



SAVOIR Mass Memory Day SESSION 2 - PROTOCOLS AND ONBOARD SERVICES

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Everyone loves standards



- Everyone loves standards, unfortunately, everyone loves their own standard!
- No standard is perfect and its clear standards must evolve to meet new needs
- In practise many changes are down to 'institutional practise' (we have always done it this way)
- Obtaining consensus is never easy and there are always 'better' ideas or 'good' reasons for change
- *But: to really benefit from the Savoir initiative we have to home in on a common set of standards agreed by all*



Different types for different reasons



- There are many types of standardisation in the scope of Savoir:
 - *Components*
 - *Boards*
 - *Units*
 - *Software*
 - *Interface between components*
 - *Interface between boards*
 - *Interface between units*
 - *Interface between software*
 - *Interface between space and ground*
 - *Interface between Agency infrastructures*



CFDP, PUS and SOIS



- The CFDP provides a standard for file transfer between the flight avionics and ground. It falls into the category of Intra and inter-Agency standardisation
 - Standard implementation in NASA and ESA ground infrastructure
- The Packet Utilisation Standard is in the category of intra-Agency
 - Standard implementation in ESA/CNES/DLR MCCs
- The SOIS File and packet store services are in the category of an Intra-Agency standard as they are intended to harmonise the services required for mass memory access and management between space and ground
- In addition they offer the mechanism to standardise the user interface to the Avionics MM and thus the features required from the MM itself



Which standard do you like?



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CFDP and SOIS File and Packet store status

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Background



- To support the transition to File based operations, two key standards are being applied in ESA developments:
 - The CCSDS file transfer protocol (CFDP) recommendation
 - The CCSDS SOIS File and Packet Store Services recommendation
- Both documents are published and available on the CCSDS and ECSS sites
- CFDP is now undergoing an update process to remove and add features based on previous operational experience and new developments. These need to be taken account of in future implementations
- The F&PS services offer the way forward in terms of standardizing the flight services available from the mass memory with those required by operation and thus support the SAVOIR goal of standard building blocks



CFDP – A bit of history



- CFDP has been around for a long time:
 - Initially proposed (by ESA) in 1998
 - Underwent exhaustive international testing
 - First published as a CCSDS standard in 2002, reviewed in 2007 and now due for 5 year review
- Lots of Information at www.ccsds.org:
 - [CCSDS 727.0-B-4](#) **Blue Book Standard**
 - [CCSDS 720.1-G-3](#) **Introduction and Overview**
 - [CCSDS 720.2-G-3](#) **Implementers Guide**
 - [CCSDS 720.3-G-1](#) **Interoperability Testing**
- Used on many NASA missions and standard in their ground segment now adopted for ESA missions and ESA ground segment



CFDP – What is it?



- CFDP provides the capability to transfer 'files' and associated 'Meta data' to and from a spacecraft mass memory
- The content of the files may be anything from a conventional timeline update to a SAR image (*the content of the file is transparent* – but could be packets)
- Files can be transmitted with a **unidirectional link**, a **half-duplex link**, or a **full-duplex link**, with near-Earth and deep space delays
- Files can be transferred **reliably**, where it is guaranteed that all data will be delivered without error, or **unreliably**, where a 'best effort' delivery capability is provided
- Doesn't need much for data transfer support - operates over any CCSDS datalink
- Uses minimum packet overhead for data transfer and allows source file compression – allowing additional efficiency in date storage and subsequent transmission



CFDP - Scalability



- CFDP has a rich mixture of features to cover many different scenarios and this results in a relatively complex specification – you don't get something for nothing!
- The specification reduces complexity by providing selectable classes of operation and options:
 - Class 1—Unreliable transfer
 - Class 2—Reliable transfer
 - Class 3—Unreliable transfer via one or more Waypoints (relays)
 - Class 4—Reliable transfer via one or more Waypoints
 - SFO – Provides a simpler alternative to class 3 and 4
 - User operations - provides CFDP user to CFDP user communication
- *Of the above only class 1 and 2 are the most applicable and possibly some of the user operations e.g. Proxy for remote file transfer initiation*



Proposed modifications to CFDP



The major changes that CFDP will undergo in the new release are:

- Extended procedures will be removed (class 3 and 4)
 - Make the protocol simpler
 - Store and Forward Overlay operations are kept in annex

- Large File Transfer support
 - Indicated using one bit in the CFDP Header (previously reserved)
 - The fields that hold the Offset and the File Size change from 32 bits to 64 bits long
 - Required for ISS operations



Proposed modifications to CFDP



- Optionally enabled identification of record boundaries in received files
 - Extends the current functionality regarding the position of the records inside the CFDP PDU
 - Indicated using one bit in the CFDP Header (previously reserved) and optionally two bits in each File Data PDU
- Optionally added per-Segment metadata
 - Indicated using one bit in the CFDP Header (previously reserved) and 6 bit in each File Data PDU to set the length.
 - It is possible to have up to 63 Bytes of extra metadata
- Both are options and driven by JPL deep space mission interests



Proposed modifications to CFDP



- Optionally returning a Finished PDU in Class 1 (unreliable transfer)
 - Useful to have a positive confirmation of the transfer when operating over a reliable link without going to Class 2
 - Indicated using one bit in the Metadata PDU (Closure requested)
 - Requested for use when underlying link is reliable E.g. cop, DTN)
- There are some other minor changes that will improve the understanding of both the Blue and Green books.
 - The new release of the Blue/green books is expected by the end of 2013 after interoperability testing



SOIS File and packet store services



- The SOIS file and packet store services identifies a mandatory and optional set of services for accessing an onboard mass memory
- It very important to appreciate that these services are implementation independent – SOIS defines **what** should be provided it does not define **how**
- The services were specified with the support of ESOC with specific account taken of operational requirements
- The intention is to provide a set of services that can be provide by the flight filing system and directly mapped to those provided by PUS



SOIS file and packet stores



- The SOIS File and Packet Store Services are for use by onboard software to:
 - Access, and manage files residing in a file store.
 - Access and manage packets residing in a packet store.

- To achieve this, the FPSS comprise the following services:
 - File Access Service (FAS);
 - File Management Service (FMS);
 - Packet Store Access Service (PSAS);
 - Packet Store Management Service (PSMS)

- *It should be noted that the SOIS File and Packet Store Services do Not define the file and packet stores themselves*



CCSDS SOIS File and packet store services



- The File Access Service interface shall implement the following primitives:
 - a) OPEN_FILE.request, as specified in 3.4.2.2;
 - b) OPEN_FILE.indication, as specified in 3.4.2.3;
 - c) CLOSE_FILE.request, as specified in 3.4.2.4;
 - d) CLOSE_FILE.indication, as specified in 3.4.2.5;
 - e) READ_FROM_FILE.request, as specified in 3.4.2.6;
 - f) READ_FROM_FILE.indication, as specified in 3.4.2.7;
 - g) WRITE_TO_FILE.request, as specified in 3.4.2.8;
 - h) WRITE_TO_FILE.indication, as specified in 3.4.2.9.

- Optionally, the File Access Service may implement the following primitives:
 - a) FILE_SEEK.request as specified in 3.4.2.10;
 - b) FILE_SEEK.indication as specified in 3.4.2.11.



CCSDS SOIS File and packet store services



- The File Management Service shall implement the following primitives:
 - a) LIST_DIR.request, as specified in 3.4.3.12;
 - b) LIST_DIR.indication, as specified in 3.4.3.13;
 - c) CREATE_FILE.request, as specified in 3.4.3.14;
 - d) CREATE_FILE.indication, as specified in 3.4.3.15;
 - e) DELETE_FILE.request, as specified in 3.4.3.16;
 - f) DELETE_FILE.indication, as specified in 3.4.3.17;
 - g) COPY_FILE.request, as specified in 3.4.3.18;
 - h) COPY_FILE.indication, as specified in 3.4.3.19;
 - i) MOVE_FILE.request, as specified in 3.4.3.20;
 - j) MOVE_FILE.indication, as specified in 3.4.3.21.

- Optionally, the File Access Service may implement the following primitives:
 - a) FILE_SEEK.request as specified in 3.4.2.10;
 - b) FILE_SEEK.indication as specified in 3.4.2.11.



CCSDS SOIS File and packet store services



- Optionally, the File Management Service may implement the following primitives:
 - a) CREATE_DIR.request, as specified in 3.4.3.2;
 - b) CREATE_DIR.indication, as specified in 3.4.3.3;
 - c) GET_CURRENT_DIR.request, as specified in 3.4.3.4;
 - d) GET_CURRENT_DIR.indication, as specified in 3.4.3.5;
 - e) CHANGE_DIR.request, as specified in 3.4.3.6;
 - f) CHANGE_DIR.indication, as specified in 3.4.3.7;
 - g) DELETE_DIR.request, as specified in 3.4.3.8;
 - h) DELETE_DIR.indication, as specified in 3.4.3.9;
 - i) RENAME_DIR.request, as specified in 3.4.3.10;
 - j) RENAME_DIR.indication, as specified in 3.4.3.11;
 - k) LOCK_FILE.request, as specified in 3.4.3.22;
 - l) LOCK_FILE.indication, as specified in 3.4.3.23;
 - m) UNLOCK_FILE.request, as specified in 3.4.3.24;
 - n) UNLOCK_FILE.indication, as specified in 3.4.3.25;
 - o) LIST_LOCKED_FILES.request, as specified in 3.4.3.26;
 - p) LIST_LOCKED_FILES.indication, as specified in 3.4.3.27;
 - q) FIND_FILE.request, as specified in 3.4.3.28;
 - r) FIND_FILE.indication, as specified in 3.4.3.29;
 - s) FILE_STATUS.request as specified in 3.4.3.30;
 - t) FILE_STATUS.indication as specified in 3.4.3.31.



SOIS Packet Store Services



- The SOIS packet store services were derived directly from those defined in the Packet Utilisation Standard
- There should therefore be no discrepancy between what mission operations require and what is provided on-board by the SSMM!
- (Thankfully) I do not propose to go through them in this presentation please refer to the Standard



Summary



- CFDP is a fully defined and tested international protocol for transferring files
- Updates are now being implemented to remove unwanted features and add new ones based on user needs. This should result in a much simpler CFDP standard tuned to single hop mission scenarios
- The SOIS packet store services are directly tuned to what we believe is required for existing packet stores
- The SOIS services for fbo include mandatory and optional services but there are still a lot of them, further profiling may be useful
- *All we need now is an update to the PUS standard which directly maps to the SOIS standards – what could be simpler?*

