ORBiT Avionics System II Architecture

ES00002

Rev: A03

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1 Introduction

1.1 Scope

This document covers both software and hardware architectures for the ORBiT Avionics System II.

1.2 Purpose

The ORBiT Avionics System II (OA-II) includes multiple independent subsystems which must operate together. This includes hardware protocols and interconnects, and software APIs.

1.3 Revision History

Rev	Author	Approver	Changes	Date
A02	Gabriel Smolnycki		System architecture cleanup	2019-06-28
A03	Jinzhi Cai		Fix BAS naming	2019-06-29
-	Jinzhi Cai		Fix VEH naming	2019-07-02
A04	Jinzhi Cai		Add Engine Testing System	2019-07-04
A05	Gabriel Smolnycki		Formatting and consistency with system architecture	2019-07-08

Table 1: Summary of Revision History

2 General Software Architecture

The software system for OA-II can be divided to three layers: data link layer, transport layer, and application layer.

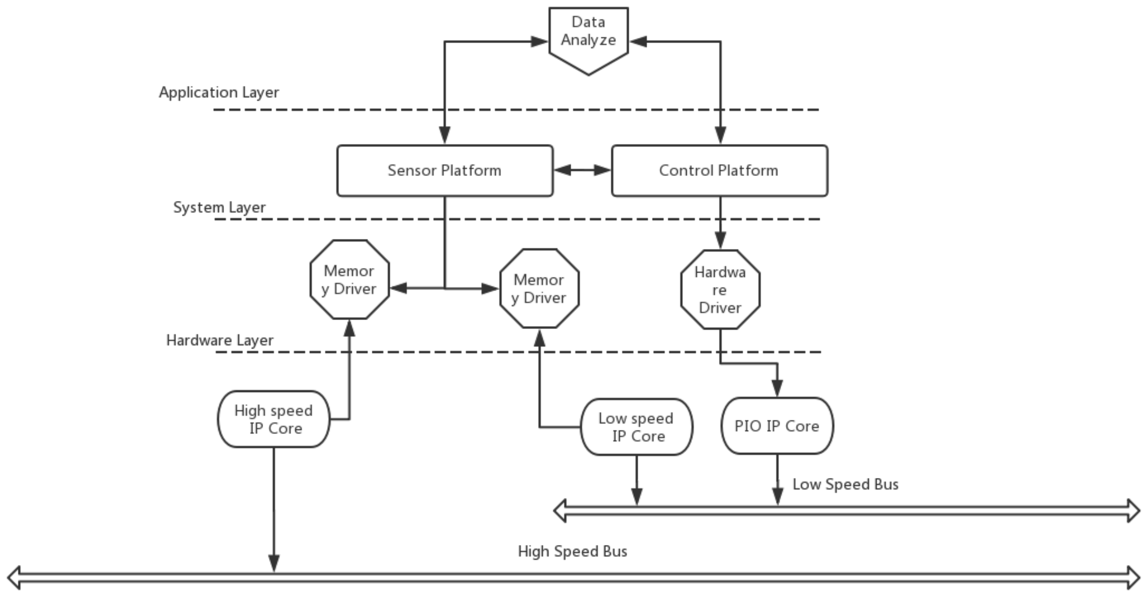

Figure 1: Software Architecture

2.1 Data Link Layer

The data link layer directly interacts with hardware memory. It include drivers for all hardware buses. It also includes programs which execute direction on the CPU.

2.2 Transport Layer

The transport layer connects the data link and application layers. It receives data from different data link layer sources and packetizes it. It will feed all the packetized data to relevant application program. It provides critical control before and during the flight. Finally, the transport layer records all data to onboard storage.

2.3 Application Layer

The application layer is used to process data provided by the transport layer, as well as to provide information that will be sent back to OA-II BAS.

3 General Hardware System Architecture

3.1 Payload Catalog

Critical Payload

The critical payload controls basic launch and recovery operations. It will attach directly to the Compute Module (CM). Any failure of the critical payload will result in a launch abort. The critical payload contains:

- Power management
- GPS receiver
- Low speed IMU
- Storage media
- Radio system

High Speed Payload

- The high speed payload contains non-critical devices, in particular sensors. This payload is primarily for research purposes. These devices will be located in the Telemetry Module (TM), and include:

- Static and dynamic air pressure sensors
- High speed IMU
- Cameras
- Temperature sensors
- Pressure sensors

Low Speed Payload

- The low speed payload contains non-critical devices which are significant EMI sources. The low speed payload must be fully galvanically isolated from the rest of the system. This includes:

- Actuators
- Pyrotechnics

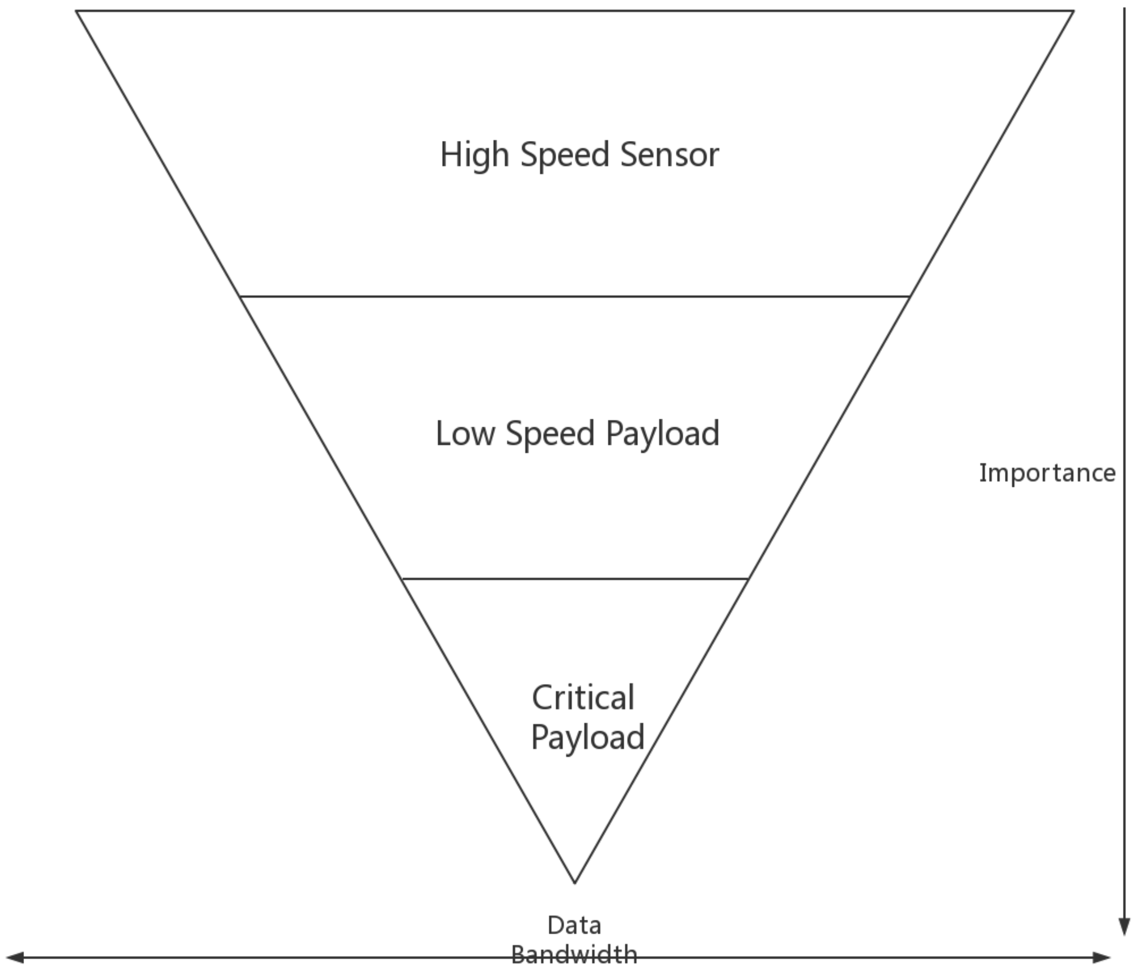

Figure 2: Payload Diagram

4 Vehicle Electronics (VEH) System Architecture

4.1 Description

The OA-II VEH is a compact, modular system which is tightly integrated with the flight vehicle.

4.2 Payload Frame (PF)

The Payload Frame (PF) contains interchangeable modules and provides a high speed bus controller and power supply. The PF should be a four layer board.

4.3 Payload Modules (PM)

Payload Modules are specialized circuits which slot into the Payload Frame. They can be divided into three primary types: Computing and Operation Module (COM), Telecommunication and Acquisition Module (TAM), and Power and Actuator Module (PAM).

Computing and Operation Module (COM)

The Computing and Operation Module (COM) has several purposes. It controls other modules and monitors the vehicle status. It collects data from Telemetry Modules, and contains long-term storage for collected data.

Telecommunication and Acquisition Module (TAM)

The Telecommunication and Acquisition Module (TAM) is an interface to both sensors and radios. The TM connects to both low and high speed sensors. The TM also FIFO buffers for high speed sensors.

Power and Actuator Module (PAM)

The Power and Actuator Module (PAM) is providing power and operating any mechanical component. It manage the main power source of the vehicle and allow CM to control high power electronic. The PAM also offer limited control for safety cutoff in case CM lost connection or power.

4.4 Backplane System (BPS)

The OA-II BPS is a unique, multi-level information exchange system that links modules in in the OA-II VEH and BAS. It provides different speed modes for different components. The BPS is a part of the PF.

- Provide different speed modes with low latency
  - Info level ($\leq 3MB/s$)
  - Data level ($\approx 50MB/s$)
  - Stream level ($\geq 100MB/s$)
- Built-in self test (BIST)
- Conformal coating
- Operation over extended 0-85°C temperature range

5 Base Station Electronics (BAS) System Architecture

5.1 General Description

The OA-II BAS is a modular launch pad and flight control center. It performs three major functions: launch control operations, live data analysis and display, and vehicle status indication.

5.2 Launch Control Module (LCM)

The Launch Control Module monitors and controls the vehicle before, during, and after flight. This includes ignition and oxidizer control, parameter tuning, and launch abort functionality.

5.3 Live Data Module (LDM)

The Live Data Module shows vehicle information during flight. This includes a 3D map of the flight path, propulsion system temperatures and pressures, and IMU data.

5.4 Vehicle Status Module (VSM)

The Vehicle Status Module performs basic analysis on the live telemetry data. This includes displaying a Range Safe/Range Live indication, vehicle orientation from sensor fusion, flight profile stages, and error monitoring.

6 Ground Testing System (GTS) Architecture

6.1 General Description

TBD

7 Backplane System (BPS) Architecture

7.1 General Description

The OA-II BPS is the main bus system for all the OA-II relative component. It will provide up to 500MB/s band width. In the same time, it also provide low data lane for smaller component and low power, sample application. It also provide 24V power for all the module that attach with it.

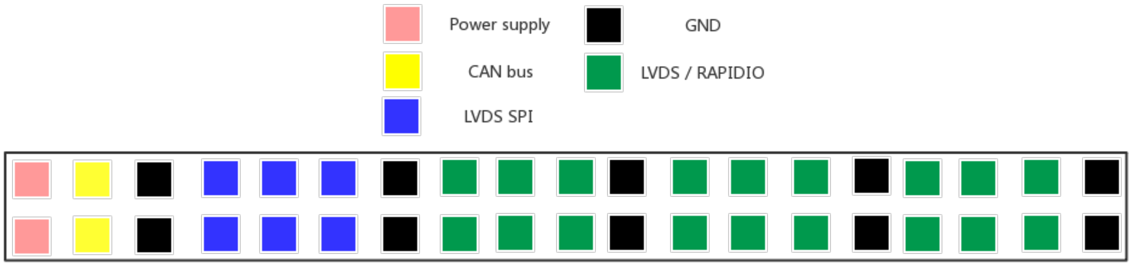

Figure 3: Example Pin Out

8 Radio Communication System (RCS) Architecture

8.1 General Description

The ORBiT Avionics II Wireless System (OA-II RCS) is use to connect vehicle and base station. It is important part of OA-II STAM and OA-II "Demonstrator". The OA-II RCS provides two type of communication between the vehicle and base station, high speed and low power modes.

8.2 High-speed Wireless Connection Protocol

The OA-II HRCS is use mainly during the fly and allow to provide high speed communication to the base station. It will download live vehicle status and video stream to the base station.

8.3 Low-speed Wireless Connection Protocol

The OA-II LRCS is mainly use for landing and component recovery. It provide location tracing and broadcast system and also allow radio locating in range.