# Planck/LFI: Management of Telemetry

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Ground tests are required before the flight of Planck. From the point of view of the telemetry management, tasks of the Data Processing Center are to create: the telemetry receiver and the database, to be integrated in the SCOS 2000 system, that contains the definition of the telemetry and telecommands used for the control of the instrument both in orbit and during testing. Furthermore, the DPC is in charge of building the Real-Time Assessment (RTA) and Quick-Look Analysis (QLA) systems to be used both in flight and during instrument ground tests.

## Large-Scale LFI Data Flow Scheme

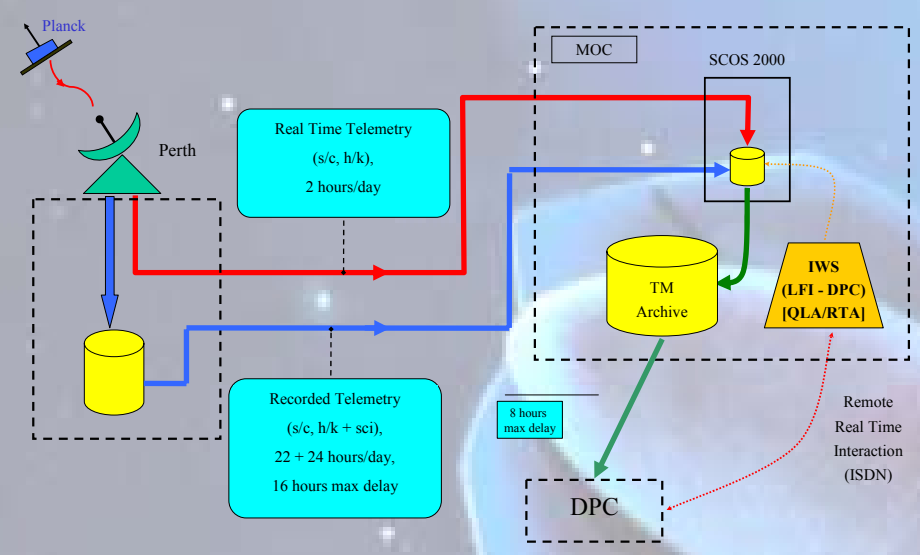


Figure 1: Data flow scheme from Planck to the Data Processing Center

## Telemetry - from the Ground Station to DPC Level 1

The main purpose of the **Level 1** of the LFI Data Processing Center (DPC) is to perform a quick-look analysis on the telemetry data to monitor normal operation of the observational plan and verify normal behaviour of the instrument.

The satellite will send the data to the Ground Station of Perth (Australia), see fig. 1, during the periods of visibility (~2 hours every day). Data will be forwarded to the Mission Operating Center (MOC) at ESA/ESOC. The telemetry downloaded is partially examined by the MOC (only spacecraft and instrument housekeeping telemetry to verify the health of the system) and it is delivered to the two Level 1 sites of the Data Processing Centers (DPC).

In the Telemetry packets there are both Housekeeping (h/k) and scientific information. Real Time housekeeping data are sent immediately from Perth to MOC, whereas housekeeping telemetry recorded on board during the period of non-visibility, and the scientific data are sent with a 16 hours max delay to the MOC. An additional delay of 8 hours max is to be considered to allow data to be sent from MOC to DPC.

At the DPC, more detailed Real-Time Assessment (RTA) and Quick-Look Analysis (QLA) will be performed on both housekeeping and scientific telemetry to evaluate instrument performance.

A feedback mechanism is foreseen between the DPC and the MOC. In the case of potential problems, the DPC, by using an ISDN network connection, is allowed to work remotely from the DPC on an Instrument Workstation (IWS) located at the MOC. There, RTA and QLA can be run to check directly the instrument real-time telemetry gathered at the MOC

## Telemetry Generators

The testing of telecommunication concepts and the creation of the ground segment for Planck/LFI requires:

1) to test in realistic conditions the Level 1 operations;
2) to measure in realistic conditions (compression + Telemetry overhead) the data rate of the instrument and its variations with the purpose of fixing a suitable compression rate;
3) to simulate transmission damages to the received data stream, in order to asses the overall impact of residual transmission errors, error recovery and error rejection strategies.

Figure 2 represents the overall data and telemetry (TM) flow of simulated data through the Level 1 of the Ground Segment of Planck/LFI. The Scientific Telemetry Simulator is inserted at the output of the Mission Simulator, whose task is to simulate the sky observation at various Planck frequencies. The data stream generated by the Mission Simulator represents a Time Ordered Data (TOD) which is packed for transmission by the Scientific Telemetry Simulator according to ESA standards. A Housekeeping Telemetry Simulator is available as well and produces housekeeping packets with different sampling rates (fast, low, thermal). Packetized data enter SCOS 2000 through a Telemetry Receiver and then they are quickly analyzed through the Quick-Look Analysis (QLA) module. A similar flow is valid for the housekeeping telemetry (Real Time Assessment - RTA), which, however, is not considered in the present document.

The Planck/LFI Ground Segment Level 1 is mainly based on the SCOS 2000 (Spacecraft Control and Operations System) environment developed by TERMA s.r.l. on ESA contract. This is a system that provides an environment including all the essential functions to monitor and control a satellite both during ground testing and in orbit. It will be the standard satellite control and monitor environment for future ESA missions. Among its various modules, SCOS 2000 includes a *telemetry processor*, a *telemetry database*, and a *telemetry archive*.

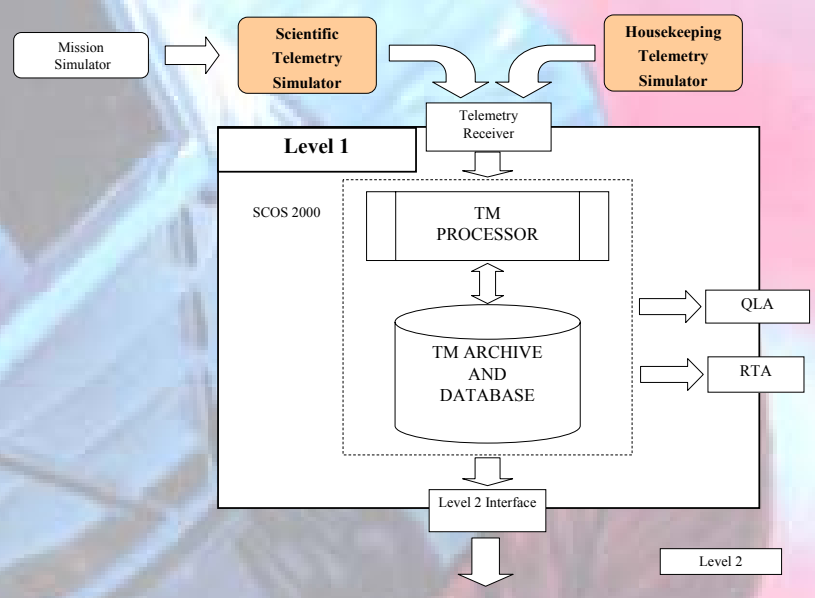


Figure 2: data flow of scientific telemetry from the Mission Simulator through the Level 1

## RTA and QLA

The Real-Time Assessment (RTA) software is expected to perform a routine analysis of the S/C and P/L Housekeeping (H/K) telemetry, in addition to what is performed at the MOC, with the aim of monitoring the overall health of the payload and detecting possible anomalies. All housekeeping data will be monitored, e.g. temperature sensors output and stability, power consumption of individual units (when recorded), cooling system parameters, etc.

Quick-Look Analysis (QLA) software is expected to perform a routine check on the science telemetry to monitor normal operation of the observation plan, verify normal behaviour of the instruments and check data integrity. No processing of the scientific data is included. Telemetry shall be analyzed at a speed several times higher than the real-time acquisition speed.

The SCOS 2000 environment will be used to build RTA and possibly QLA as well. If it is not possible perform QLA within SCOS 2000, we are intentioned to convert Telemetry into Time Ordered Information and use the latter to check the scientific telemetry values.

The Time Ordered Information (TOI) objects, (see TM2TOI of fig. 3, that is an output of the Telemetry Export - TME), are built from a number of telemetry packets by extracting successive samples at the same channel or of the same housekeeping parameters taken between starting time and an ending time. With the reconstructed pointing information, delivered later by the MOC as “auxiliary data” we obtain TOIs complete with coordinates.

The output of Level 1 is the whole set of TOIs, which is used to perform further DPC processing; it is therefore reasonable to used also as an alternate mechanism to perform QLA.

## Development of RTA and QLA

A first version of the RTA and QLA software, tested by means of a simulated instrument telemetry data flow (instrument output simulation), will be delivered and installed on the LFI EGSE computers to support the Instrument Level Tests (ILTs) of the LFI. More refined versions will be available for the Integrated Module Tests (IMTs) and Integrated System Tests (ISTs).

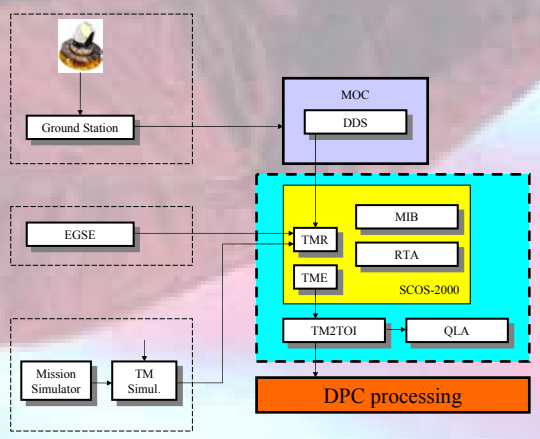


Figure 3: evolutionary philosophy for the development of RTA and QLA

The final version will be ready for Operations and will be installed at the Level 1 site: following system tests a copy of RTA and QLA will be installed on the Instrument Workstation (IWS) at MOC to support the Commissioning and PV phases.

There is an evolutionary philosophy for the development of RTA and QLA, shown in figure 3. From the analysis of simulated telemetry to support to Planck operations through ground tests (ILTs and ISTs), the system architecture is kept the same.

The first version of the system is already available. While RTA is developed within the SCOS-2000 framework and uses its telemetry database (MIB), QLA needs an intermediate conversion step (TM2TOI), which is in any case needed to feed the rest of the DPC processing pipeline.

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