SAVOIR

space avionics open interface architecture

SAVOIR Mass Memory Day 2014
Wrap-up

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ESTEC
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Introduction

- This summary provides a wrap-up of the SAVOIR Mass Memory Day 2014
  - GROUND AND SPACE SEGMENT REQUIREMENTS FOR FILE-BASED OPERATIONS
  - PROTOCOLS AND ONBOARD SERVICES
  - FILE BASED MASS MEMORIES – DEVELOPMENTS AND LESSONS LEARNED
  - ROUND TABLE

- It is not intention to provide detailed analysis of all topics discussed, rather it attempts to capture the salient points of each paper and summarize the results of the discussion during the day

Agenda 1/2

Time	Title	Presentation + Q&A
08:30 – 08:45	**Introduction / Welcoming (chair J.Ilstad)**	**10 min**
08:45 – 09:15	ADCSS 2012 conclusions and SAVOIR mass memory requirements (G.Magistrati, ESTEC)	30 min
09:15 – 09:45	File-based operations from the OPS perspective (E.Montagnon ESOC)	30 min
09:45 – 10:15	CNES background, needs and views on file-based ops and protocols (P.Arberet CNES) •The File management and file transfer CNES overview analysis (C. Pouliquen CNES) •CNES Mass Memory Units development Overview (P.LeMeur CNES) •Files in Space: Management & Transfer (B.Dellandréa TAS-F)	30 min
	BREAK	
10:30 – 11:00	Euclid Operational Considerations and Ground Segment Infrastructure (F.Keck and F.Flentge ESOC)	30 min
11:00 – 11:30	EUCLID: Data Handling Architecture and CFDP Tailoring (A.Tramutola – TAS-I)	30 min
11:30	**END SESSION 1**	
	SESSION 2 – PROTOCOLS AND ONBOARD SERVICES	
11:30 – 11:40	**Intro session 2 (chair C.Taylor)**	**10 min**
11:40 – 12:00	CFDP standard updates and SOIS file and packet store services (C.Taylor ESTEC)	20 min
12:00 – 12:30	PUS standard updates - file services (S.Valera ESTEC)	30 min
12:30 – 13:30	**END SESSION 2** **LUNCH BREAK**	**60 min**
	SESSION 3 - FILE BASED MASS MEMORIES – DEVELOPMENTS AND LESSONS LEARNED	
13:30 – 13:40	**Intro session 3 (chair C.Honvault)**	**10 min**
13:40 – 14:10	CFDP Reference and Test Facility (S.Fowell SciSys)	30 min
14:10 – 14:30	CFDP simulator demo (A.Valverde ESTEC)	20 min
14:30 – 14:50	EucliDem - Demonstrator of the Euclid Mission File Management Service (FMS) and CCSDS File Delivery Protocol (CFDP) (S.Candia TAS-I)	20 min
14:50 – 15:20	HW/SW architecture implications in relation to CFDP and file system operation (T.Pike, Y.Charnet Airbus Defense and Space)	30 min
15:20 – 15:35	**END SESSION 3** **BREAK**	**15 min**

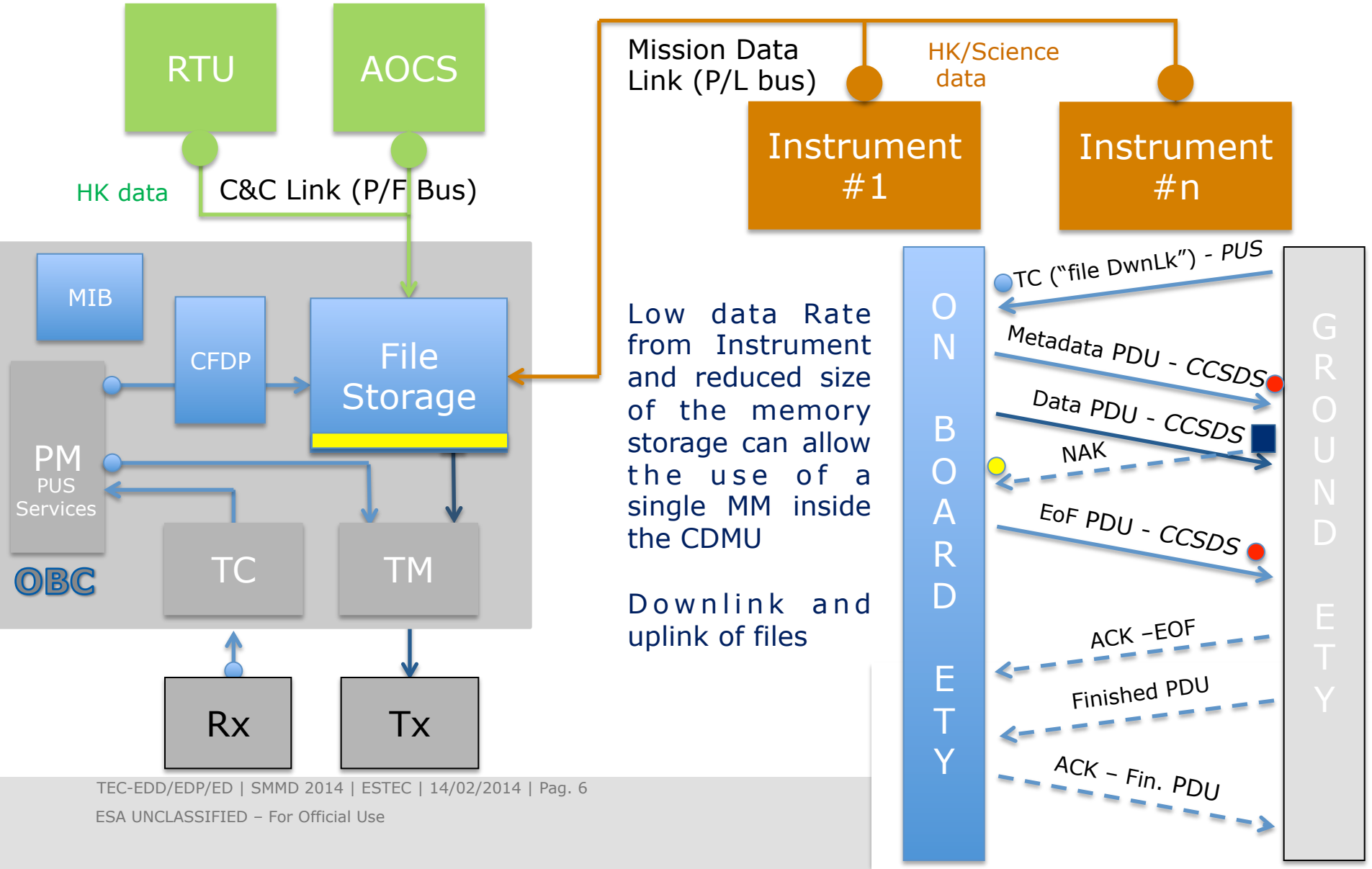
Agenda 2/2

Time	Title	Presentation + Q&A
	ROUND TABLE	
15:35 – 16:35	**- Lessons Learned on SSMM OPS (E.Montagnon ESOC)** **- File systems considerations for on-board SSMMs (C.Honvault ESTEC)** **- File based vs. Packet Store Mass Memories (Chair C.Taylor ESTEC)** **- On-going and planned technology development activities (J.Ilstad and C.Honvault) - TBD**	60 min
16:35 – 17:00	**Wrap-up**	**25 min**

Session 1 Wrap-up 1/5

- **ADCSS 2012 conclusions and SAVOIR mass memory requirements (G.Magistrati - ESTEC)**
  - The presentation started with a summary of the conclusions from the day-3 of ADCSS 2012 "Mass Memories for P/L applications and file based operations". http://congrexprojects.com/2012-events/12c25/introduction.
  - SAVOIR initiative and SAVOIR products (in particular the Generic OBC spec) have been briefly introduced.
  - Different options for the implementation of CFDP on board are possible depending on mission requirements (see following slide).
  - A SAVOIR sub-group (still to be established) will define a set of requirements in the SAVOIR docs for:
    - Implementation of the complete set of interfaces to access files on-board, which includes CFDP, PUS, SOIS, FBO and MBO
    - The identification of the needs in term of file storage management (partitions, file size, access rights, etc.)
    - The support of the different mass memory units and technologies.

Session 1 Wrap-up 2/5



Session 1 Wrap-up 3/5

- **ESOC - File Based Operations from ESA perspective (E.Montagnon - ESOC)**
  - The presentation gave an overview from the FBOPS working group recommendations.
  - The file based operations study led by ESOC has completed and concluded that file based operations will bring benefits and is the way forward; CDFP has been selected as the baseline for file transfer and will be made available in the ground segment as a standard service
  - The use of K-Band infers that transmission will be subject to increased data loss such that retransmission may be required
- **CNES - background, needs and views on file-based ops and protocols (P.Arberet, C. Pouliquen, P.LeMeur - CNES)**
  - Presented an overview of the CNES activities/studies on FBOPS. The studies confirmed the importance of files to enhance the autonomy & simplify satellite operations.
  - Challenging to close the loop between ground and spacecraft in relation to retransmission of missing data segments, due to very high data rates in addition to end-to-end encryption.
  - The trend is that clients/users require all data to be made available i.e. incomplete data sets is in general not acceptable. It is no longer feasible to manually re-transmit payload data as it is too time consuming due to large data volumes.
  - File based mass memories would allow for much more flexibility in relation to how telemetry is selected for D/L.
  - Earth observation data is often required to be encrypted by the client. This complicates greatly re-transmission of missing data sets as the decryption of the data is performed only at the client side. Missing data can only be detected ones data has been decrypted.
  - **Open points**
    - Definition of Standard file management services is necessary.
    - Overlaps between protocols such as CFDP, DTN and SOIS standards to be harmonised
    - Solve the re-transmission issues for encrypted payload data.
    - Advanced On-board payload data compression is needed to cope with the very high on-board data rates.
  - In CNES missions the CFDP has not been identified as a real need up till now, but are prepared transition to CFDP ones the mission needs arise.
  - Two classes of satellites are developed by CNES: High Resolutions missions and Microsat, CNES have developed mass memories solutions for both the two classes.

Session 1 Wrap-up 4/5

- **Files in Space: Management & Transfer (B.Dellandra - TAS-F)**
  - TAS has performed a CNES study on On-Board File Management system with participation of Airbus Defence & Space resulting in a common IRD for a File Management System from *non-conflicting URDs*
  - First objective of the study : specification of a generic File Management System (FMS) compliant with
    - ECSS-E-70-41A PUS (service 13 Large Data Transfer)
    - CCSDS CFDP
    - ECSS-E-70-41A PUS (service 23 File management service)
  - Comprehensive mission application study for the various telecommand and telemetry use cases has shown files to be appropriate most cases. It can be debated whether instrument data in CCSDS Space Packet format is better suited as a packet store, however a file can offer the same functionality.
  - A Prototype has been developed in ADA 2005.
  - During the study it became clear that every mission applied ad-hoc FMS/FMGT implementations.
  - A standard definition of FMS services is required.
- **ESOC - Euclid Operational Considerations and Ground Segment Infrastructure (F.Keck, F.Flentge - ESOC)**
  - Euclid will host an on-board file system which will be used for:
    - Science Data Files, Files as containers to store H/K TM packets, SW images, OBCPs
  - CFDP will be used on the Ka downlink, which is inherently unreliable, but should also be used for the uplink.
  - ESOC suggest placing CFDP entities in the GND stations as opposed to being in the MCS due to terrestrial network bottle necks between GND station and MCS.
  - Feasibility study is currently on-going in relation to placing CFDP entities in the GND station. This approach closes the loop for re-transmission between GND station and spacecraft rather than mission control centre (MCU) and spacecraft.

Session 1 Wrap-up 5/5

- **EUCLID CFDP tailoring (A.Tramutola - TAS-I)**
  - TAS-I presented the proposed CFDP implementation in Euclid.
  - A large BoL storage capacity of 4GB is required.
  - A tailored version of the CFDP standard has been implemented having in mind a simplification of the first implementation of CFDP (e.g. user operations have not been implemented because Ground and satellite can communicate directly)
  - It is suggested to split CFDP metadata PDU's through reliable X-band link while file data PDU units can be transported either via Ka band or X band link. This particular point generated a discussion among the participants in relation the justification of this approach as it fosters a non-standard implementation.
  - Class 1 for Up-link and class 2 for downlink have been proposed
  - Questions raised after the presentation:
    - How is it ensured that e.g. OBCP files maintain integrity on the uplink? Dedicated on-board SW verifying file integrity based on error check bits is required.
    - Is it possible to transfer the current EUCLID PUS service number 140 to the planned PUS service 23? Few problems are expected by this.
    - ESOC representative E.Montagnon mentioned the importance to tailor CFDP for each mission scenario in order to define the maximum number of transactions allowed to be active at any one time. This is particular important for missions experiencing long round-trip delays.

Session 2 – Wrap-up

- **Introduction for session 2 (C.Taylor - ESTEC)**
  - CFDP is a fully defined and tested international protocol for transferring files.
  - The main message relayed in the introduction is the importance to agree on a defined set of standards and protocols.

- **CFDP standard updates and SOIS file and packet store services (C.Taylor - ESTEC)**
  - **Main updates to the CFDP standard**
    - CFDP PDU can contain any data, there's even an option to transfer packets.
    - The extended procedures Class 3 and 4 will be removed to make the protocol simpler.
    - Store and forward overlay is kept in the Annex.
    - Large file transfer support to be indicated in the CFDP PDU header.
    - Optionally enabled id of record boundaries
    - Optionally per segment indication
    - Extend Class 1 to optionally return a finished PDU which is requested for DTN protocol
  - **SOIS file and packet store services**
    - SOIS standards defines services to be made available onboard in relation to file management and packet stores, however do not specify how to do it, which is intentional.
    - The intention is to match the SOIS services with those services being defined in updated PUS-C standard.
    - The standard defines optional services such as e.g. file seek
    - There should be no discrepancies between PUS and SOIS.

- **PUS standard updates - file services (S.Valera - ESTEC)**
  - Comprehensive document containing definition of 24 services now including file management services,
  - ST 13 Large data transfer is under discussion, limited to up to 64kb packets
  - Service 23 is defined for file operations.
  - Service type 6 can manipulate data structures at low level. Can be used to patch files.
  - ST 23 file services does not dictate which file management or file transport layer to be used.
  - Question: have you applied the SOIS services (file management services)? Yes this is mapping is done and were required seen from a ground ops perspective. Functions such as file copy and create is considered onboard application specific and as such not included in the PUS services.

Session 3 – Wrap-up 1/3

- **CFDP Reference and Test Facility (S.Fowell - SciSys)**
  - Reference CFDP implementation which covers class 1 and 2 with all the options intended for end-to-end test and development.
  - Java based, supporting 3rd party applications to interface with the CFDP client.
  - Questions raised at the end of the presentation:
    - Does the test script allow validation of executed test commands? Yes this is possible.
    - Availability of the tool? License can be obtained for a small handling fee. The intention is that both the ESOC JAVA CFDP core implementation as well as the ESTEC CRTF can be licensed users.
    - Have relevant mission scenarios been tested? The reference mission scenarios defined in the CFDP standard has been used for the test cases. It is a matter of configuring the link characteristics to reflect the expected mission constraints.
- **CFDP simulator demo (A.Valverde - ESTEC)**
  - A demonstration of the CTRF showed some of the capabilities of the CTRF application to test various scenarios such as round-trip latencies, link packet loss rates and monitoring capabilities
  - A plug-in for the well known WireShark protocol dissector tool is available for CFDP.
  - Questions:
    - Does the tool support simultaneous Up and D/L ? Yes that can be configured.

Session 3 – Wrap-up 2/3

- **EucliDem - Demonstrator of the Euclid Mission File Management Service (FMS) and CCSDS File Delivery Protocol (CFDP) (S.Candia - TAS-I)**
  - The presentation generated some discussion related to the approach taken in relation to splitting protocol PDU's and FDU's between the X band and Ka band. The rationale behind this choice is not fully clear. This is a deviation considered to be non-standard, and induces complications of the on-board implementation which is costly and possibly hard to validate when considering the test cases to be covered.
  - A question directed to TAS-I was whether it had been considered to use the ESA developed CFDP test facility to study the effect different link outage characteristics between X and Ka band could have? There is still a need to develop additional features and harmonise towards the actual MSO implementation. The use of the ESA tools will be taken up for consideration.

Session 3 – Wrap-up 3/3

- **HW/SW architecture implications in relation to CFDP and file system operation (Y.Charnet - Airbus Defense and Space)**
  - Preliminary HW/SW partition for functions of a Mass Memory implementing CFDP has been presented
  - Retransmission of missing data, in case where memory sectors are large, may be solved by using secondary read stream that can extract missing data parts from of a memory sector (which can e.g. up to 128Mb).

Round Table summary 1/3

The round table hosted short introductory presentations on the following topics:

- Lessons Learned on SSMM operations
  - The session gave first an overview on lessons learned and considerations to be taken into account for future generations of onboard mass memory.
  - Main messages from the operators:
    - Greater autonomy of the SSMM operations including autonomous FDIR features.
    - Avoid situations where operators are required to carry out fine grained actions to recover failed SSMM units.
    - Required performances and operational capabilities must be validated according to expected in-flight scenarios.
    - Greater observability of SSMM internal status registers.

Round Table summary 2/3

- Lessons Learned on SSMM operations continued:
  - Use of files will allow for advanced techniques to improve scientific quality.
  - Services for configuration / high level control of file management and transfer services with minimum ground intervention is much more important for operations.
- File System considerations for onboard mass memories
  - The presentation covered important considerations relevant for file systems for onboard mass memories where the main considerations in relation file based operation of mass memories are:
  - **Support of several on-Board CFDP entities (OBC, P/L)**
  - **Network File Access,** Network Packet Access and **Remote Block Storage** Protocols not standardised at the moment.
  - **Consolidation of an uniform on-board file system interface** i.e. file services are memory technology independent from the user perspective.
  - SOIS and PUS services is at present not mapped 1-to-1.
- FDIR particularly relevant for file system for large capacity **SSMMs**

Round Table summary 3/3

- **Files vs. Packet stores SSMM's**
  - The main topic of the talk was to highlight the difference between packet stores and files. In most cases files will cover most needs.
  - It was also debated whether or not files can serve the exact same function as for packet stores, - although this requires onboard SW to support searching of files that are structured in a suitable format.
- **On-going and planned technology development activities from ESTEC**
  - A short status update was given on the current technology development activities run by the ESTEC data and software system divisions as well as memory technology qualification activities supported by ESTEC quality department.
  - Planned activities to be initiated relevant to onboard mass memories were introduced;
    - Fully integrated OBC Mass Memory
    - File management services standardization
    - Further details can be found on EMITS and presentation from round table session.

General Summary 1/2

- There is a good agreement between the stake holders in relation to implementations needed for file based operations.
- Currently FBO and the use of CFDP is baselined for Euclid and Juice and should be considered as baseline for all future science missions. For Earth observation programs the use of encryption over the complete protocol data units (incl. protocol headers), limits the use of CFDP and any other file transfer protocol. This needs to be explored further.
- Ground segment: The downlink speeds from the flight segment can far exceed the link capability from the Ground station to the control centre. In these cases an option may be host the CFDP entity in the ground station but send any uplink meta data to the control centre and from there be forwarded to the flight segment
- Flight Segment: No major issues are foreseen in the flight segment. Savoir is updating the present OBC functional specification to incorporate requirements for file services and the use of file transfer
- In order to achieve the goal of Savoir, which is to have standardised flight units, there must be a strict adherence to the standards. We should only deviate from the standard where absolutely necessary.
- The continued use of packet stores separate from files may not be necessary. The packet store functionality can be provided using files, however it may be required to incorporate specific packet management services e.g. packet selection. These files should be relatively short and for example cover a day of operation. The complete file would then be downloaded.

General Summary 2/2

- The SOIS file and packet store services seem adequate to cover all file access and management requirements but it may be advantageous to define a smaller subset based on actual mission needs.
- CFDP is accepted as the baseline protocol for file transfer. Of the new planned enhancements, the increase in file size and the use of final acknowledgement over class 1 are the most interesting for European missions.
- The use of files release the instruments from the need to use packets to store their data in the flight mass memory. Instrument providers will need advice on what formats they should use.
- A file based operations working group should be taken under consideration.

Contact

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We would like to thank everyone that contributed to the event.