Appendix A

1 Export of SimpleSAT SRDB data into MIB data exchange format

In [3], authors have built and have shown how M&C data of SimpleSAT SRDB are defined. In this appendix, we aim to illustrate how this data could be represented in a set of MIB-compliant files. The detailed definition of MIB files (also called tables) is provided in the SCOS-2000 standard document[1]. Together MIB files constitute a relational database that aims to capture a comprehesive definition of M&C data. Nevertheless, Figure 1 summarizes these files and their relations.

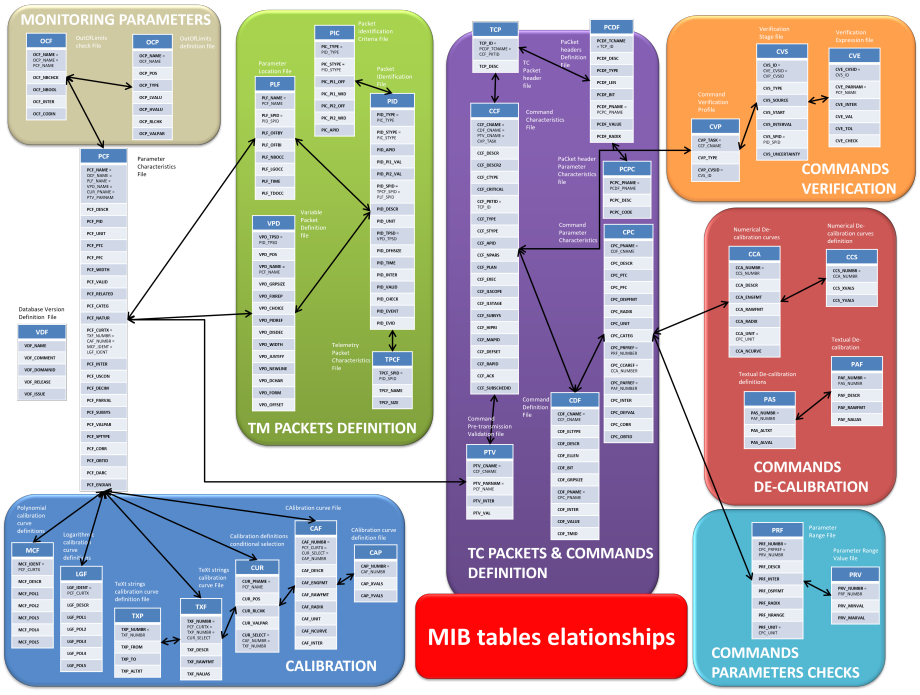


Figure 1: Graphical representation of MIB files and their relationships

1.1 MIB definition of service 2 TC to switch on the RW

In this section, we show how the definition of PUS service 2 TC can be defined in MIB files to switch on the RW of SimpleSAT. PUS service 2 is an OBSW service that could be used to send low level commands such as MilStd-1553 Bus Controller(BC) to Remote Terminal (RT) commands from the MCS. Figure 2 shows what MIB files are used to encode the service 2 TC already mentioned before sending it to the onboard systems of SimpleSAT. Table 1 details the different steps of the encoding process.

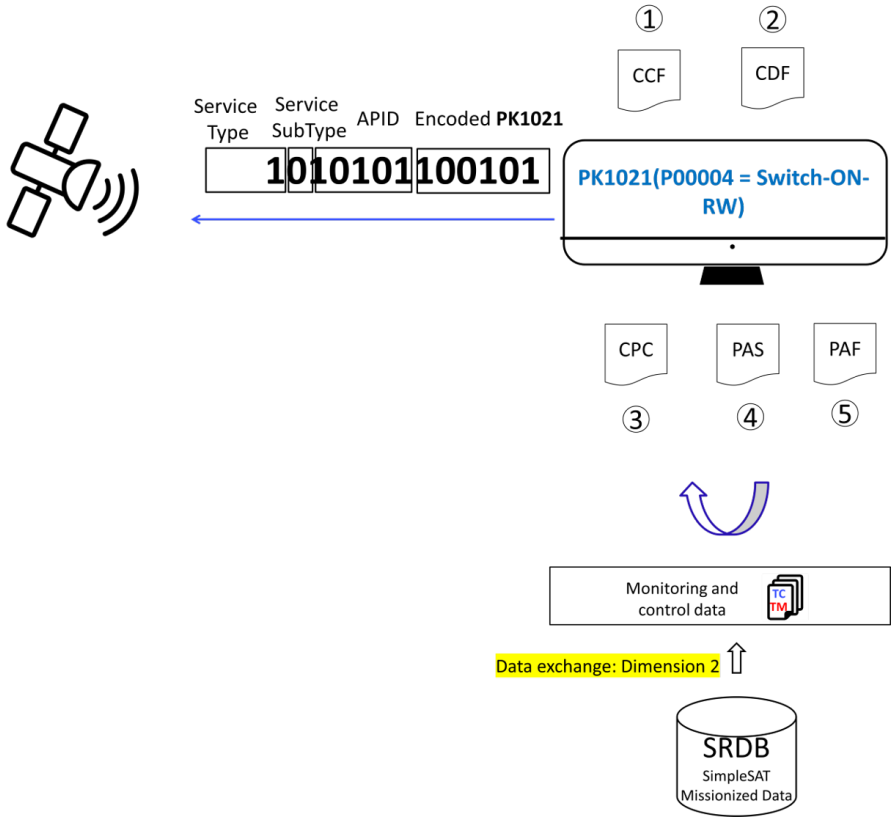


Figure 2: Example of encoding service 2 TC of SimpleSAT to switch on the RW

In Figure 2, each column represents a value of the corresponding attribute in the table `CCF` shown in Figure 1.

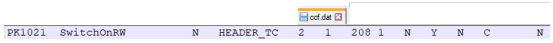
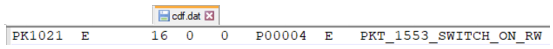
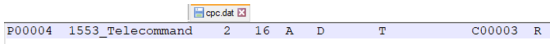
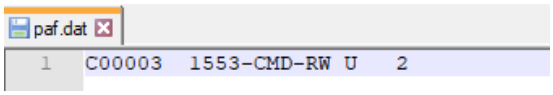
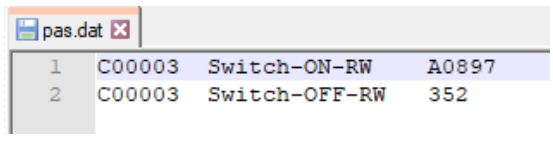
Step	MIB files role	MIB file content
1	The operator selects the service 2 TC `PK1021` whose definition is in the file `CCF`	
2	The TC is associated with the parameter `P00004` in the file `CDF`. The role of this parameter is to capture the action to be done by the RW	
3	`P00004` parameter details are defined in the file `CPC`. This parameter carries the encoding of the action to be performed by the service 2 and it refers to the calibration `C00003`	
4	The calibration `C00003` associates a raw value with the textual value S̈witch ON RW:̈ The value is the encoding of the Mil-Std-1553 packet that will actually switch on the RW onboard. The definition of the properties `C00003` is in the file `PAF`	
5	The mapping between raw values and their textual labels in `C00003` are captured in the file `PAS`	

Table 1: MIB data encoding example for SimpleSAT

1.2 MIB definition of a housekeeping packet to report RW temperature

The second scenario consists in showing how MIB files, exported from SimpleSAT SRDB, can be used to decode incoming housekeeping packet (PUS service 3). We reproduce the decoding process presented in our paper as depicted in Figure 3 and we show what MIB files are involved in this process as summarized in Table 2.

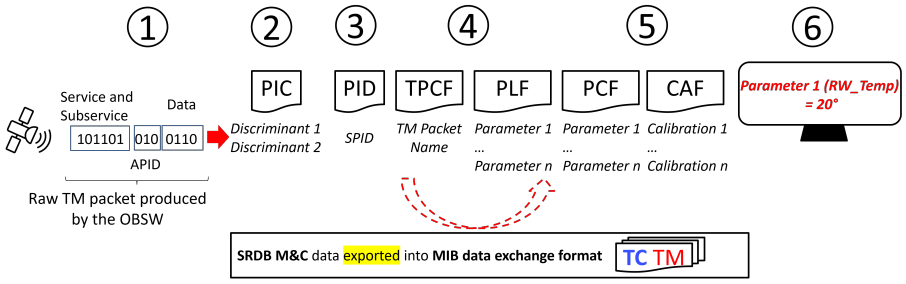


Figure 3: SimpleSAT example of decoding TM raw data using MIB files

Step	MIB files role	MIB file content
1	A raw TM packet flow arrives. As it is a representation of a PUS-compliant packet, the packet's service, subservice and application process identifier (APID) are extracted from its header. The structure of PUS-compliant packets is detailed in [2]	
2 3	By relying on information in the `PIC` file, which is part of the MIB exchange format, it is possible to determine whether this flow also contains the values of one or two discriminants. Discriminants aim to identify each TM packet separately from the others Once the values of the tuple <Service,Subservice,APID,Disciminants> are determined, then using information in the file `PID`, it is possible to identify the packet identifier named SPID[4]. The SPID represents a unique identifier of every TM packet	
4	Using this SPID: (1) The name of the packet is determined by relying on information in the file `TPCF`. This name is **PKT001**. This is what operators will see on their screen.(2) The parameters contained in the packet are determined by relying on the information in the file PLF. This list includes the parameter **P00001**	tpcf.dat 24500 PKT001 26 24501 PKT003 22 24502 PKT004 22
5	Once the list of parameters is identified, their properties are determined by relying on the content of the file `PCF`. Among these properties, we can find the identifier of the parameter's calibration whose content is determined from the file `CAF` . This calibration is then used to calculate the engineering value corresponding to the raw value of the parameter	pcf.dat P00000 Filler 3 11 N R F N P00001 RW_Temperature degC 3 12 N R C00012 F N 2 P00002 RW_Status 1 0 S R C00002 F N P00003 RW_Global_Status 3 14 N R F N P00005 TC_PACKET_ID 3 12 N R F N P00006 TC_PACKET_SEQ_CTRL 3 12 N R F N caf.dat 1 C00010 Ohm_to_temperature R U D 2 2 C00011 Raw_to_Ohm R I 2 3 C00012 Raw_to_temperature R U D 1
6	These are the values along with their units which are displayed to the end user	

Table 2: MIB data decoding example for SimpleSAT

2 Verification of MIB files

The comprehensive set of MIB files need to be coherent. This coherency needs to be tested against the integrity rules defined in the MIB ICD standard[1]. From the MIB ICD, we can extract hundreds of integrity rules of data defined in MIB files. A simple example of integrity rule is that if the entries of a calibration are defined in the file `PAS` as shown in Figure **??**, then there must be an entry of with the same calibration name in `PAF` file as shown in Figure **??**.

References

[1] Sylvie Haag et al. *SCOS-2000 Database Import ICD*. `https://bit.ly/3EMVLCk`. Accessed: 3/4/2023. 2017.

[2] ECSS. *ECSS-E-ST-70-41C- Telemetry and telecommand packet utilization*. `https://ecss.nl/standard/ecss-e-st-70-41c-space-engineering-telemetry-and-telecommand-packet-utilization-15-april-2016/`. Accessed: 3/4/2023. 2016.

[3] Malik Khalfallah. "Satellite Reference Database Validation: Towards an End-to-End Digitalized Process". In: *The Workshop on Simulation for European Space Programmes (SESP) 2023*. 2023.

[4] Michael Wendler et al. "A New Offline Data Processing System for TanDEM-X and TerraSAR-X Mission". In: *SpaceOps 2010 Conference by AIAA*. 2010, p. 2228.