PrimeSupplier Cross-Program Impact Analysis and Supplier Stability Indicator Simulation Model

This application has potential uses in supply-chain and enterprise-resource planning software.

John F. Kennedy Space Center, Florida

PrimeSupplier, a supplier cross-program and element-impact simulation model, with supplier solvency indicator (SSI), has been developed so that the shuttle program can see early indicators of supplier and product line stability, while identifying the various elements and/or programs that have a particular supplier or product designed into the system. The model calculates two categories of benchmarks to determine the SSI, with one category focusing on agency programmatic data and the other focusing on a supplier's financial liquidity.

To expand further on programmatic data, excessive time gaps between manufacturing, repair, and/or failure analysis requirements [and subsequent purchase orders supporting the logistics purchase requests, established by the project elements through Logistics Supportability Analysis (LSA), which are for flight hardware (personal property) only] focus on hardware mean-time-between failure, manufacturing lead time, quantity per assembly, and system effectiveness. Procurement minimum buy quantities, Federal Acquisition Regulations (FARs), and International Traffic and Arms Regulation (ITAR) also influence, and sometimes extend, this time-gap exposure for manufacturing product, thus leaving the supplier and subsequent second- and third-tier suppliers vulnerable to financial instability. This results in either poor product quality, or in a supplier-induced product discontinuance.

To understand this time-gap exposure, the last supplier product or service requirement need date, and first expected need dates, are documented in number of days for all three supplier offerings of manufacturing, repair, or failure analysis. Each functional capability of manufacturing, repair, and failure analysis is weighted slightly differently, with manufacturing having a heavier weight than repair, and repair would have a heavier weight than failure analysis.

The programmatic data feeding into the weighting calculations are collected from internal logistics support analysis data, like Line Replaceable Unit Probability of Sufficiency (LRUPOS), mean-time-between-failure, and repair generation rate forecasts, as well as last supplier capability need dates and first capability need dates that are all reported from the NASA project elements to the Program Office. Supplier capabilities include: manufacturing, repair and sustaining engineering, failure analysis and teardown, and test and evaluation. Other programmatic weighting factors include: procurement data, contract value, a supplier's percentage distribution of NASA business, and procurement-order time-gap exposure. The financial benchmarks include liquidity performance measures, such as net profit margin, current ratio (current assets over current liabilities), and price earnings ratio. These financial indicators are all compared against industry standards with various business-centric weighting factors, and could be automated with a real-time data feed.

PrimeSupplier was developed to help NASA smoothly transition design, manufacturing, and repair operations from the Shuttle program to the Constellation program, without disruption in the industrial supply base. Complicating this effort are today's economic conditions that have created unprecedented volatility within the country's industrial supply base, negatively affecting quality and ability to deliver. PrimeSupplier helps organizations identify at-risk suppliers by providing a holistic assessment of suppliers' total economic stability accounting for programmatic and enterprise-wide demands and general economic conditions.

This work was done by Michael Galluzzi of Kennedy Space Center. Learn more about PrimeSupplier at http://www.fuentek.com/technologies/Primesupplier.htm. For more information, please contact Karen Hiser at (919) 622-9995 (ksc13185@fuentek.com) or Pasquale Ferrari at (321) 867-4322. KSC-13185

Integrated Planning for Telepresence With Time Delays

An artificial-intelligence assistant helps a human supervisor control a distant robot.

NASA's Jet Propulsion Laboratory, Pasadena, California

A conceptual "intelligent assistant" and an artificial-intelligence computer program that implements the intelligent assistant have been developed to improve control exerted by a human supervisor over a robot that is so distant that communication between the human and the robot involves significant signal-propagation delays. The goal of the effort is not only to help the human supervisor monitor and control the state of the robot, but also to improve the efficiency of the robot by allowing the supervisor to "work ahead." The intelligent assistant is an integrated combination of an artificial-intelligence planner and a monitor of states of both the human supervisor and the remote robot. The novelty of the system lies in the way it uses the planner to reason about the states at both ends of the time delay.

To enable the human supervisor to work ahead of the robot, the planner and executive parts of the artificial-intelligence system must comprehend that execution of a task becomes split into two stages: that of the "leader" (the human supervisor) and that of the "follower" (the robot). Although a task is not truly complete until done by both the leader and the follower, it is nevertheless essential for the planner and executive parts of the artificial-intelligence system to work on the assumption that the follower will indeed follow, until this assumption is violated. Violations can occur (1) when the human supervisor intentionally or unintentionally deviates from activities previously planned in coordination with robot activities directed toward a goal, (2) the robot fails to execute a command as directed or fails to do anything else required of it within a maximum allowable time, or (3) the robot environment changes or is progressively revealed to be significantly different from what was previously assumed.

The planner part of the intelligent assistant must respond gracefully to such violations and notify the human supervisor. Graceful response must include replanning, for which it is necessary to cause the state model to revert to the most recent known state of the robot. In re-planning, it is also necessary to recognize which goals have been reached so as not to again expand and schedule the constituent tasks involved in reaching those goals.

The purpose served by the assistant is to provide advice to the human supervisor about current and future activities, derived from a sequence of high-level goals to be achieved. To do this, the assistant must simultaneously monitor and react to various data sources, including (1) actions taken by the supervisor, including commands being issued by the supervisor to the robot; (2) actions taken by the robot as reported with delay; (3) the environment of the robot as currently perceived with time delay; and (4) the current sequence of goals. As any of these change, the assistant must respond appropriately, detecting both normal completion of tasks and exceptional conditions.

This work was done by Mark Johnston and Kenneth Rabe of Caltech for NASA's Jet Propulsion Laboratory.

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-43520.

Minimizing Input-to-Output Latency in Virtual Environment

Ames Research Center, Moffett Field, California

A method and apparatus were developed to minimize latency (time delay) in virtual environment (VE) and other discrete-time computer-based systems that require real-time display in response to sensor inputs. Latency in such systems is due to the sum of the finite time required for information processing and communication within and between sensors, software, and displays. Even though the latencies intrinsic to each individual hardware, software, and communication component can be minimized (or theoretically eliminated) by speeding up internal computation and transmission speeds, time delays due to the integration of the overall system will persist. These "integration" delays arise when data produced or processed by earlier components or stages in a system pathway sit idle, waiting to be accessed by subsequent components. Such idle times can be sizeable when compared with latency of individual system components and can also be variable in duration because of insufficient synchrony between events in the data path. This development is intended specifically to reduce the magnitude and variability of idle-time type delays and thus enable the minimization and stabilization of overall latency in the complete VE (or other computer) system.

This work was done by Bernard D. Adelstein and Stephen R. Ellis of Ames Research Center and Michael I. Hill of San Jose State University Foundation. Further information is contained in a TSP (see page 1).

This invention is owned by NASA and a patent application has been filed. Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-5761. Refer to ARC-15102-1.