



## Dynamically Alterable Arrays of Polymorphic Data Types

An application library package was developed that represents data packets for Deep Space Network (DSN) message packets as dynamically alterable arrays composed of arbitrary polymorphic data types. The software was to address a limitation of the present state of the practice for having an array directly composed of a single monomorphic data type. This is a severe limitation when one is dealing with science data in that the types of objects one is dealing with are typically not known in advance and, therefore, are dynamic in nature. The unique feature of this approach is that it enables one to define at run-time the dynamic shape of the matrix with the ability to store polymorphic data types in each of its indices. Existing languages such as C and C++ have the restriction that the shape of the array must be known in advance and each of its elements be a monomorphic data type that is strictly defined at compile-time. This program can be executed on a variety of platforms. It can be distributed in either source code or binary code form. It must be run in conjunction with any one of a number of Lisp compilers that are available commercially or as shareware.

*This program was written by Mark James 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-42071.*

## Identifying Trends in Deep Space Network Monitor Data

A computer program has been developed that analyzes Deep Space Network monitor data, looking for changes of trends in critical parameters. This program represents a significant improvement over the previous practice of manually plotting data and visually inspecting the resulting graphs to identify trends. This program uses proven numerical techniques to identify trends. When a statistically significant trend is detected, then it is characterized by means of a symbol that can be used by pre-existing

model-based reasoning software. The program can perform any of the following functions:

- Given an expectation that data in a given list should exhibit an upward, downward, constant, or unknown trend, it can determine whether the data do or do not follow such a trend.
- Given a list of data, it can identify which of the aforementioned trends the data follow.
- Given two lists of data, it can determine whether or not both follow the same trend.

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## Predicting Lifetime of a Thermomechanically Loaded Component

NASALIFE is a computer program for predicting the lifetime, as affected by low cycle fatigue (LCF) and creep rupture, of a structural component subject to temporally varying, multiaxial thermomechanical loads. The component could be, for example, part of an aircraft turbine engine. Empirical data from LCF tests, creep rupture tests, and static tensile tests are used as references for predicting the number of missions the component can withstand under a given thermomechanical loading condition.

The user prepares an input file containing the creep-rupture and cyclic-fatigue information, temperature-dependent material properties, and mission loading and control flags. The creep rupture information can be entered in tabular form as stress versus life or by means of parameters of the Larson-Miller equation. The program uses the Walker mean-stress model to adjust predicted life for ranges of the ratio between the

maximum and minimum stresses. Data representing complex load cycles are reduced by the rainflow counting method. Miner's rule is utilized to combine the damage at different load levels. Finally, the program determines the total damage due to creep and combines it with the fatigue damage due to the cyclic loading and predicts the approximate number of missions a component can endure before failing.

*This work was done by Pappu L. N. Murthy of Glenn Research Center, John Z. Gyekenyesi of N&R Engineering and Management Services Corp., Subodh Mital of the University of Toledo, and David N. Brewer of the U. S. Army Aviation Systems Command. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18081.*

## Partial Automation of Requirements Tracing

Requirements Tracing on Target (RETRO) is software for after-the-fact tracing of textual requirements to support independent verification and validation of software. RETRO applies one of three user-selectable information-retrieval techniques: (1) term frequency/inverse document frequency (TF/IDF) vector retrieval, (2) TF/IDF vector retrieval with simple thesaurus, or (3) keyword extraction. One component of RETRO is the graphical user interface (GUI) for use in initiating a requirements-tracing project (a pair of artifacts to be traced to each other, such as a requirements spec and a design spec). Once the artifacts have been specified and the IR technique chosen, another component constructs a representation of the artifact elements and stores it on disk.

Next, the IR technique is used to produce a first list of candidate links (potential matches between the two artifact levels). This list, encoded in Extensible Markup Language (XML), is optionally processed by a "filtering" component designed to make the list somewhat smaller without sacrificing accuracy. Through the

GUI, the user examines a number of links and returns decisions (yes, these are links; no, these are not links). Coded in XML, these decisions are provided to a “feedback processor” component that prepares the data for the next application of the IR technique. The feedback reduces the incidence of erroneous candidate links. Unlike related prior software, RETRO does not require the user to assign keywords, and automatically builds a document index.

*This program was developed by Jane Hayes, Alex Dekhtyar, Senthil Sundaram, and Sravanthi Vadlamudi of the University of Kentucky for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14976-1.*

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### Automated Synthesis of Architectures of Avionic Systems

The Architecture Synthesis Tool (AST) is software that automatically synthesizes software and hardware architectures of avionic systems. The AST is expected to be most helpful during initial formulation of an avionic-system design, when system requirements change frequently and manual modification of architecture is time-consuming and susceptible to error. The AST comprises two parts: (1) an architecture generator, which utilizes a genetic algorithm to create a multitude of architectures; and (2) a functionality evaluator, which analyzes the architectures for viability, rejecting most of the non-viable ones. The functionality evaluator gener-

ates and uses a viability tree — a hierarchy representing functions and components that perform the functions such that the system as a whole performs system-level functions representing the requirements for the system as specified by a user. Architectures that survive the functionality evaluator are further evaluated by the selection process of the genetic algorithm. Architectures found to be most promising to satisfy the user’s requirements and to perform optimally are selected as parents to the next generation of architectures. The foregoing process is iterated as many times as the user desires. The final output is one or a few viable architectures that satisfy the user’s requirements.

*This program was written by Savio Chau, Joseph Xu, Van Dang, and James F. Lu 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-42607.*

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### SSRL Emergency Response Shore Tool

The SSRL Emergency Response Shore Tool (wherein “SSRL” signifies “Smart Systems Research Laboratory”) is a computer program within a system of communication and mobile-computing software and hardware being developed to increase the situational awareness of first responders at building collapses. This program is intended for use mainly

in planning and constructing shores to stabilize partially collapsed structures. The program consists of client and server components, runs in the Windows operating system on commercial off-the-shelf portable computers, and can utilize such additional hardware as digital cameras and Global Positioning System devices.

A first responder can enter directly, into a portable computer running this program, the dimensions of a required shore. The shore dimensions, plus an optional digital photograph of the shore site, can then be uploaded via a wireless network to a server. Once on the server, the shore report is time-stamped and made available on similarly equipped portable computers carried by other first responders, including shore wood cutters and an incident commander. The staff in a command center can use the shore reports and photographs to monitor progress and to consult with structural engineers to assess whether a building is in imminent danger of further collapse.

*This program was written by Robert W. Mah, Richard Papsin, Dawn M. McIntosh, Douglas Denham, and Charles Jorgensen of Ames Research Center; Bradley J. Betts of Computer Sciences Corporation; and Rommel Del Mundo of QSS Group, Inc. 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) 604-2954. Refer to ARC-15461-1.*