

# Executive/Decision Making Systems for Autonomous Vehicles: Validation

By: Connor Lange

## 6. Validation:

To validate the implementation of the GDMFAS system, a “systems test” approach will be taken. Since the GDMFAS system has a significant AI component, traditional benchmarking and performance measurement are difficult to apply. Further, no sufficient testing frameworks exist for the purpose of testing the overall functionality of an executive system framework. Because of this, the validation of GDMFAS will focus on various system properties. Properties of the system that will receive validation include functionality (including all modules and submodules), usability, and performance of the various algorithms included in the various modules.

### 6.1 Validation of Functionality:

Some previous systems, such as ASOF, used a metric to evaluate how well the system meets certain criteria. Criteria evaluated include the intelligence of the system, the inspectability of the system, how predictable the system is, and how repairable the system is. Each criterion was given a score on a scale of “Poor” to “Excellent”. The exact meaning of the scores different by criterion and were outlined in the work. The evaluation of GDMFAS will likely use a similar approach as part of the validation of the system. In addition to validating how well the GDMFAS system accomplishes its goals, it also imperative to validate that the GDMFAS system is operating correctly.

To verify that the GDMFAS system is functionally correct, it must be tested on an actual autonomous system. While deployed on a space system, the performance of the system could be evaluated by a human to determine if GDMFAS was making the correct decisions.

Unfortunately, deploying the GDMFAS system on a spacecraft during a mission has an extremely small chance of actually occurring within the timeframe of a thesis. Instead, it is more feasible to deploy the GDMFAS system on both a ground-based system and a development satellite. Although the space environment cannot be accurately replicated on the ground, the GDMFAS system’s behavior could still be evaluated. Sensors on the chosen vehicle would still

provide readings and the vehicles would still consume resources. Therefore, functionality of the system could still be tested on the ground.

By trading physical hardware for a more accurate environment, the GDMFAS system could be tested using a spacecraft simulator. The simulator would be able to emulate the conditions in space and could provide sensor data to the GDMFAS system. This approach has been taken by JPL on some of their projects. The downside to this approach is that a complete model of the spacecraft needs to be created. It would be a very time-consuming process to create a simulator that encompasses every detail of a spacecraft and the simulation results would only be as reliable as the simulator implementation. For example, if the simulator doesn't accurately model the power consumption of the vehicle, anything that relies on power would be inconsistent with the actual system. In the interest of time and accuracy, functional validation of the GDMFAS system will probably be carried out using actual hardware.

In addition to testing the system's interaction with hardware, it is also important to validate that the code base for the GDMFAS is functionality correct. In order to validate the code base, various analysis tools will be used. Further research into these types of tools is required, but, at the minimum, testing will incorporate unit tests and line coverage.

## **6.2 Usability:**

Although usability isn't the main focus of the validation, it will still be important for justifying system usability and quantifying the complexity of the system as it appears to the end-user. As with many previous usability experiments, the validation of the GDMFAS system's usability will include surveying engineers of various backgrounds after they interact with the GDMFAS system. In the experiment, users will execute common end-user tasks such as adding or updating tasks, sending commands, and interpreting mission status logs. The exact format of the experiment and the analysis of the results are still TBD.

## **6.3 Performance:**

Despite the fact that doing a performance evaluation of the entire system is infeasible, specific parts of the GDMFAS are excellent candidates for performance analysis and measurement. Specifically, the scheduling and planning algorithms' execution times can be measured and the complexity of the algorithms can be determined. In addition to the algorithm components of the GDMFAS system, the space complexity of data structures used by the Task

Manager and other modules can be calculated. The results of these measurements can be compared to previous systems to determine what performance benefits are offered by the GDMFAS system.