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MÁSTER UNIVERSITARIO EN SISTEMAS ESPACIALES

SYSTEM REQUIREMENTS DOCUMENT ATLANTIS 2025

ATLANTIS25_SRD_v1.1

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Changelog

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Atlantis Team	1.0	22/10/2024	All	Draft
Atlantis Team	1.1	25/10/2024	All	Addition of A-COM-20/1.1 Addition of A-ODH-10/1.1 Addition of A-ODH-20/1.1 Addition of A-ADC-40/1.1 Addition of A-ADC-50/1.1 Addition of A-PRO-30/1.1 Addition of A-MSS-100/1.1 Modification of A-EPS-10/1.0 Modification of A-STR-10/1.0 Modification of A-STR-20/1.0 Removal of A-MSS-50/1.0 Removal of A-ADC-20/1.0 Removal of A-STR-30/1.0 Removal of A-PRO-20/1.0

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Acronyms

ADCS Attitude Determination and Control System

COTS Commercial-Off-The-Shelf

IoT Internet of Things

LEO Low Earth Orbit

LoRa Long Range

MOS Margin of Safety

SRD System Requirements Document

ODH On-Board Data Handling

1 Introduction

The present document states the system requirements involved in ATLANTIS 2025 mission during phase 0 of its development. The structure of the document is composed of two main blocks: a general description and the specific requirements.

- Firstly, a general description of the mission is provided. The motivation and objectives are defined.
- Secondly, the requirements to accomplish the mission objectives are defined according to the constraints.

2 General Description

IoT technology has recently been implemented in maritime transport to monitor, among other things, the condition of cargo containers. These smart containers are equipped with sensors that provide information on temperature and humidity inside, the presence of fires, vibrations, etc. Due to the lack of infrastructure, the coverage of traditional mobile networks is limited to a few kilometers from the coast. Therefore, satellite communications are essential for transmitting container data from any point along the route. The primary goal of the mission is to design a constellation of low Earth orbit satellites that can provide coverage for 500 IoT devices being transported across the Atlantic Ocean. This includes the sizing and selection of components for all satellite subsystems, selection of the launcher, operational orbits, number of satellites, etc. The mission will have a 10-year duration, and the onboard components will be COTS products. Specifically, the main payload of each satellite will be an IoT communications and data management system. Additional payloads may be included to maximize the use of the constellation.

3 Specific requirements

3.1 Naming convention

The requirements will be identified with the following name: A-XXX-YY/VER.

Code	Description
A	Atlantis 2025
XXX	Category of requirement by subsystem
YY	Enumeration of the requirement within the category
VER	Version of the SRD in whick the requirement was implemented, or lastly modified

Table 3.1: Naming convention.

3.2 List of requirements

Each requirement will include a rationale explaining why it is well defined. A structured naming convention has been used to classify the requirements, which not only highlights the type of requirement and its relevance to different stages of the mission but also ensures traceability. This system allows for tracking the development and modifications of each requirement throughout the mission's lifecycle. Moreover, all requirements are unique, without overlap, as each one addresses a specific and distinct specification.

3.2.1 Mission

- **A-MSS-10/1.0**: The operational lifetime of the satellites shall be at least 10 years.
- **A-MSS-20/1.0**: The satellites shall orbit in LEO.
- **A-MSS-30/1.0**: The constellation shall cover the Atlantic Ocean.
- **A-MSS-40/1.0**: The constellation shall receive and forward 10 KB of data per device from 500 devices every two hours.
- **A-MSS-60/1.0**: The satellites shall be microsatellites up to 25 kg mass and 400 mm X 250 mm X 250 mm envelope.
- **A-MSS-70/1.0**: The satellites design shall follow the margin philosophy.
- **A-MSS-80/1.0**: All satellite components shall be COTS.
- **A-MSS-90/1.0**: Satellites shall carry and operate an additional payload.
- **A-MSS-100/1.1**: The satellites shall deorbit before 25 years since the start of the mission.

3.2.2 Electrical Power System

- **A-EPS-10/1.1**: The power subsystem shall ensure the operation of the subsystems during the mission's lifetime.
  Each satellite shall have the capability to maintain active subsystems to ensure the mission's lifetime.

3.2.3 Communications

- **A-COM-10/1.0**: The ground Segment communication channel shall work with a bitrate up to 2.5 Mbit/s for the downlink, and up to 128 kbit/s for the uplink, at a frequency of 2 GHz, comprised in the S-band.
  This configuration allows for the possibility of including a payment payload in the same frequency band, ensuring the efficient transmission of all devices, as well as the satellite and the payment payload. This provides us with operational flexibility and ensures smooth communication between satellite and ground stations.

- **A-COM-20/1.1**: The communications subsystem shall be compatible with LoRa technology for receiving data from IoT devices.
  This requirement ensures that the communications subsystem is compatible with LoRa technology in all regions necessary for the mission, allowing the reception of data from IoT devices and ensuring connectivity with these devices.

3.2.4 On-Board Data Handling

- **A-ODH-10/1.1**: The satellite shall be capable of receiving, storing, and transmitting telemetry and payload data from IoT devices and ground stations, then relaying it to ground stations.
  This requirement ensures the satellite can manage the reception, storage, and retransmission of telemetry and payload data from IoT devices and ground stations to ensure mission operations.

- **A-ODH-20/1.1**: The on board computer shall have processing and telecommand capabilities.
  This requirement ensures that the on board computer can execute commands from the ground station and process data from various subsystems, guaranteeing the control and operability of the satellite during the mission.

3.2.5 Attitude Determination and Control System

- **A-ADC-10/1.0**: The satellite shall have the capability to determine its position throughout the mission.
  The ADCS subsystem shall gather positioning information to provide information about its location assuring orbit characteristics and maneuvers.

- **A-ADC-30/1.0**: The satellite shall be able to maintain its orbit.
  The ADCS subsystem shall consider orbit interferences to assure that each satellite maintains its designated orbit during the time stipulated. This will be archived via orbital adjustments, corrections satellite orientation and configuration.

- **A-ADC-40/1.1**: The ADCS subsystem shall have the capability to determine its orientation throughout the mission.
  The determination of the orientation made with the ADCS components is crucial for the control determination of the satellite.

- **A-ADC-50/1.1**: The ADCS subsystem shall maintain the satellite orientation to nadir with a precision of at least $\pm 5°$.
  To ensure the correct communication to the clients and ground segment, it has been defined that the satellite shall be oriented to nadir. The orientation of the satellite could not be the same as the antenna/s nor solar cells orientation.

3.2.6 Propulsion

- **A-PRO-10/1.0**: The propulsion system shall enable orbital adjustments.
  The propulsion system shall provide orbital corrections for all satellites in the constellation to maintain their designated low Earth orbit during the 10-year mission lifetime.
- **A-PRO-30/1.1**: The satellite shall be capable of reaching its designated position in the constellation.
  After the launcher sets the satellite into its first orbit, each satellite shall be able to make the necessary orbit maneuvers to reach its designated orbit.

3.2.7 Thermal

- **A-THR-10/1.0**: The thermal control system of the satellite shall cope with the space environment throughout the mission.
  The thermal control provisions shall be able to maintain all subsystems within their nonoperational and operational temperature ranges.

3.2.8 Structure

- **A-STR-10/1.1**: The structure shall store the payload and the components of the satellite throughout its entire lifetime.
  The satellite's structure is designed to distribute and also, to protect the payload and the components from the extreme conditions of the space environment. If the structure fails, the payload and the components could be damaged.

- **A-STR-20/1.1**: The structure shall withstand the loads produced during the manufacturing, testing, transportation, launch, and in-orbit operation of the satellite with positive MOS.
  The satellite is subjected to loads and vibrations throughout its entire lifetime, so the structure must withstand them to avoid compromising the mission. The stiffness of the structure shall ensure higher natural frequencies of the structure than the launch vehicle frequencies, thus mitigating dynamic coupling, avoiding high structural flexibility, and ensuring structural stability.

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