFM with respect to mass, CoG, overall envelope, connector positions, fixation points, power consumption and housing material/surface properties.

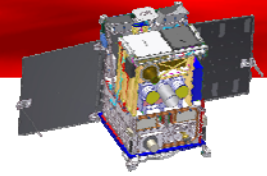
■EM (Engineering Model)

Used for interface and SW verifications on system level as well as for mission reference and trouble shooting

>>> identical to PFM in form, fit, function.

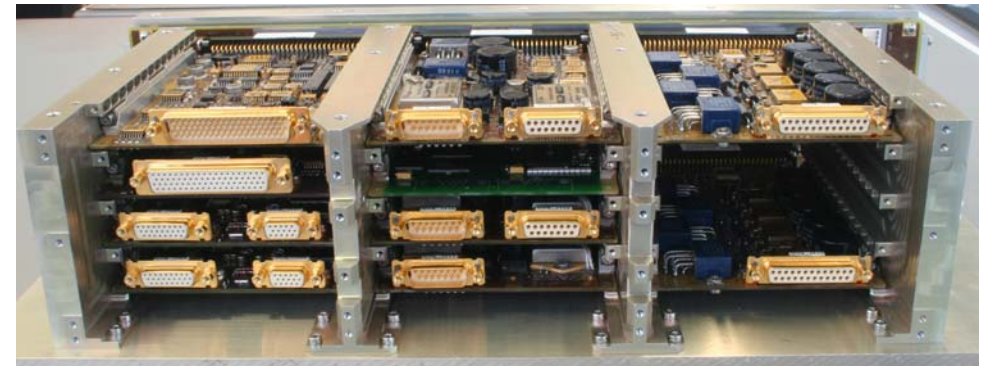
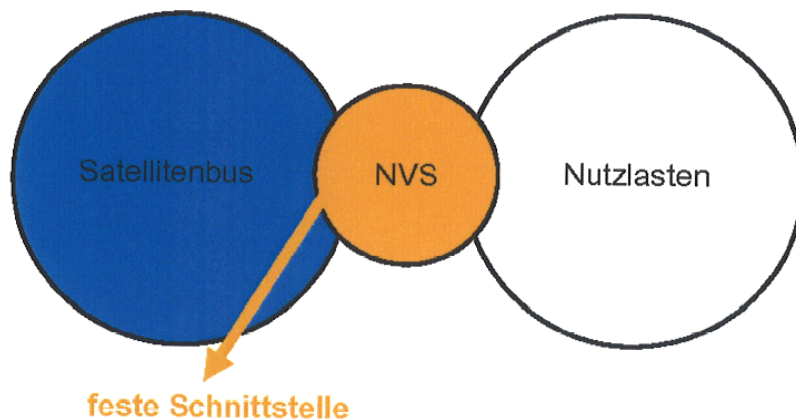
■PFM(Proto Flight Model)

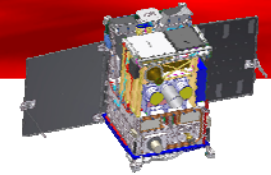
Shall demonstrate performance, compatibility to TET interfaces and mission environment.



Payload Supply System (1)

- Payloads are not having a direct interface to the satellite.
 - All power and data interfaces are routed via the Payload Supply System (Nutzlastversorgungssystem – NVS).
- All NVS power outputs are LCL protected.
- All NVS data I/F are galvanically decoupled or differential.
- The NVS is a modular system which can accommodate up to 12 modules.
- TET-1 occupies 9 slots leaving 3 as spares and/or for accommodation of payload modules.

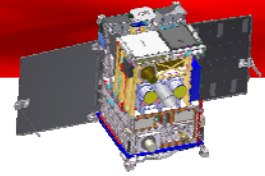




Payload Supply System (2)

TET-1 Configuration

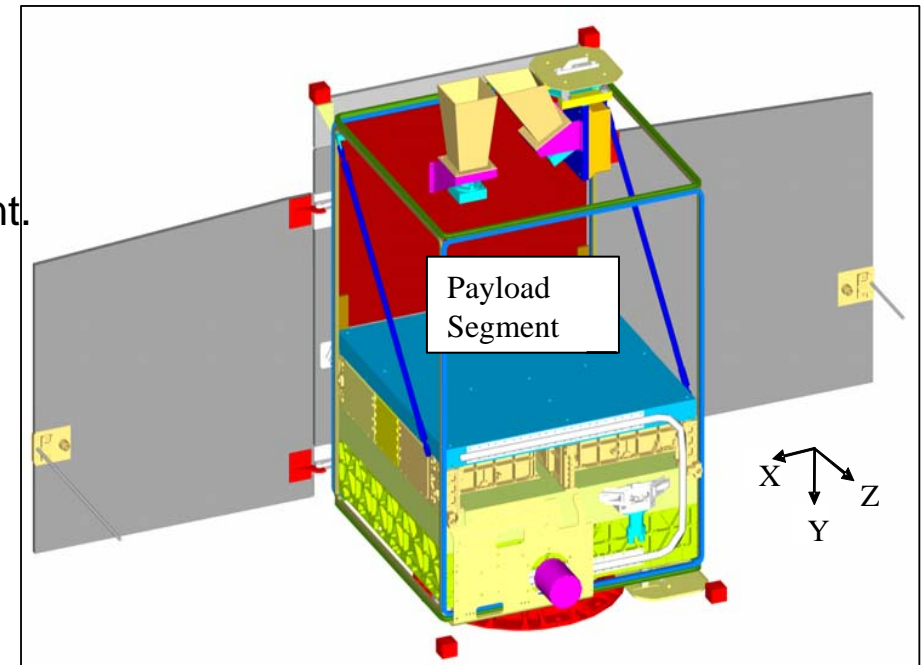
Interface Type	Quantity	Quantity	Remarks
Primary power	2 (8A)	4 (3A)	17 – 24V
Secondary power + 5V	1 (1A)		DC/DC converter
Secondary power ± 12V	1 (1A)		DC/DC converter
UART RS-422	6		differential (115,2 kBit/s max.)
I2C	1		differential
Spacewire	3		differential (14Mbit/s max.)
Digital-In	9		Optocoupler / relay on payload
Analog-In	11		differential, 5 Spares
Temperature sensors	18 (AD590)	6 (PT1000)	2-wire, 4 x AD590 Spares
Digital-Out	20		Optocoupler on payload, 4 Spares
Digital-Out serial	1		Optocoupler on payload (DAC Control)
PPS	2		Time synchronisation
Relay commands	22		600mA max., 2 Spares
	basic	optional	

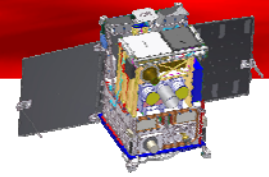


Resources, Interfaces, Requirements (mechanical)

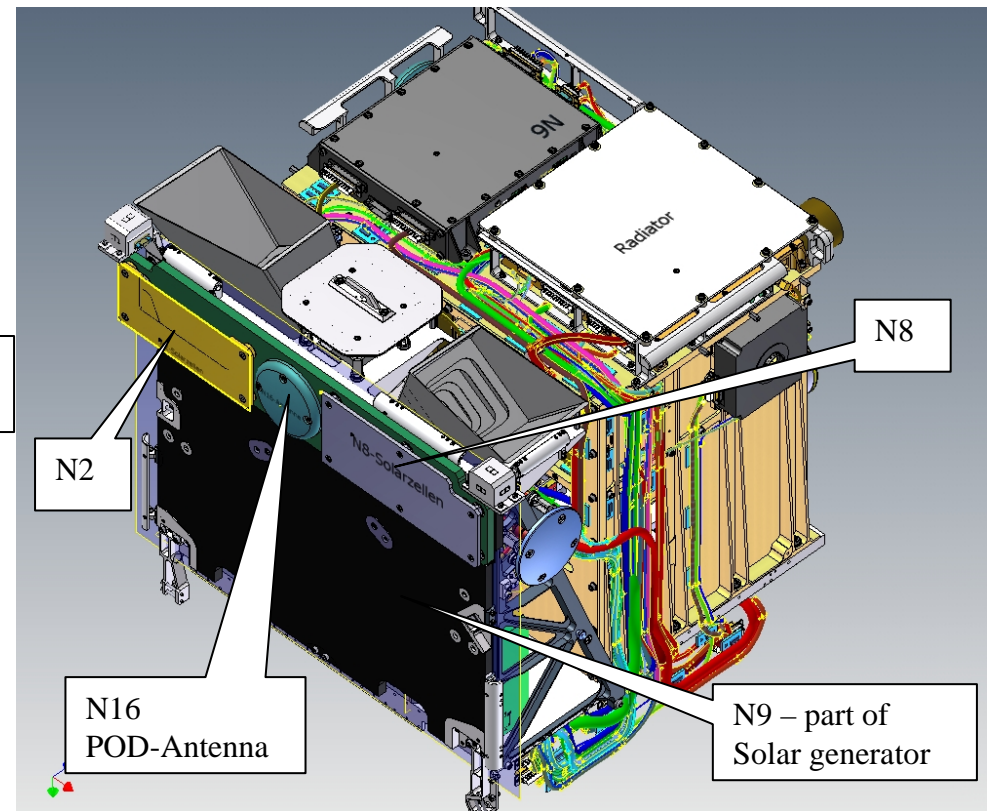
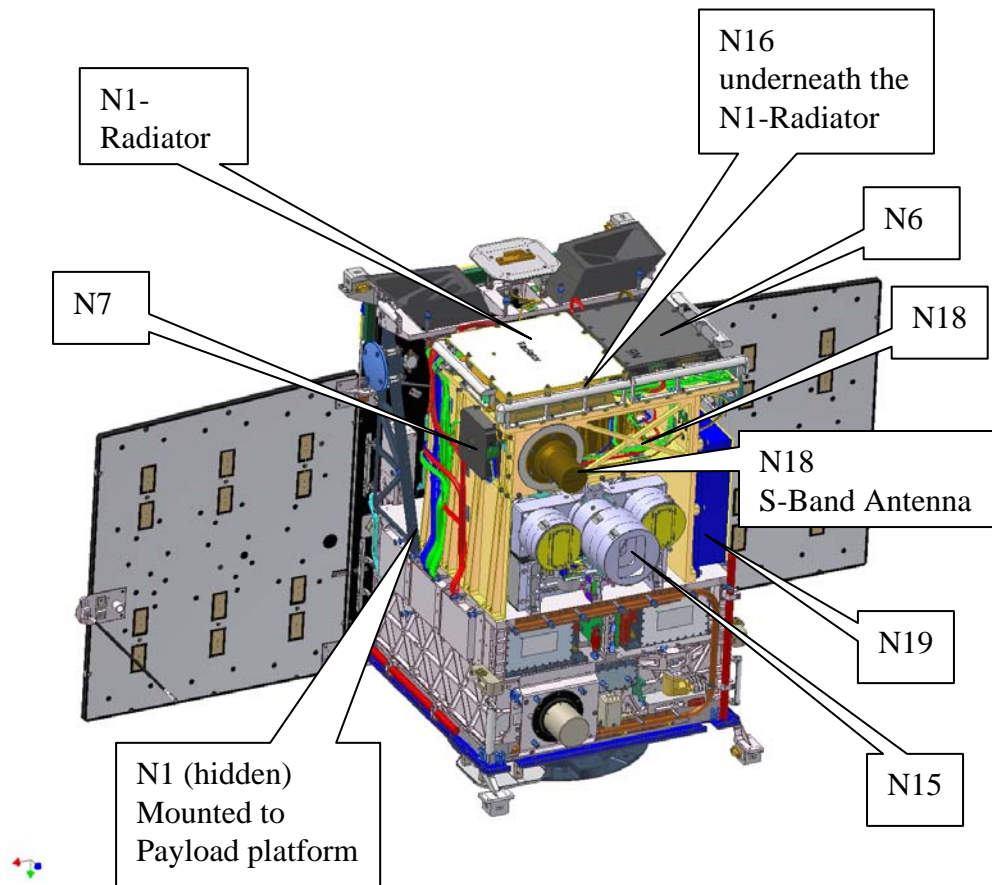
- Volume of Payload segment: $460 \times 460 \times 428\text{mm}^3$
- Area of external Payload Panel: about $420 \times 95\text{mm}^2$
- Allowable mass of total payload: 50kg
 - >>> including mass of NVS (basic version 4kg)
- Dedicated secondary structures are provided for payload accommodation inside the payload segment.

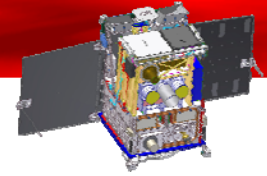
- **Required information from payloads, e.g.:**
 - Mass
 - Centre of Gravity
 - Dimensions
 - Position of mounting holes / connectors
 - Texture of surface and treatment
 - Position and size of venting holes
 - Position and marking of labels
 - Remanent magnetism value





Accommodation (TET-1 Configuration)





Resources, Interfaces, Requirements (electrical)

■ The power to payloads (including NVS) is limited to:

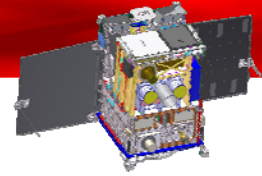
- Constant power: up to 20W (thereof about 8W are reserved for the NVS)
- Peak power: 160W, max 6000Wmin per orbit and 54000Wmin per day (power losses inside the NVS to be considered).

>>> in all cases the thermal budget of the satellite must not be compromised.

- Primary power is isolated to structure
- Secondary GND is connected to structure (need to be separable)

Required information from payloads, e.g.:

- Power Input range
- Power Consumption, differentiated into operational modes and duration
- Input current (inrush, nominal, peak)
- Level, impedance, coupling of I/O signals
- Requested resolution, accuracy of analog data acquisition
- Timing constraints
- Sketches of I/F circuits and grounding diagram



Resources, Interfaces, Requirements (communication)

■ Downlink capability:

- High Gain Antenna: **2,2 Mbit/s**
- Low Gain Antenna: **137,5 Kbit/s**

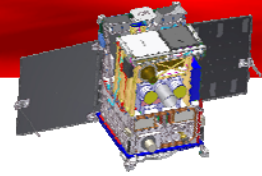
■ Uplink capability: **4 kB/s**

■ Data Storage (NVS): **512 MB**

■ All payload data are packed into CCSDS frames before storage and downlink.

Required information from payloads, e.g.:

- Data volume per operational Mode and duration.
- If applicable, size and duration of data bursts.
- Data format.
- Data rate.
- Definition of commands and command sequences per mode.
- Treatment of off-nominals.



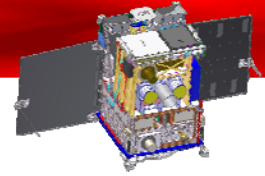
Resources, Interfaces, Requirements (thermal)

■ The payload platform is kept within a temperature range of -10°C and $+30^{\circ}\text{C}$.

- Assumption: 20W continuous payload power consumption.
- Higher payload power consumption need to be sequenced by operation scenario.
- Payloads on secondary structures may see lower/higher temperatures due to temperature gradients.
- Payloads exposed to Space may see temperatures between about -20°C and $+110^{\circ}\text{C}$.
- Details are derived by Thermal Analysis and Test (STM)
- Payload safe mode is activated at $+40^{\circ}\text{C}$.

Required information from payloads, e.g.:

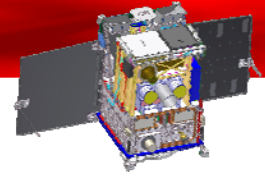
- Material of housing.
- Surface treatment.
- Contact area and texture of fixation points.
- Alpha/epsilon values of surface
- Location and temperature of hot spots
- Operational and non-operational temperatures



Verification

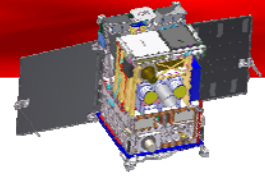
- Preparation of **AIV-plan** summarizing steps and procedures how assembly, integration and verification shall be conducted.
- Performance of HW inspection by customer prior PCB coating and assembly
 - >>> workmanship, forbidden materials, safety critical aspects/hazard control
- Verification of performance by payload provider
 - >>> specification of payload, compliance to OOV goals
- Verification of mechanical/electrical/SW interfaces to TET (payload provider/TET team)
 - >>> Step 1: verification with NVS-simulator
 - >>> Step 2: verification with NVS
- Verification of compliance to environmental conditions (payload provider)
 - >>> Vibration loads, Thermal/Vacuum, Electro-magnetic Compatibility

- All I/Fs and requirements defined in **ICD and User Manual** need to be verified.
- A Verification Control Document (**VCD**) shall crosslink requirements and reports together with a pass/fail identifier.



Documents

- A list of required documents and related milestones is provided in the User Manual.
- Customer Approval is requested for:
 - EIDP (End Item Data Package >>> for contents list see User Manual)
 - ICD (Interface Control Document)
 - DCL (Declared Components List)
 - DML (Declared Materials List)
 - VCD (verification Control Document)
 - CR (Change Requests after approval of above documents)
 - RFW (Request for Waiver >>> related to failed Requirements)
 - PAD (Part Approval Documents >>> non qualified components in I/F circuits)
 - Major NCR/SPR (Non-Conformance Reports/SW-Problem Reports)
- The numbering scheme to be used is given in the User Manual.



PA Requirements

PA requirements for payload supplier: TNL-RD-QP-DLR-1118/D, Iss. 2.2, 13.07.2007

The following points shall be high-lighted:

- No single Point Failure shall be transferred to NVS interfaces >>> **Worst Case Analysis**
- Derating to be applied on I/F and safety critical components >>> **Derating Analysis**
- Qualified components to be used in IF-circuits >>> **Declared Components List**
- US export licences to be provided to TET project
- Appropriate Material selection (outgassing, flammability, corrosion/cracking, toxic, magnetism) >>> **Declared Materials List**
- Inspections/Verifications to be performed >>> **Verification Control Document**
- Safety assessment/hazard analysis to be supported
- Space Debris requirements