On Board Mission Planning, Autonomous Software, LEO Satellite

MTS-UFS-CONAE

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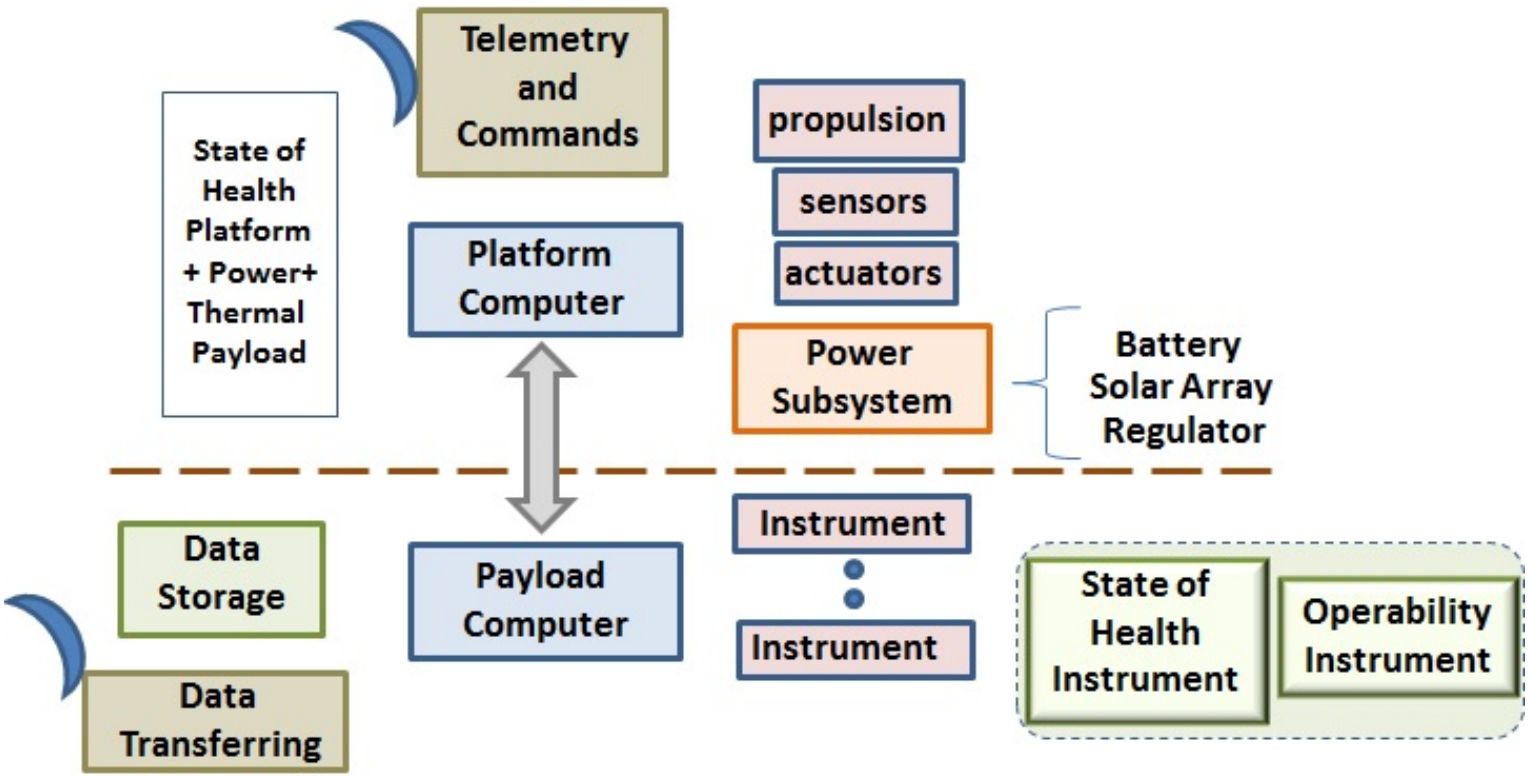
Agenda

Origen.

- This work is part of the thesis in Maestría en Tecnología Satelital (Master on Satellite Technology) to conclude the study and obtain the Master Degree, in Formación Superior-CONAE associated with UTN-FRC University.
- In this framework emerged the need to reduce the ground operations tasks and execute them on-board, allowing an intelligent handling and control of the payload.
- An on-board planner is presented as a solution to deal mainly with the on board monitoring and fulfillment of the mission plan.
- The mission planning can be adopted as a reduced version of the ground operations but running in the payload on-board computer.

Introduction
General Satellite Topology

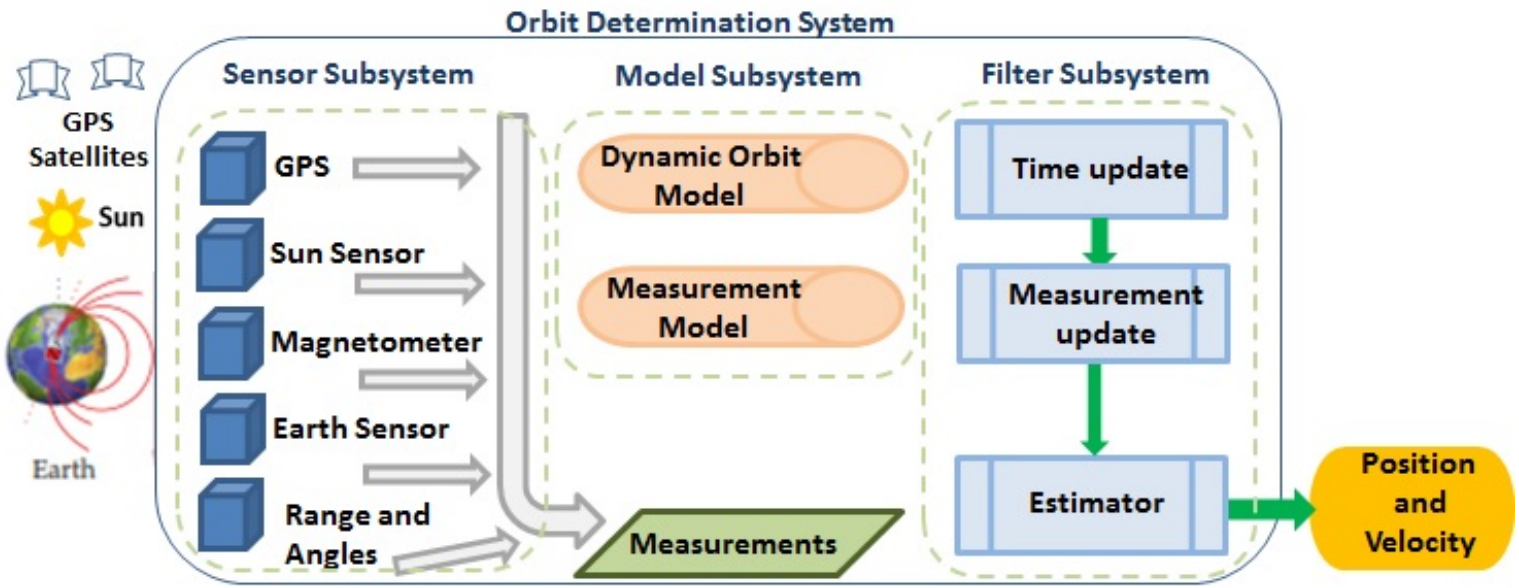


Functions
Short description

1. Orbit Determination: Calculation of the best possible orbit using the sensors that are indicated as necessary (GPS, Mag + Sun, etc.)
2. Attitude Determination: Calculation of the best possible attitude using all available sensors on board.
3. New Scenario Generation: Scenario is a sector on Ground where the satellite has to perform an action. The most common is to turn the transmitter ON when the position is inside the circle around the antenna. This polytopes exist according to the mission plan script. In case of being necessary a new polytope can be created by this function in real time.
4. Mission Plan Addendum: Determines if a point, in this case the satellite is inside the polygon. It is called as many polygons are included in the plan to be checked.
5. Predictive Events: Generates future events based on geometric, kinematic or dynamic computations.
6. Trend Analysis: Generates alerts for anomalous performance in voltage and/or temperature of the payload components

Orbit Determination

The orbit determination is the process of estimating the satellite's state variables (position and velocity) by comparing the difference between the measurement data and the estimated data.



Orbit Determination
Filtering

Owing to the nonolinear dynamic model of the satellite orbit motion, the filtering method applied should be appropiate. They can be:

1. Extended Kalman Filter (EKF),
2. Linearized Kalman Filter (LKF).

Both are based on the analytical Taylor series expansion of the nonlinear systems and measurement equations. However, the Taylor series approximations in EKF introduce large errors due to the neglected nonlinearities. The LKF is similar to the EKF except the linearization takes place about a pre-computed nominal trajectory.

The process to be estimated and the associated measurement relationship may be written in the form:

$$\dot{\mathbf{x}} = f(x, u_d, t) + u(t)$$

$$\dot{\mathbf{z}} = h(x, u_d, t) + v(t).$$

Where f and h are known functions, ud is a deterministic forcing function, and the u and v are white noise processes with zero cross-correlation.

Filtering
Linearized Kalman Filter

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Thank you for attend this research