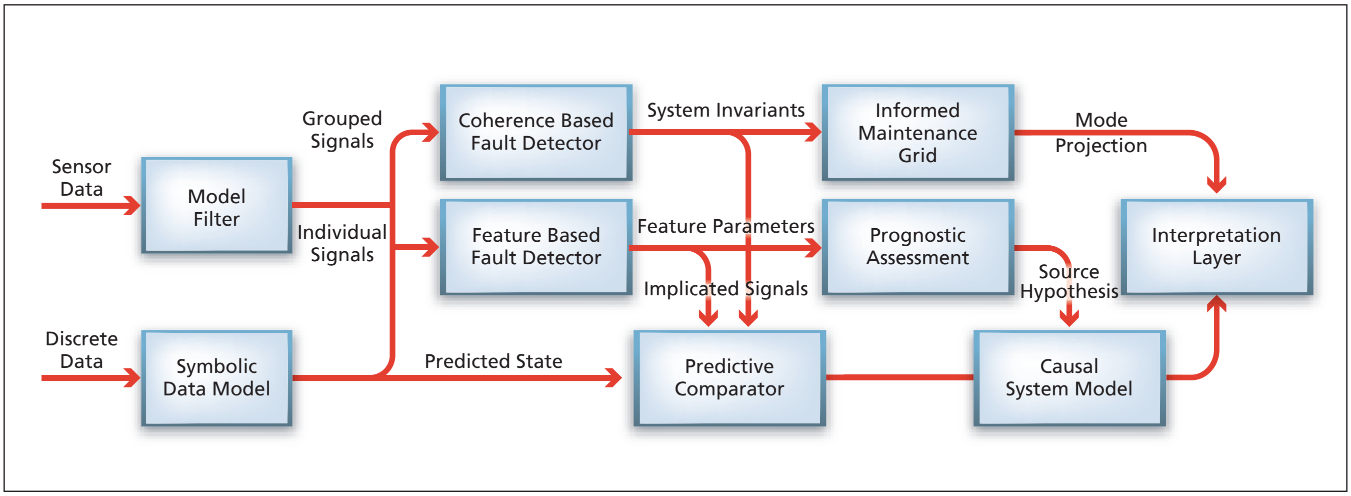
Flight-Tested Prototype of BEAM Software

NASA's Jet Propulsion Laboratory, Pasadena, California

Researchers at JPL have completed a software prototype of BEAM (Beacon-based Exception Analysis for Multimissions) and successfully tested its operation in flight onboard a NASA research aircraft. BEAM (see *NASA Tech Briefs*, Vol. 26, No. 9; and Vol. 27, No. 3) is an ISHM (Integrated Systems Health Management) technology that automatically analyzes sensor data and classifies system behavior as either nominal or anomalous, and further characterizes anomalies according to strength, duration, and affected signals. BEAM (see figure) can be used to monitor a wide variety of physical systems and sensor types in real time. In this series of tests, BEAM monitored the engines of a Dryden Flight Research Center F-18 aircraft, and performed onboard, unattended analysis of 26 engine sensors from engine startup to shutdown. The BEAM algorithm can detect anomalies based solely on the sensor data, which includes but is not limited to sensor failure, performance degradation, incorrect operation such as unplanned engine shutdown or flameout in this example, and major system faults. BEAM was tested on an F-18 simulator, static engine tests, and 25 individual flights totaling approximately 60 hours of flight time. During these tests, BEAM successfully identified planned anomalies (in-flight shutdowns of one engine) as well as minor unplanned anomalies (e.g., transient oil- and fuel-pressure drops), with no false alarms or suspected false-negative results for the period tested. BEAM also detected previously unknown behavior in the F-18 compressor section during several flights. This result, confirmed by direct analysis of the raw data, serves as a significant test of BEAM's capability.

This program was written by Ryan Mackey, Raffi Tikidjian, Mark James, and David Wang of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42727.



Top-Level BEAM Architecture is used for monitoring physical systems in real time.

Mission Scenario Development Workbench

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The Mission Scenario Development Workbench (MSDW) is a multidisciplinary performance analysis software tool for planning and optimizing space missions. It provides a number of new capabilities that are particularly useful for planning the surface activities on other planets. MSDW enables rapid planning of a space mission and supports flight-system and scientific-instrumentation trades. It also provides an estimate of the ability of flight, ground, and science systems to meet high-level mission goals and provides means of evaluating expected mission performance at an early stage of planning in the project life cycle. In MSDW, activity plans and equipment-list spreadsheets are integrated with validated parameterized simulation models of spacecraft systems. In contrast to traditional approaches involving worst-case estimates with large margins, the approach embodied in MSDW affords more flexibility and more credible results early in the lifecycle through the use of validated, variable-fidelity models of spacecraft systems. MSDW is expected to help maximize the scientific return on investment for space missions by understanding early the performance required to have a successful mission while reducing the risk of costly design changes made at late stages in the project life cycle.

This program was designed and written by Mark Kordon, John Baker, John Gilbert, David Hanks, and Dan Mandutianu of Caltech for **NASA's Jet Propulsion Laboratory** *and David Hooper of Emaginit. Further information is contained in a TSP (see page 1).*

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