National Aeronautics and Space Administration

Marshall Space Flight Center

# Flight and Ground Software and Simulation

## Flight and Ground Software and Simulation

The Flight and Ground Software and Simulation Division provides comprehensive engineering expertise for the development of flight and ground software and simulation, including software development facilities, avionics and software ground systems test facilities, and operation facilities. The division is a Capability Maturity Model Integration (CMMI) Maturity-Level 3 appraised organization.

## Capabilities

The division develops flight software, real-time simulations, automation tools, hardware-in-the-loop testing facilities, digital twins, and cloud-based data analysis tools. It also provides software insight to support external partners.

SLS Artemis I launch at night.

### Flight Software

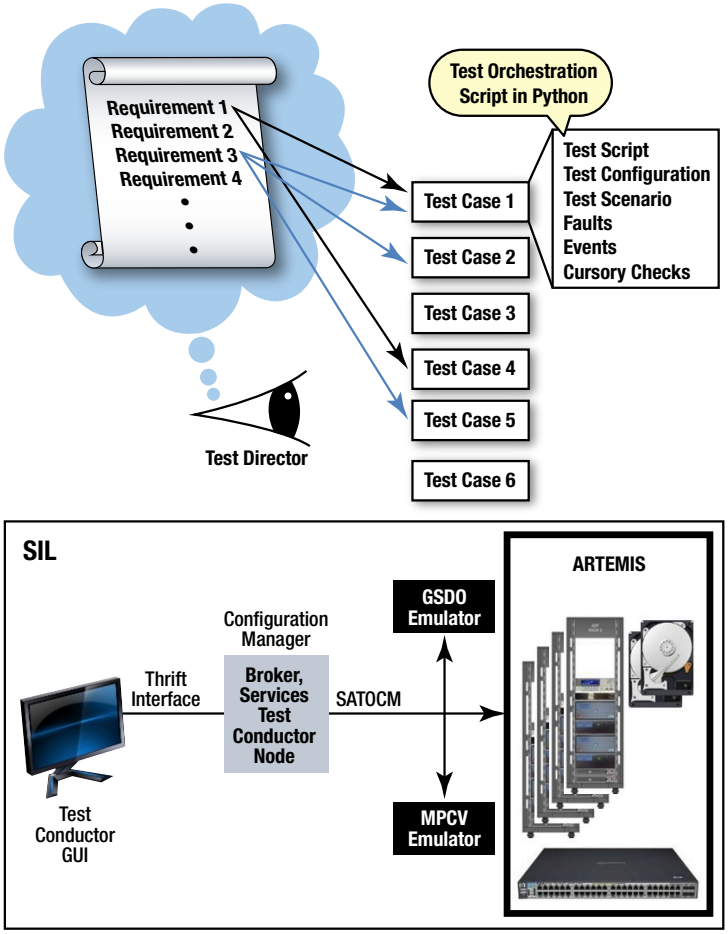
The division develops the human-rated flight software for the Space Launch System (SLS) rocket. The team leads the effort through the entire software lifecycle, including requirements, design, test, verification, day-of-launch operations, and configuration management.

In addition to SLS, the division also develops flight software for the Mars Ascent Vehicle (MAV), 4-bed Carbon Dioxide Scrubber (4BCO2), Urine Processor Assembly (UPA), and many other projects.

### SImulation

The division develops the Advanced Real-Time Environment for Modeling Integration and Simulation (ARTEMIS) simulation software. ARTEMIS implements the simulation and test components of the Integrated Avionics Test Facility (IATF). ARTEMIS is the real-time simulation environment used to integrate the avionics components with flight software and perform formal certification testing of the integrated avionics and flight software suite.

To complement the ARTEMIS simulation software, the division also develops the Managed Automation Environment for Simulation Test and Real-time Operation (MAESTRO) software. MAESTRO is an automation, configuration, and orchestration framework for running ARTEMIS simulations and viewing the results.




- A single test script will cover the majority of test cases
- The test script runs during test execution Beginning with the initialization command through the stop test command.
- Lab configuration, archiving, and post test analysis are handled outside of the test script
- MAESTRO implements the SATOCM spec for communication with emulators.

**ARTEMIS and MAESTRO architecture showing the test conductor graphical user interface (GUI), configuration manager, emulators, and the ARTEMIS interface.**

**IATF System Integration Lab (SIL) and System Integration Test Facility (SITF)**

## Hardware-in-the-Loop Test Facilities

The division has developed the Integrated Avionics Test Facility (IATF) hardware-in-the-loop lab for verification of the SLS program. For the SLS Block 1 configuration, the IATF represents the integrated SLS vehicle. The IATF consists of the SLS Vehicle System Integration Laboratory (SIL), CS System Integration Test Facility (SITF), Software Development Facility (SDF), and emulators designed for supporting the integration and test of the SLS avionics and software components. For the Block 1B configuration, the IATF represents the integrated SLS vehicle, which consists of the integrated booster, CS and Exploration Upper Stage (EUS) elements as a system. The IATF consists of the EUS System Integration Lab (SIL) and CS SIL, EUS SITF and CS SITF, SDFs, and emulators designed for supporting the integration and test of the SLS avionics and software components. IATF emulators are hardware/software simulations that represent the SLS core vehicle for Block 1 and the intelligent connected vehicles (ICVs) for Block 1B.

## Data Analysis Tools, Artificial Intelligence (AI)/ Machine Learning (ML), and Digital Twins.

The division develops several data analysis tools to automate test and verification activities. These tools parse large amounts of data and verify the systems producing the data are meeting requirements and design.

The initial versions of the data analysis tools ran on the engineers' laptops, but the desktop/laptop software required the users to copy the data from a test machine or shared server. The latest versions of the data analysis tools have been developed using cloud resources, which eliminate the need to install software or copy data from a server. The cloud-based versions of the software also provide advanced capabilities, such as increased scalability, ML, and digital twins. The division has been prototyping an enhanced anomaly detection capability that uses AI/ML to augment the traditional software testing.


**Example visualization of 4BCO2 sorbent bed data.**

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