Mass Memories – Main Messages from ESOC Operators

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Missions providing the feedback

- **Most ESA missions implement an off-line operations concept relying critically on on-board mass memories.**
- **The feedback presented here has been collected mainly from ESA science missions, with critical mass memory requirements in terms of storage, number of on-board interfaces and autonomy.**
- **Flying missions**
  - Rosetta (L: 2004)
  - Mars Express (L: 2003) / Venus Express (L: 2005) – same SSMM
  - Herschel / Planck
  - GAIA (L: 2013)
- **Missions in development**
  - BepiColombo / Solar Orbiter – same SSMM
  - Exomars
- **We have a lot of in-flight experience. Don't hesitate to contact us if you want to know more.**

Operator feedback on mass memory (1)

- **On-board architecture**
  - Science data routed directly to mass memory
    - Better for missions with high rate science generation
    - Keep this unit outside any system command and control process.
  - Files for spacecraft commanding / operations stored locally to the processor running the associated services
    - Keep this unit robust to intermittent and permanent failures.
- **Mass memory design**
  - Better performance
    - to be accounted for early in the design, using realistic flight scenarios.
    - storage and retrieval shall be supported in parallel without constraints.
  - More autonomy
    - minimise the need for ground intervention / micromanagement
    - no disruption of key processes in failure cases (e.g. processor switch-over, data corruption)
    - no need for ground to manage the unit at low hardware level (e.g. fragmentation, memory maps).
  - More observables
    - Nominal case (e.g. internal processes, memory array filled state)
    - Failure case (e.g. location and impact of data corruption)

Operator feedback on mass memory (2)

- **Use of files**
  - On-board storage already exceeds typical downlink capability. Invest on more advanced on-board data management / processing techniques instead !
  - Use of files on the uplink is state of the art for most recent ESA science missions - though not standard
  - Use of files for science storage would enable use of advanced techniques to improve scientific quality of data returned on the downlink (selective downlink)
    - this needs new on-board services and large margins on storage capacity
  - File transfer protocol is only (a small) part of the story.
    - Services for configuration / high level control of file management and transfer services with minimum ground intervention is much more important for operations.
    - This is not covered by standards.
  - Why does it seem that file management services for spacecraft are reinvented from scratch, while such services are part of everyday life in ground applications (e.g. computers, mobile phones, cameras)?