Flight Software Implementation and Verification on IRIS CubeSat

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Abstract:
Flight software (FSW) is essential in the operation of a satellite program. It is important to verify the functionality and performance of the FSW on ground before being deployed in space. We discusses the implementation and verification of the FSW of the Intelligent Remote-Sensing and Internet Satellite (IRIS) CubeSats.

01 Introduction

The IRIS program aims to design and launch two CubeSats: IRIS-A and IRIS-B.

Mission objective:

IRIS-A → Internet of Things (IoT) demonstration
LoRa implementation
Doppler frequency estimation/compensation
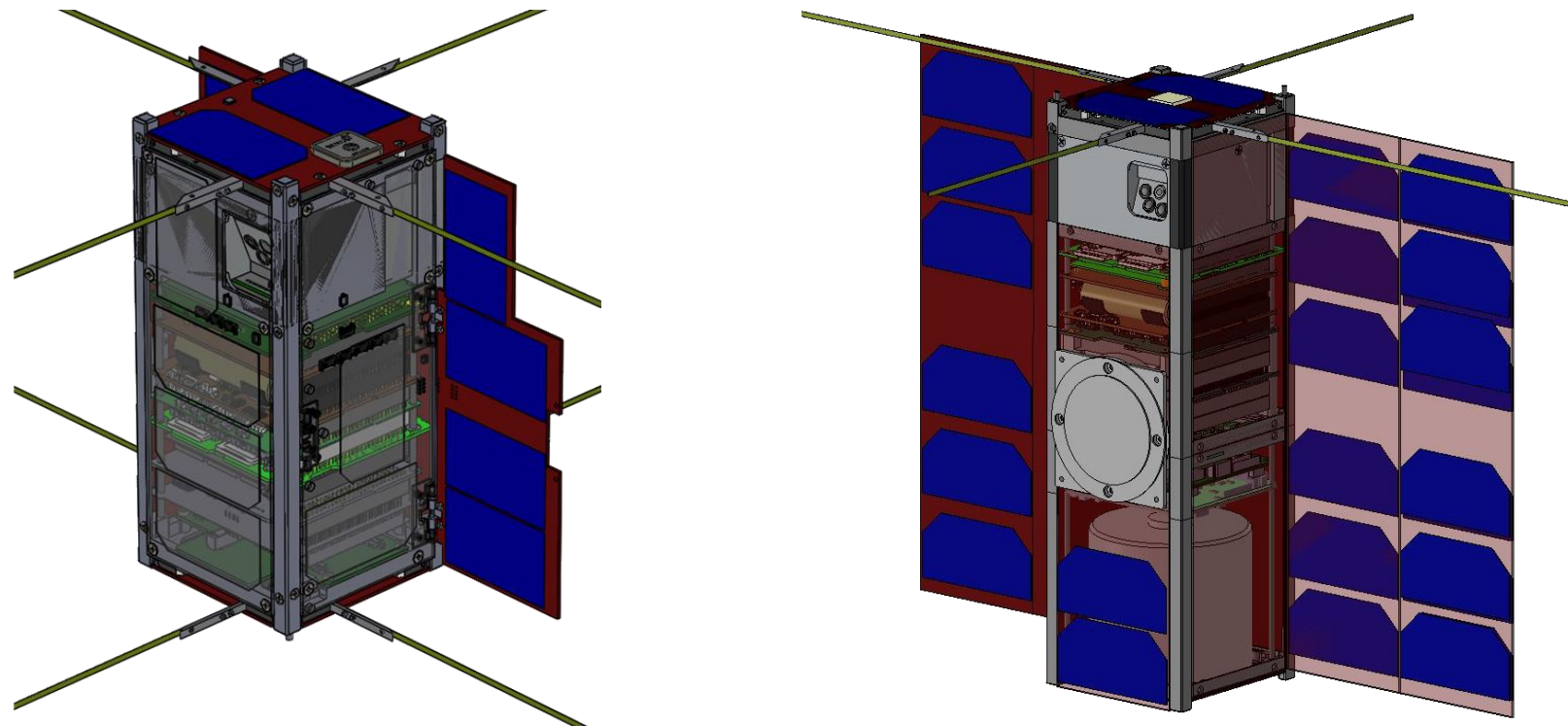
IRIS-B→ In-orbit intelligent remote sensing

02 Overview of IRIS

Subsystems:
• EPS
• OBDH
• TT&C
• ADCS
• Motherboard
• Daughterboard

Payload:

IRIS-A
• GPSR
• Reference clock
• LoRa receiver

IRIS-B
• GPSR
• RS payload

03 Flight Software Requirement

Robustness	The system should detect fault and recover from anomalies.
Modularity	The functionality can be easily added, modified or removed without affecting core of architecture.
Reusability	The software is able to migrate to different platform with least effort.
Autonomy	The system can do specific operation by itself.

04 Software Implementation

• Hardware: ISIS-iOBC (ARM-9, 32bit processor)
• Operating system: FreeRTOS
• Solution of the requirements:

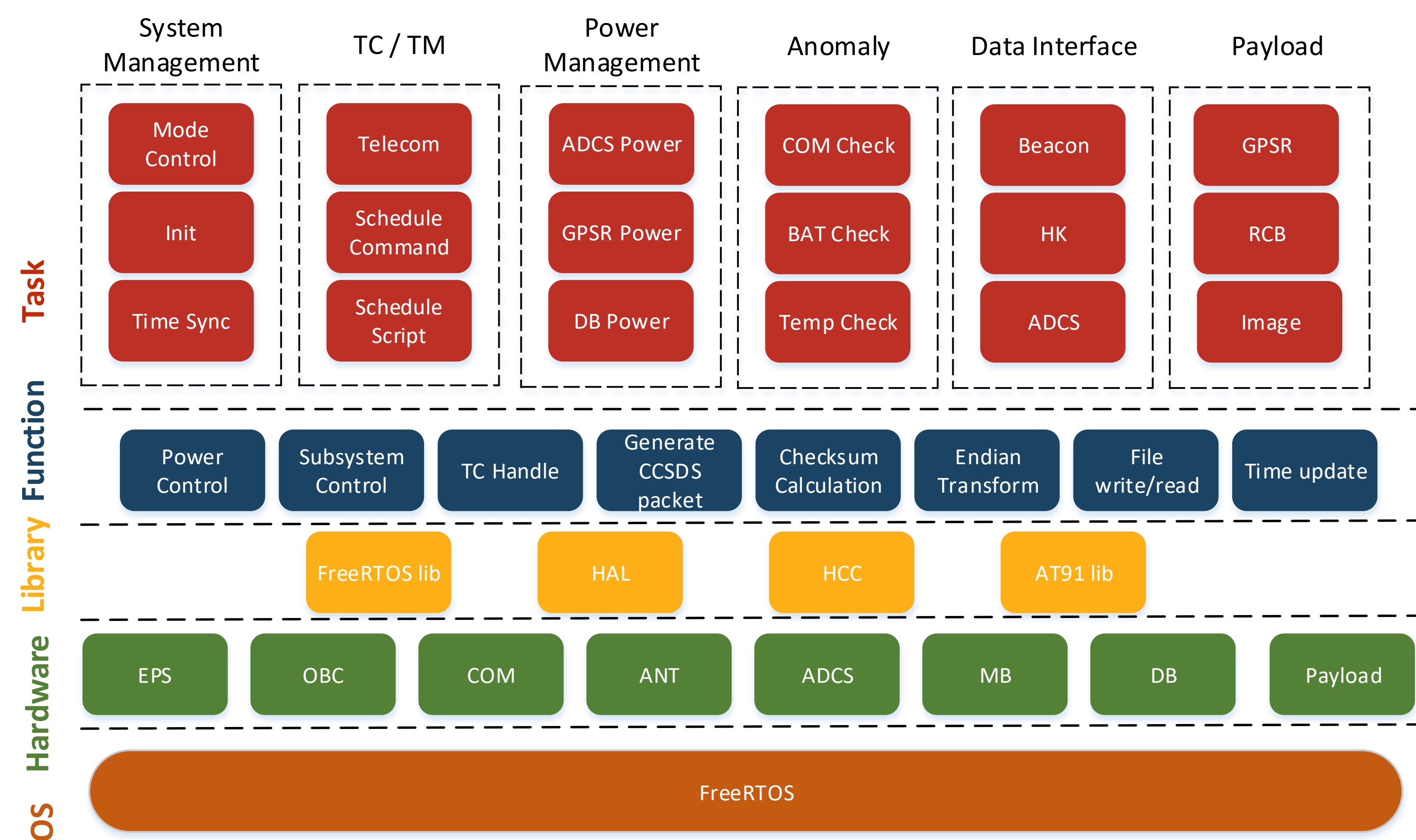| Robustness | FDIR mechanism (COM check, Temp check, BAT check) |
Modularity	Task-oriented architecture
Reusability	Hierarchical architecture
Autonomy	Schedule telecommand, mission timeline

• Software architecture:

	System Management	TC / TM	Power Management	Anomaly	Data Interface	Payload
Task	Mode Control / Init / Time Sync	Telecom / Schedule Command / Schedule Script	ADCS Power / GPSR Power / DB Power	COM Check / BAT Check / Temp Check	Beacon / HK / ADCS	GPSR / RCB / Image
Function Library	Power Control / Subsystem Control / TC Handle / Generate CCSDS packet / Checksum Calculation / Endian Transform / File write/read / Time update					
	FreeRTOS lib / HAL / HCC / AT91 lib					
Hardware	EPS / OBC / COM / ANT / ADCS / MB / DB / Payload					
OS	FreeRTOS					

05 Software Verification

• Low-level test
> Test the basic function of the system
> Based on debugging console

• FlatSat platform
> Test interface communication
> Subsystem integration

RCB GPSR EPS

ADCS ANT COM MB OBC
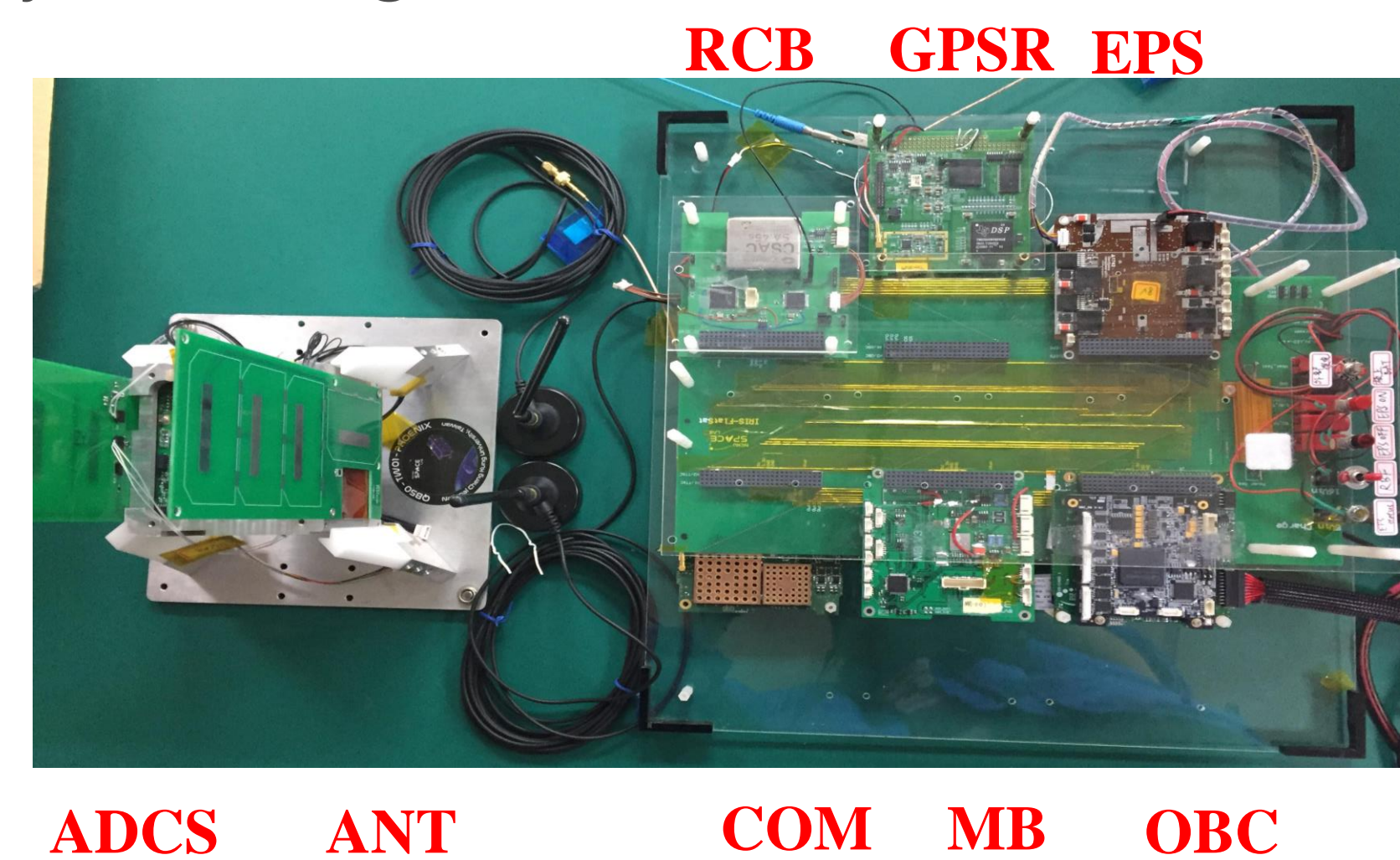
• End –to –end communication
> Test communication with ground station

• Software test bed
> Use Arduino to simulate subsystem anomalies

TNC SCS Radio

06 Conclusion & Future Work

• Mission verification
> Real mode operation verification
• Software architecture tracking
• Code generation
> To reduce the effort of development