HICoPS

Study and Design of a
Highly Integrated Communalised Payload System
for a Planetary Exploration Rover

Contract No. 19175/05/NL/PA

Executive Summary

Technical Note for WP —

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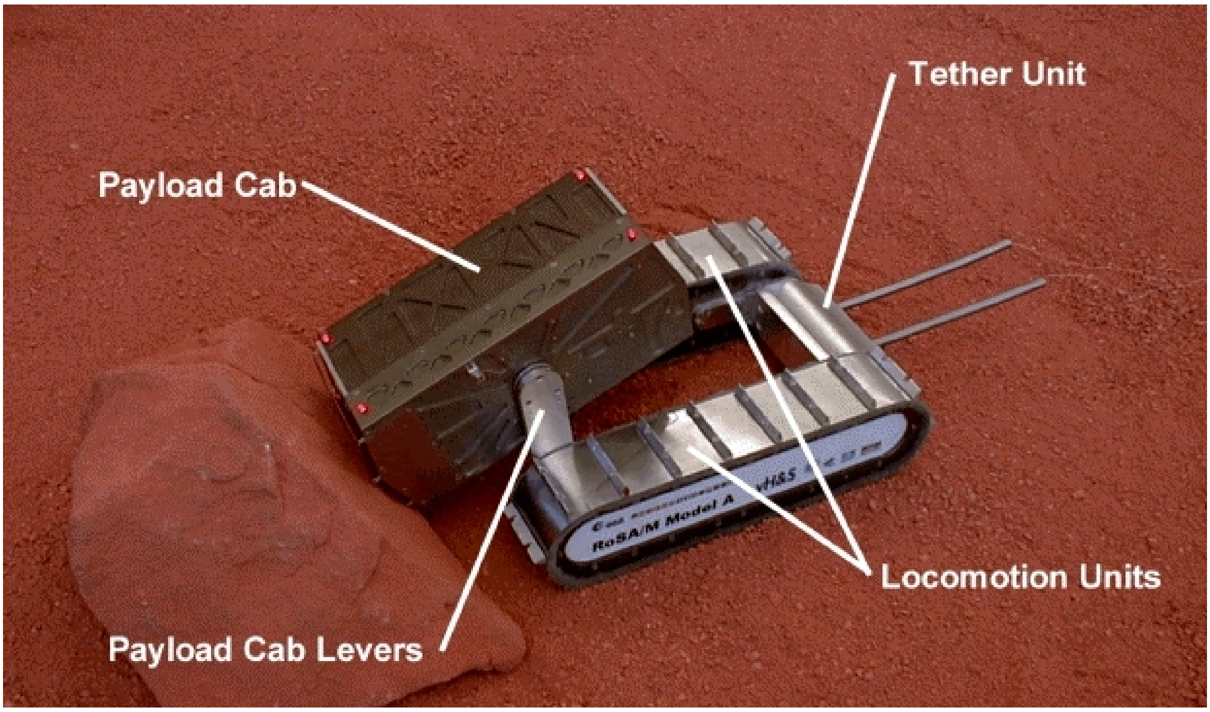

Figure 1: Nanokhod Rover.

1 Introduction and Objectives

Purpose of the HICoPS paper study, described in this summary, is a combination of a miniature rover and a set of miniaturised scientific experiments for planetary research. The instrumentation allows to analyse a planet with a broad spectrum of very efficient techniques. The rover Nanokhod, based on a proposal by Dr. Rudolf Rieder (MPCh Mainz) and vH&S, has undergone several evolutionary design steps in the past 10 years. This rover has the ability to carry a full set of miniaturised scientific instruments inside a levered rotationally mounted miniature compartment ("Payload Cab"), see Fig. 1 and 2. Prior to HICoPS, there were mainly two precursing studies: GIPF and MRP. The rover has been completely redesigned by vH&S within the MRP ("Mercury Robotic Payload") study contract. GIPF ("Geochemistry Intrument Package Facility´) describes a full set of scientific instrumentation for remote geochemistry analysis in planetary research. GIPF and MRP developments have been performed in parallel, with the final integration in mind, which is now commenced by the HICoPS activity.

All electronics needed to be highly miniaturised and shall completely fit into the Nanokhod rover. The mechanical arrangement of the rover and locomotion related PCBs and sensors has been designed in the precursing MRP study. Thus many MRP circuit designs could directly go into the HICoPS design, whereas the scientific payload of GIPF needed more effort of further miniaturisation. One of the key elements of the HICoPS study was to find as many commonalities and to remove the overhead of the existing electronic designs.

The individual instruments, the Mössbauer Spectrometer (MIMOS), the Alpha-Particle-X-Ray-Spectrometer (APXS), and the miniaturised stereo camera (MIROCAM) have a high level of functional maturity, and two of them are space-proven on NASA's twin "Spirit" and "Opportunity" rovers on the Martian surface.

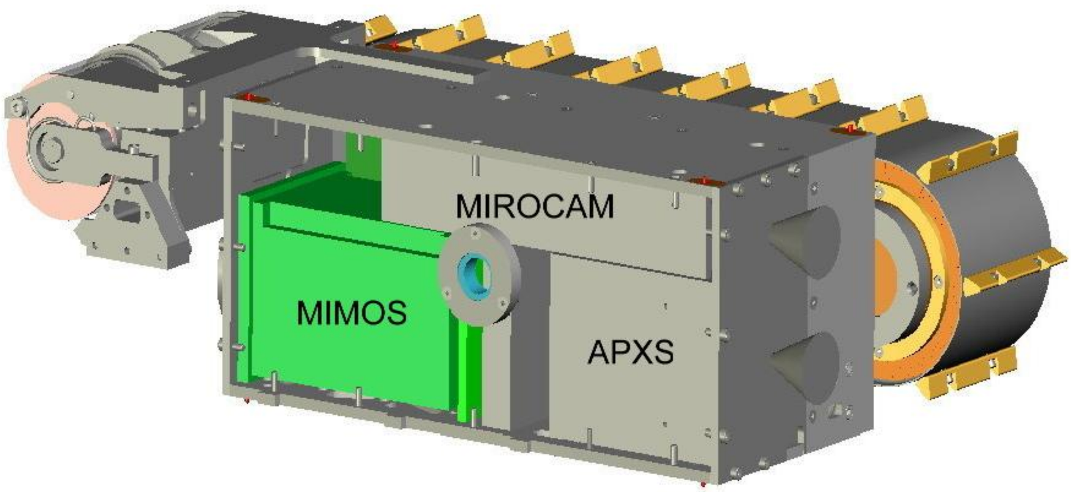

Figure 2: Rover and Payload

Package	Activity	Technical Notes
WP 1000	Assessment	HICOPS-TN-110
WP 2000	Definition	HICOPS-TN-222, HICOPS-TN-230
WP 3000	Detailed Design	HICOPS-TN-310

Table 1: HICoPS Work Packages

2 Work Packages

HICoPS was split into the work packages shown in Table 1.

3 Results

HICOPS-TN-110 describes the outcome of the requirement assessment with respect to resources, environment and user requirements. Based on the environmental conditions, a requirements network has been drawn as shown in Fig. 3 for missions to both Mercury and Mars. This directed graph presents, from top to bottom, the main environmental requirements and their implications on the various aspects of an overall HICoPS system design.

HICOPS-TN-222 presents the vH&S approach of the preliminary electronics design for a fully integrated rover system including all instruments. In the corresponding WP 2200 all subsystems (instrument frontends, main instrument electronics, rover subunits) are reviewed regarding their development status. Then the overall system is repartitioned into functional building blocks, namely optimised instrument frontends and instrument functions that can be integrated into a fully digital Common Subsystem FPGA. In this development all electronics circuitry from the instruments and the rover is integrated together into one object. As one outcome, Fig. 4 shows a blockdiagram of the modules that have been taken as the input to the following detailed design phase.

HICOPS-TN-310 is finally the detailed electronics design report. All design files are provided. All submodules are described throughout the document with their individual internal interfaces and functionality. The document provides all circuit drawings and verilog FPGA

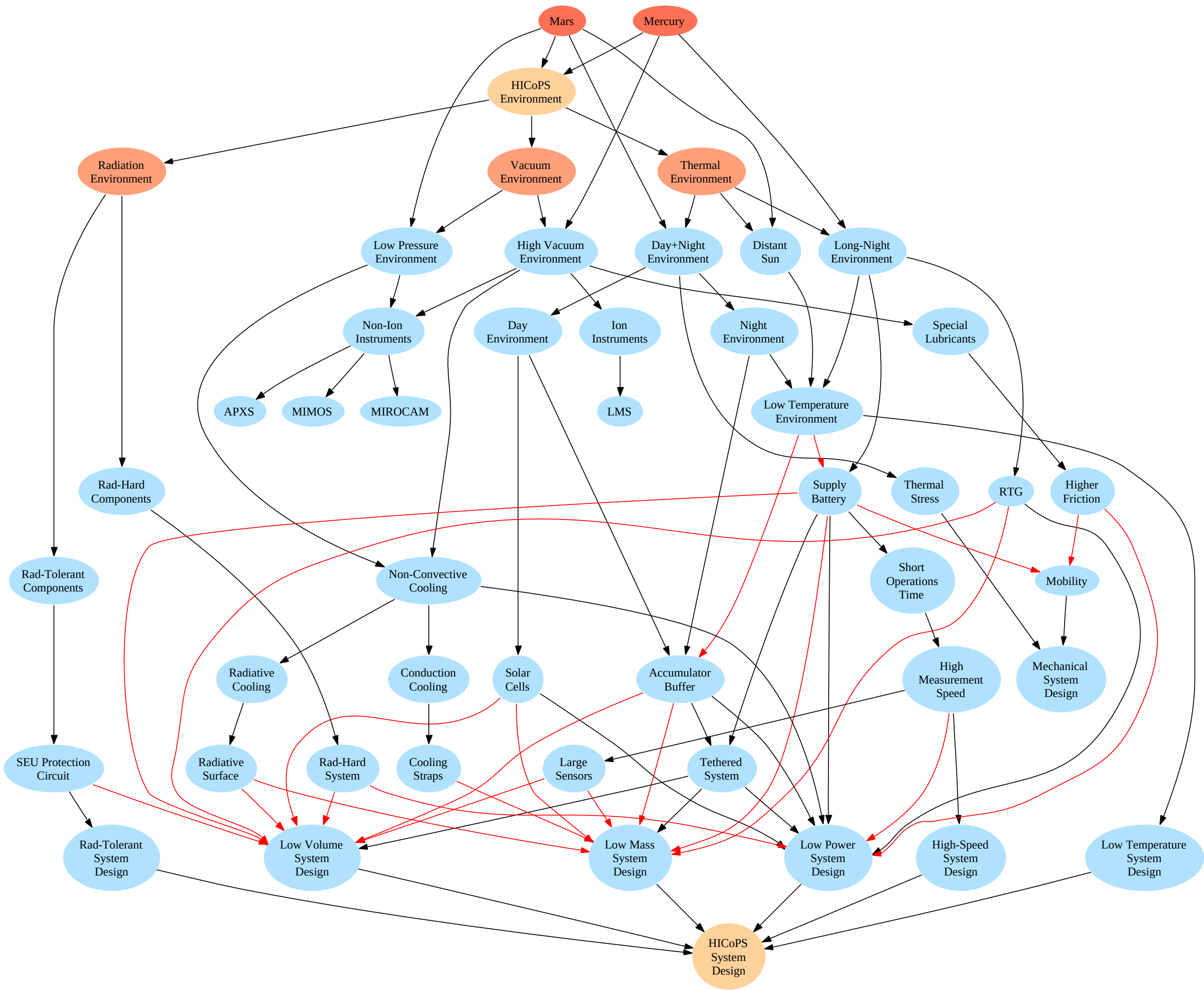

Figure 3: Requirements network for HICoPS given by Mercury and Mars environments.

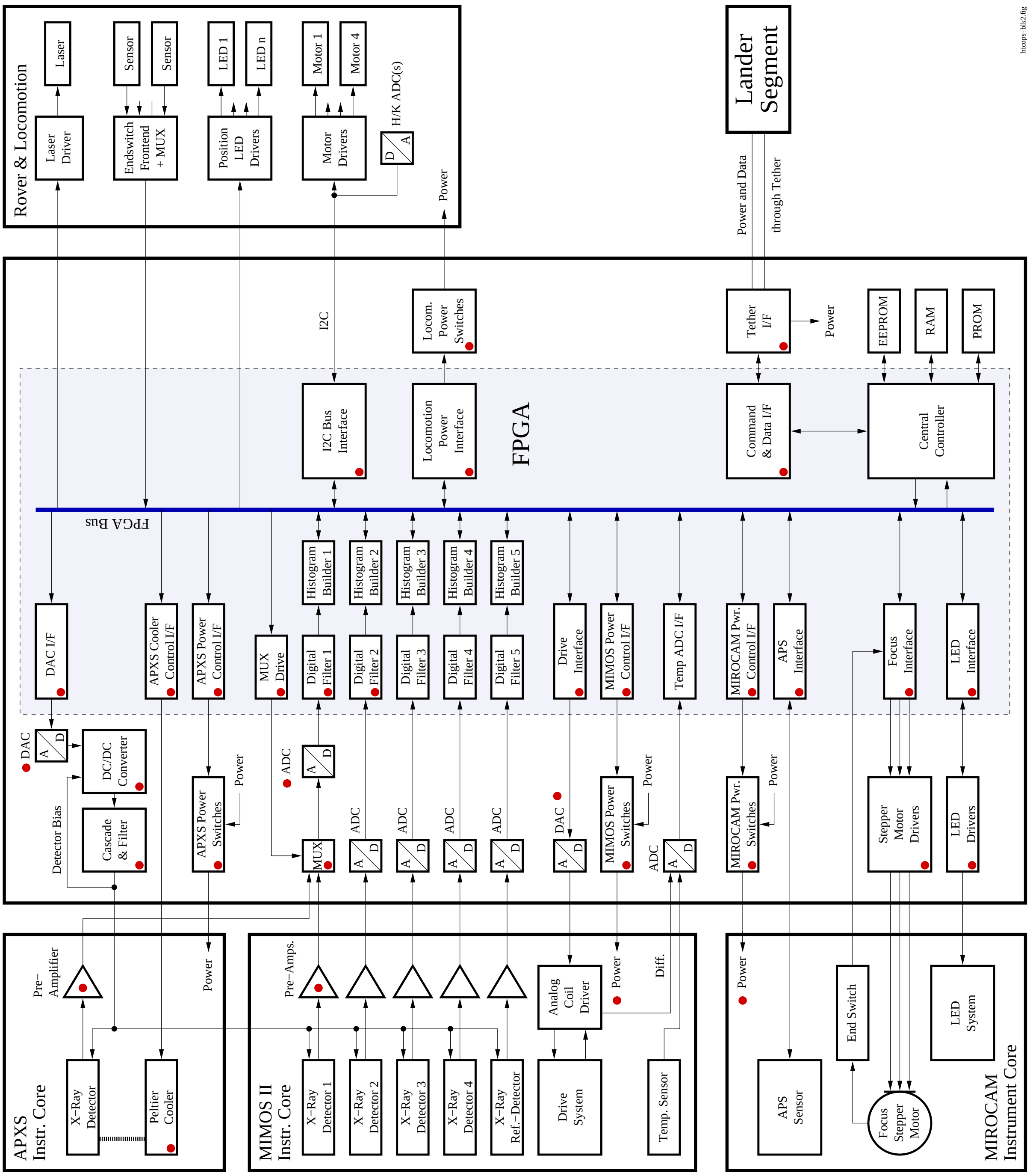

Figure 4: Block diagram of overall HICoPS system.

code including simulations. Due to the high grade of miniaturisation, the selection of reliable but small components is critical. A list of critical parts is provided, together with a PCB space estimation and FPGA resources calculation.