# Real-Time Sensor Validation System Developed for Reusable Launch Vehicle Testbed

A real-time system for validating sensor health has been developed for the reusable launch vehicle (RLV) program. This system, which is part of the propulsion checkout and control system (PCCS), was designed for use in an integrated propulsion technology demonstrator testbed built by Rockwell International and located at the NASA Marshall Space Flight Center. Work on the sensor health validation system, a result of an industry-NASA partnership, was completed at the NASA Lewis Research Center, then delivered to Marshall for integration and testing.

The sensor validation software performs three basic functions: it identifies failed sensors, it provides reconstructed signals for failed sensors, and it identifies off-nominal system transient behavior that cannot be attributed to a failed sensor. The code is initiated by host software before the start of a propulsion system test, and it is called by the host program every control cycle. The output is posted to global memory for use by other PCCS modules. Output includes a list indicating the status of each sensor (i.e., failed, healthy, or reconstructed) and a list of features that are not due to a sensor failure. If a sensor failure is found, the system modifies that sensor's data array by substituting a reconstructed signal, when possible, for use by other PCCS modules.
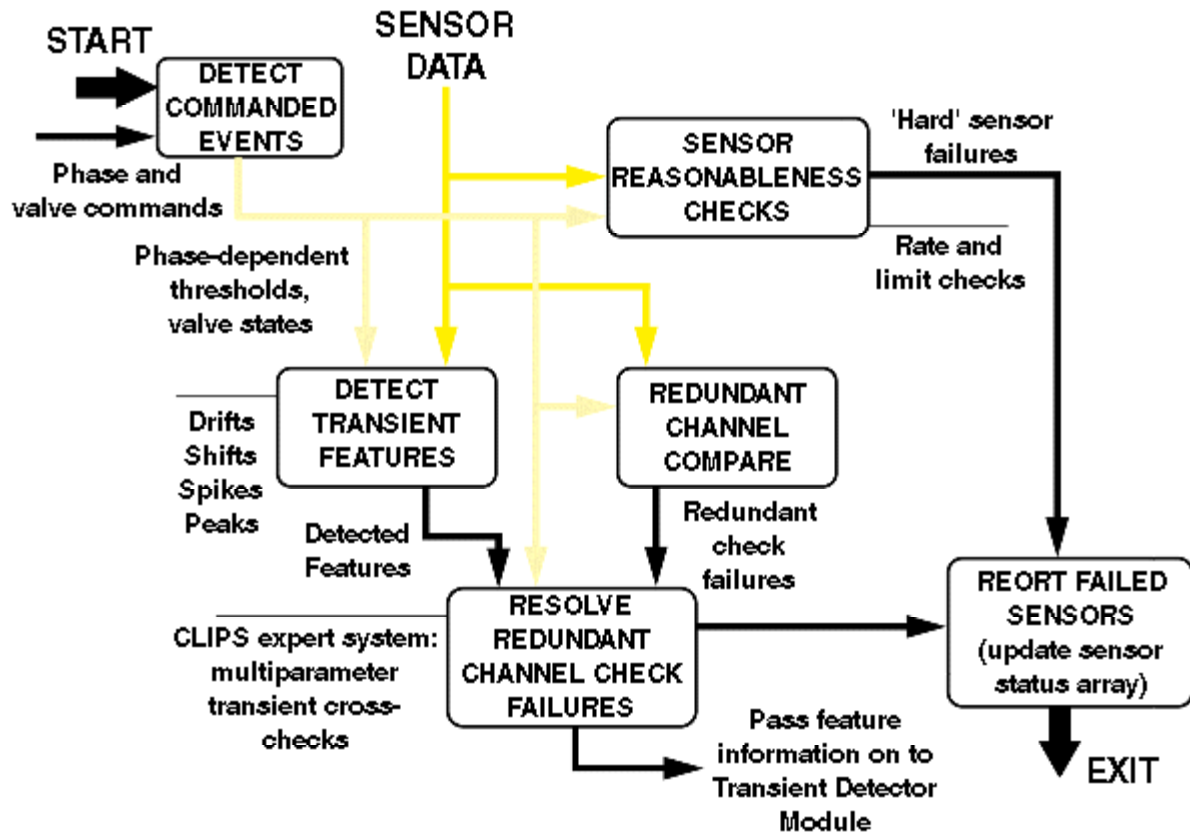
Sensor validation function.

To determine whether a sensor has failed, the software first scans for hard failures by checking its range and rate of change against predetermined limits. The data are then processed to find any features such as drifts, shifts in level, peaks and spikes, and disagreement between redundant channels. Any discrepancies found among redundant sensors during steady-state system operation are compared with features found in the data. This arbitration is performed by an expert system encoded by using an expert system shell. Any detected features that are not associated with a failed sensor are checked against planned system events, such as valve changes. Features that cannot be explained by a malfunctioning sensor or known system event are reported as transient behavior. This information is then used by other PCCS modules to determine the health of the remaining system components.
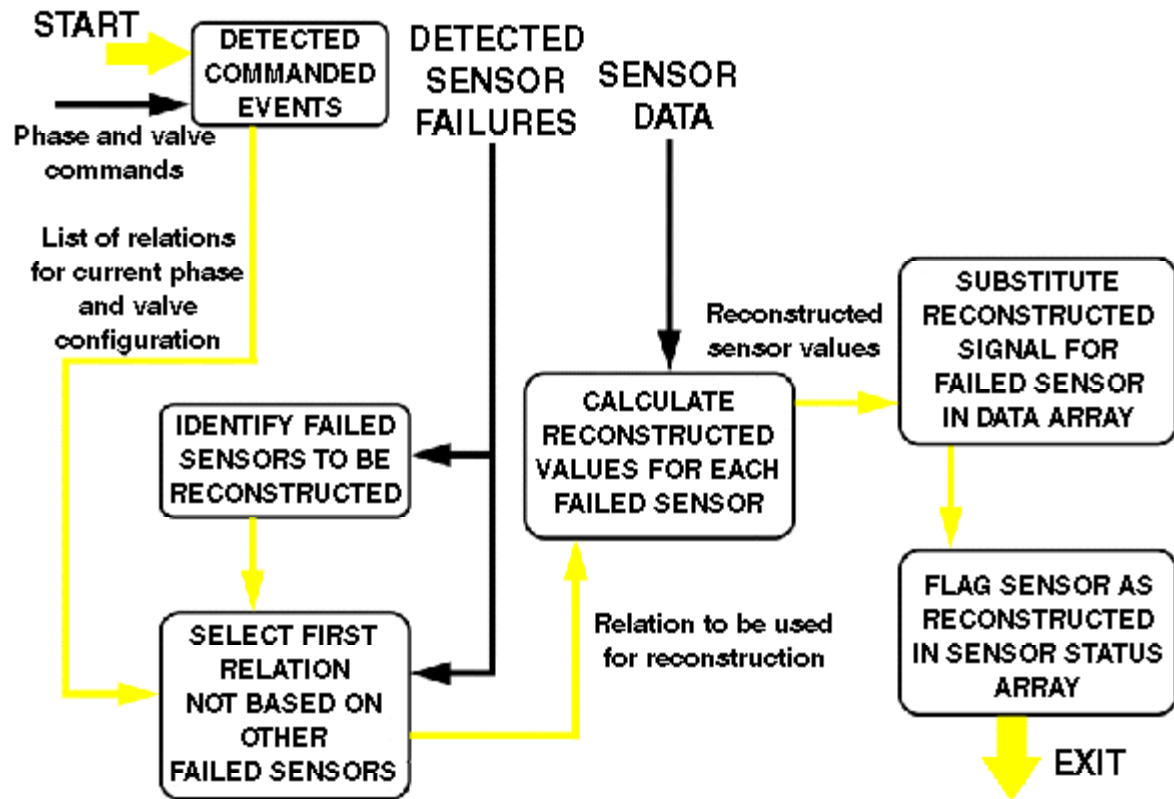
Sensor reconstruction function.

Review of test data from initial integration testing verified operation in real time. Tests were performed for both hard and soft sensor failures, and the sensor validation system was shown to work properly.
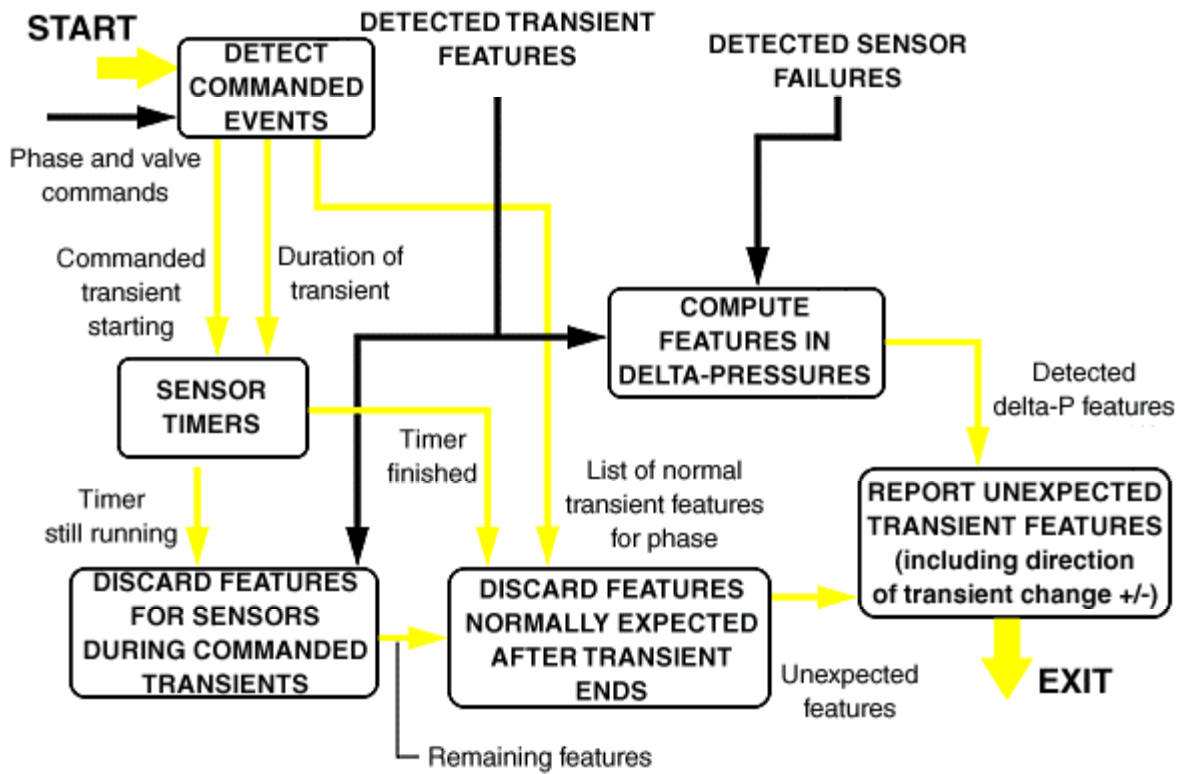
System transient detector function.

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