National Aeronautics and Space Administration

FY24 Strategic Initiatives Research and Technology Development (SRTD)

# Autonomica: Designing and Testing Autonomous Systems

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**Strategic Focus Area:** Model Based Assurance of Autonomy | **Strategic Initiative Leader:** Martin S Feather

## Background

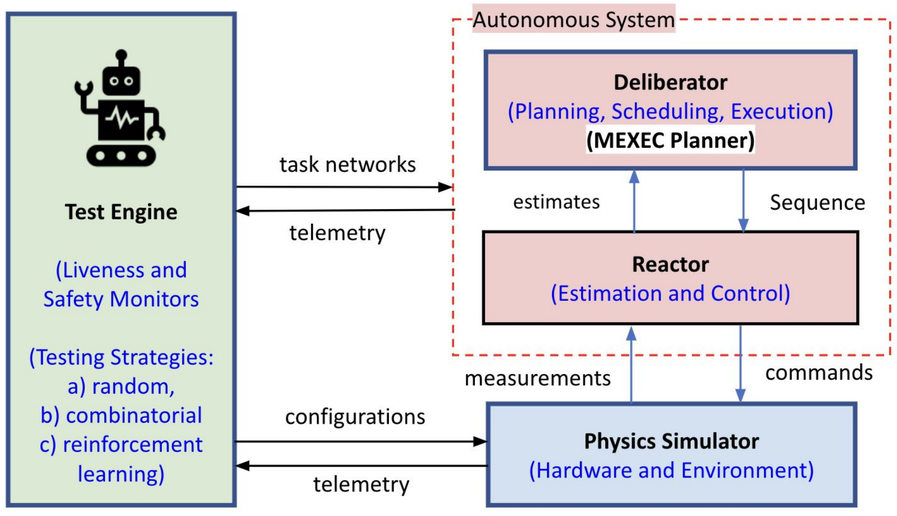
Advancements in missions' use of autonomy will require advancements in techniques to assure their correct operation. Testing is an important assurance activity for future autonomous systems but is challenged because the very circumstances, in which autonomy is desired, namely those exhibiting a wide range of possible variations, necessitate very many tests to cover that range. Our research addresses this challenge by introducing automation into the generation of tests and the interpretation of their outcomes.

## Objectives

a) Defining a test engine that uses monitoring with multiple testing strategies (e.g., random, combinatorial, reinforcement learning, and reactive monitoring).
b) Building a simpler example mission (2D-Cruiser) to exercise the testing engine
c) Applying the test engine to test the TLR prototype of the rover that is proposed in the Endurance mission
d) Using visualizations as a way to understand the testing results.

## Approaches and Results

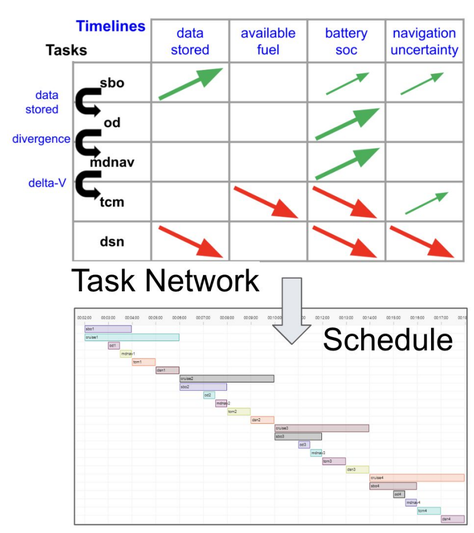
### a) Testing Engine

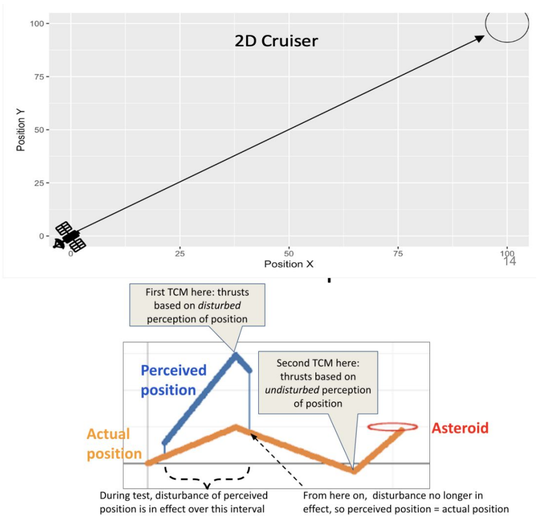



a) Failure testing: finding test cases that lead to failures

b) Robustness testing: finding regions of parameters space that do not lead to failures

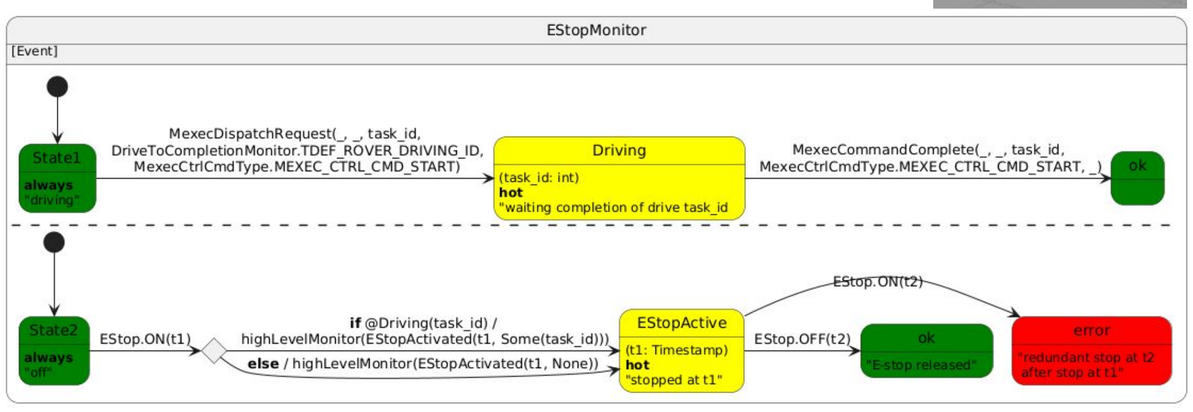
### b) 2D-Cruiser Example



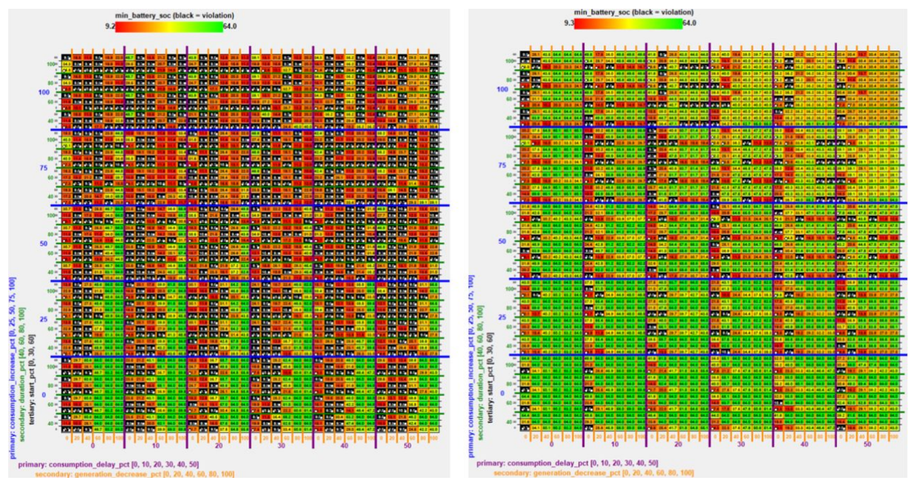




### c) TLR Rover Case Study

The **EStopMonitor** tracks the status of a system during driving tests, responding to both emergency stops and completions.




### d) Results Visualizations



Visualization of 5-parameter-combinations showing widespread improvement due to onboard planning

## Significance / Benefits to JPL and NASA

a) Development of efficient monitors / testing strategies
b) Strategy to perform robustness and failure testing
c) Strategy to analyze results with visualizations
d) Contribution of 2D-Cruiser as open source example
e) Validating approach on a realistic mission (TLR rover)
f) Bug fixes / new features added to MEXEC and Daut

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NOTE: Temporal logic monitors simplify log and telemetry analysis by segmenting and summarizing what happens at runtime.

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