Flying Laptop
Abschlussworkshop

Missionsplanung und Satellitenbetrieb
Jonas Keim
Initial Satellite Operations
LEOP

- Preparation for LEOP phase started in mid 2016
  - Preparation of verified flight procedures for all LEOP tasks
  - Operations lecture and simulator trainings

- LEOP: Launch on 14.07.2017 6:36:49 UTC on-board a Soyuz Fregat from Baikonur
  - Operations performed 20 hours a day in two shifts (9 positions)
  - 60 passes executed within 4 days
    - DLR ground station network (Weilheim - Germany, Inuvik - Canada, O‘Higgins - Antarctica)
  - Solar panels deployed on second day
  - Higher attitude control devices and modes checked
    -pointing accuracies below 1°
Initial Satellite Operations
Commissioning

- 2 daily shifts (4 positions) using only passes over ground stations in Germany
- Increasing workload for mission planner
  - shift from live execution to time-tagged execution
- All payload devices were taken into operation
  - First image from PamCam received 5 days after launch
  - AIS antenna deployed and first AIS signals received
- Redundant satellite bus components were checked out
  - On-board computer, IO-Boards, CCSDS-Boards
  - Transmitter
- IRS ground station taken into operation
Transition to Nominal Satellite Operations

- Need for on-board software updates
  - Bug-Fixes (Star tracker handling, TM storage, GPS overflow, Queue …)
  - Improvement of ACS performance

- Problem: Parts of development and operations team share same personal
  - High workload

- Increasing number of requests for payload data and experiment slots
  - Available software tools to handle requests required significant manual work
  - Command stack were created manually by command controller (error prone)
  - Scheduling conflicts and inflexible mission planning
  - On-board queue not used efficiently
Transition to Nominal Satellite Operations

• Solution: in-house development of ground-based automation software tools
  • Flight dynamics
  • Mission planning (ground station and satellite activity scheduling)
  • Routine and Payload request handling
  • Technology demonstration (OSIRIS pointing pattern)

• Result: Staffing and pass execution reduced drastically
  • Uplink passes reduced to one each working day (5 passes each week)
  • Scheduled downlink only passes (26 passes each week)
  • Passes: only one team member sends pre-defined command stack and monitors live TM and antenna (no “Lights Out” operations due to legal reasons)
  • Flight Director works independently of passes
  • ”Last Minute” changes for satellite activities possible (Uplink – Uplink scheduling)
• activity tracking is done in “redmine”
• browser based tool to track activities
• based on “issues“ (~ “Ticket”)
• each type of issue is like a form to be filled out for a specific operations related action
• Interacts with automation tools
Satellite Operations Documentation and Mission Planning
Redmine Issues Overview and Hierarchy

- Week → Mission Schedule
- Day
  - Pass with uplink (includes Pass Plan)
  - Combined TC Stack
  - (PL) - Recommendation
  - Pass downlink only (includes Dump Plan)

No strict hierarchy
- Anomaly Report
- Change Requests
- PL - Campaign
### Overview: Ground Segment Automation Tools

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### Mission Information Base (MIB)

- PyOPS
- SCOS - 2000
- SC Request
- Mission Schedule
- Downlink only/Uplink Pass
- Payload Request
- Command Stack
- Redmine
Mission Planning
Flight Dynamics Program

- 2x daily GPS data processing and OPM/TLE generation
- SGP4 and TLEs used for daily 4 week orbit propagation
- Weekly GS scheduling (including external GS) and pass utilization
Mission Planning
Routine Operations Handling

- Handles all time-tagged activities between two uplink passes
  - Transmitter (de)activation
  - Mode changes and pointing manoeuvres
    - Handles overlapping passes
  - Telemetry dumps and deletion
  - All timings based on pass data in Flight Dynamics DB
- Live activities during the uplink pass
  - Spacecraft Green Check
  - Upload of TLE for on-board propagator
  - Communication Timer
- Command stack is automatically created before the pass
Mission Planning
Payload request handling

- User fills form for (non)-recurring data takes
- Starts observability calculation
- Considering uplink passes, latest TLE and constraints
- Observability Report
- Requests single data take or start campaign
- On-board memory allocation
- Conflict check with mission schedule
- Payload dump pass allocation
- Stack creation and uplink pass allocation
- Status tracking and email notifications
- Re-dumps are scheduled automatically
Payload Request Handling

Automatic

< 30 s

Manual

> 60 min

Visibility Start: 2019-110T06:37:16
Max. elevation: 83.0°
Sun angle at max. elev.: 62.67°
Cloudiness: 3%

Visibility Start

Max. elevation

Sun angle at max. elev.

Cloudiness

Groundtrack

MICS FOV #10637
Payload Tickets

1672

Aktive parallele Kampagnen
24
Thank you!

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Workshop Ansätze

- Einschätzung/Vergleich Stand Missionsplanung und Satellitenbetrieb mit anderen Institutionen
- Was lief gut/schlecht bzw. würde sich besser machen lassen
- Relevanz für die Zukunft (weitere Missionen, Multimissionsfähigkeiten, neue Ansätze ...)

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Mission Planning

Key Python Stack Module

- Stack Parser and Checker
  - Input: command stack file
  - Output: list of all TCs with calibrated parameters (MIB)
  - Check Report (critical commands, pointing, modes ...)

- Stack Creator
  - Use Python syntax to create command stacks
  - Commands or sequences as objects with parameters as attributes
  - Render to different command stacks
  - Based on commands and procedures (seq.) from MIB

- Stack Combiner
  - Combines all stacks indented to be uplinked during a pass
  - Checks uplink duration with pass duration (flight dynamics db)