OPS-SAT:
automation tools and typical pass sequence

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Overview

- Groundstation link configuration
- Schedule uplink
- On-board queue check
- Macro execution
- File sync
- Software updates
- Telemetry checks
- Closing groundstation links
- Dissemination of files
- E-mail report generation
- Pass archiving in Uberlog
- Offline telemetry replay
1. Groundstation link configuration

- **S-band**
  - ☑ SCOS TC Spacon set to CLTU
  - ☑ Data-Proxy started and connected to Cortex

- **UHF**
  - ☑ SCOS TC Spacon set to Packet
  - ☑ Opening of SSH tunnels to UHF groundstations (Ireland + Austria)
  - ☑ Data-Proxy started and connected to UHF VM

- **Hybrid**
  - ☑ SCOS TC spacon set to CLTU
  - ☑ Data-Proxy started and connected to Cortex + supplementary UHF TM

- Groundstation booking, Cortex and tracking configuration is scheduled directly from mission planning, not from MATIS
2. Schedule uplink

- Mission Planning System generates MATIS MAES+MAUS .xml files -> loaded into MATIS
- Mission timeline for 24-hours is uplinked at AOS via TT-commands (Individual PLUTO procedures)
- MATIS performs initial uplink (can range 100 – 2000 commands depending on schedule)
3. On-board queue check

- Schedule completion via listOperation telecommand to check on-board queue contents
- MATIS uses SMF TMpacket Provisioning to access data fields in the packets
- Stacks for missing commands are auto-generated and loaded into SCOS by MATIS
- Procedure exists when every command sent from ground is verified present on the satellite OBQ

```plaintext
## TTO ## relSSC=7873, SSC=304, execution time=2020.343.19.34.42.000
## TTO ## relSSC=7875, SSC=306, execution time=2020.343.19.34.43.000
## TTO ## relSSC=7877, SSC=308, execution time=2020.343.19.35.58.000
## TTO ## relSSC=7879, SSC=310, execution time=2020.343.19.45.43.000
## TTO ## relSSC=7881, SSC=312, execution time=2020.343.19.46.43.000
## TTO ## relSSC=7883, SSC=314, execution time=2020.343.19.47.13.000
## TTO ## relSSC=7885, SSC=316, execution time=2020.343.19.47.43.000
## TTO ## relSSC=7887, SSC=310, execution time=2020.343.19.48.43.000

### No time-tagged TCs to be reuplinked ###
```
4. Macro executions

- Macros are a custom FCT component developed to easily pre-program Linux commands to run on the S/C
- Backend all handled by MATIS
- Tagged with a passnumber
- MATIS waits for the TC link to become available and uplinks the programmed Shell commands
- Single consolidated logfile for each pass
5. File sync (1/2)

- MATIS triggers dump of payload OBC target directory
  - `<md5sum> <filepath> <size (blocks)>`
- Files and checksums are correlated with available files on ground
  - List of ‘missing’ files is generated
  - CFDP transfers invoked for every discrepancy
  - On-board housekeeping (OBHK) performs auto-archiving and deletion of old files
5. File sync (2/2)
6. Software updates

- New software and patches uplinked as IPK packages, installed using `opkg`
- For very large IPK files
  - ✓ Only the binary delta is uplinked and a patched IPK file is generated on-board + installed
- After each installation, the version of all packages on-board the spacecraft is dumped
  - ✓ Always an up-to-date log available of version status of every SW component on the satellite

```
[07-12-2020 16:41:12] alsac音f - 1.1.4.1-r0.4
[07-12-2020 16:41:12] angstrom-fed-configs - v2017.12-r17.4
[07-12-2020 16:41:12] avahi-daemon - 0.6.32-r0.12
[07-12-2020 16:41:12] avahi-utils - 0.6.32-r0.12
[07-12-2020 16:41:12] bandsel - 1.0-r1.6
[07-12-2020 16:41:12] base-files - 3.0.14-r80.6
[07-12-2020 16:41:12] base-passwd - 3.5.21-r0.9
[07-12-2020 16:41:12] bridge-disable - 1.1
[07-12-2020 16:41:12] bridge-enable - 1.1
[07-12-2020 16:41:12] bsdiff - 4.3+git90+b4d685842-r0.0
[07-12-2020 16:41:12] busybox - 1.24.1-r0.10
[07-12-2020 16:41:12] busybox-syslog - 1.24.1-r0.10
[07-12-2020 16:41:12] busybox-udhcpc - 1.24.1-r0.10
[07-12-2020 16:41:12] ca-certificates - 20170717-r0.4
[07-12-2020 16:41:12] cam-utils - 0.0+git04ec8bf05cb4-r0.1
[07-12-2020 16:41:12] cam0-setup-service - 1.0-r0.0
[07-12-2020 16:41:12] cpufrequtils - 008-r5.6
[07-12-2020 16:41:12] dbus-1 - 1.10.20-r0.11
[07-12-2020 16:41:12] e2fsprogs-e2fsck - 1.43.5-r0.5
[07-12-2020 16:41:12] ethtool - 4.11-r0.0
```

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7. Telemetry checks

- Main TM monitoring done by on-board FDIR
- Ground TM checks and consolidation by MATIS
- SMF TMpacketProvisioning
8. Closing groundstation links

- Tunnels to UHF groundstations are killed
- MCS disconnected from Cortex and UHF VM
9. Dissemination of files

- Downloaded files:
  - Rsynced to a backup VM
  - Sent to a server for industry to have realtime access to the downloaded files
  - Reported to Uberlog
  - Reported in an e-mail
10. E-mail report generation

- Spacecraft status E-mailed to FCT
- Dump of the matis-server.log for the respective pass is contained in the e-mail
11. Pass archiving in Uberlog

- Curl commands generated for each pass based on procedure completion and/or failures
- High-level view of a pass

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event Description</th>
<th>Status</th>
<th>Log Entry Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/12/2020</td>
<td>03:38:20</td>
<td>GND_ALL_N220 Disconnect ground segment after S-band pass COMPLETED</td>
<td>OSU</td>
<td></td>
</tr>
<tr>
<td>08/12/2020</td>
<td>03:36:53</td>
<td>OSMC #05368 2020-12-08 03:22 UTC ESOC1 19 deg</td>
<td>OSU</td>
<td></td>
</tr>
<tr>
<td>08/12/2020</td>
<td>02:07:13</td>
<td>OSMC #05368 2020-12-08 01:52 UTC TUG 02 deg</td>
<td>OSU</td>
<td></td>
</tr>
<tr>
<td>07/12/2020</td>
<td>20:02:52</td>
<td>OSMC #05363 2020-12-07 19:48 UTC CORK 24 deg</td>
<td>OSU</td>
<td></td>
</tr>
</tbody>
</table>
12. Offline telemetry replay

- Not yet automated with MATIS, but should be possible with SMF S2kTmReplayerServices
- Long-term data is stored on the payload OBC and compressed
- Downloaded as binary packet files
- TM transfer frames generated and appended using scripts
- Ingested in SCOS as VC1 packets