



# NASA SOFTWARE

2019-2020 CATALOG



**NASA TECHNOLOGY  
TRANSFER PROGRAM**

BRINGING NASA TECHNOLOGY DOWN TO EARTH

```
elif_operation == "MIRROR"  
    mirror_mod.use_x = False  
    mirror_mod.use_y = True  
    mirror_mod.use_z = False  
elif_operation == "MIRROR"  
    mirror_mod.use_x = False  
    mirror_mod.use_y = False  
    mirror_mod.use_z = True  
  
#selection at the end  
mirror_ob.select= 1  
modifier_ob.select=1  
bpy.context.scene.objects  
print("Selected" + str(modifier_ob))  
#mirror_ob.select = 1  
#bpy.context.select  
#bpy.data.objects[0].name
```



# I am pleased to present the fourth edition of the NASA Software Catalog.

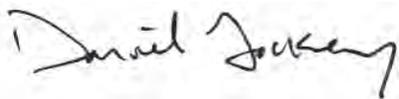
The release of this publication occurs at a particularly exciting time. The Agency has celebrated 60 years of discovery and exploration. Now, looking to the future, NASA is focusing its efforts on returning humans to the Moon while keeping an eye on Mars and beyond.

Charged to benefit humankind at its inception, NASA continues the fulfillment of that obligation with its newest software catalog. Within these pages, you will find codes that have played key roles in space shuttle launches, trips to the International Space Station, rover landings on the red planet, and the list goes on.

Comprising more codes than ever before, the 2019 – 2020 catalog is organized by discipline. These tools have been tested and proven. They have enabled NASA to meet its mission needs by providing solutions in the areas of structures and mechanisms, design and integration, data processing and handling, as well as propulsion, electronics, life support, aeronautics, and business systems.

For decades, tax dollars spent in space have resulted in Earth-bound technology used to improve everyday lives. NASA innovations routinely address technical challenges in the private sector, serve as the foundation for new products, complement existing ones, and provide jumping off points for startups.

Could a NASA software code benefit you or your company? We hope so.



Daniel Lockney  
Technology Transfer Program Executive  
Space Technology Mission Directorate  
NASA Headquarters





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# Using the Catalog

Offering an extensive portfolio of software products for a wide variety of technical applications, the NASA Software Catalog is organized into fifteen broad subject matter categories.

The codes within each category are listed alphabetically. All catalog entries include the software title, the product ID number (known internally as the NASA case number), a short description, and the software's specified release type. Some software descriptions contain links to additional information or downloading options.

Each code listed in the catalog is available at no cost and has been evaluated for access requirements and restrictions:

- **General Public Release** — For codes with a broad release and no nondisclosure or export control restrictions
- **Open Source Release** — For collaborative efforts in which programmers improve upon codes originally developed by NASA and share the changes
- **U.S. Release Only** — For codes available to U.S. persons only, with no further transfer of the software allowed without the prior written approval of NASA
- **U.S. and Foreign Release** — For codes that are available to U.S. persons and (under special circumstances) persons outside of the U.S.
- **U.S. Government Purpose Release** — For codes that are to be used on behalf of the U.S. government
  - **Project Release** — For use under a contract, grant, or agreement
  - **Interagency Release** — For use by U.S. government agencies
  - **NASA Release** — For use only by NASA personnel and contractors



The software catalog is continually updated.  
Please visit the NASA Technology Transfer Portal  
for the latest updates and revisions:

**[technology.nasa.gov](https://technology.nasa.gov)**

# Requesting Software

NASA software may be requested through the NASA Software Catalog Web site:

[software.nasa.gov](https://software.nasa.gov)

1. Select the Request Software button below the item description for the catalog entry. Many open source software codes and mobile apps provide a URL link so that the requester can download the software directly; it is not necessary to use the Request Software button for these codes.
2. Complete the request form. All required fields must be filled in before you can submit your request. Requests will automatically be routed to the appropriate center's Software Release Authority (SRA) for processing.

## Points Of Contact

Each NASA center has a Software Release Authority (SRA) representative ready to assist you with your software requests. Contact information is provided below:

Case Number	NASA Center	Contact Information
ARC-XXXXX	Ames Research Center	arc-sra-team@mail.nasa.gov
DRC-XXX-XXX	Armstrong Flight Research Center	afrc-ipo-softwarecatalogue@mail.nasa.gov
GSC-XXXXX	Goddard Space Flight Center	gsfc-softwarerelease@mail.nasa.gov
HQN-XXXXX	NASA Headquarters	hq-sra-team@mail.nasa.gov
NPO-XXXXX	Jet Propulsion Laboratory	jpl_ott@jpl.nasa.gov
KSC-XXXXX	Kennedy Space Center	ksc-dl-software-request@mail.nasa.gov
LAR-XXXXX	Langley Research Center	larc-sra@mail.nasa.gov
LEW-XXXXX	Glenn Research Center	grc-sra-team@mail.nasa.gov
MFS-XXXXX	Marshall Space Flight Center	msfc-sra-team@mail.nasa.gov
MSC-XXXXX	Johnson Space Center	jsc-ttco-software-request@mail.nasa.gov
SSC-XXXXX	Stennis Space Center	ssc-technology@nasa.gov

# 2018 NASA Software of the Year Award

The Software of the Year competition recognizes development teams who have set high standards for significant software that is creative, usable, and transferable. An advisory panel with representatives from across the agency reviews entries and recommends winners to the Inventions and Contributions Board.

## OnSight

OnSight allows scientists and engineers to immerse themselves within a reconstruction of the Mars terrain around the Curiosity rover. Prior to OnSight, scientists worked primarily by viewing two-dimensional (2D) images or panoramas sent back by the rover. But, it is extremely difficult to get a sense of three-dimensional relationships by viewing 2D images. Three-dimensional visualization on traditional computer screens has been available to a subset of Mars mission operations teams since the late 1990s. However, these interfaces have not been available to the full mission science team and do not offer the same intuitive understanding as exploring the Earth.

Using an immersive display, OnSight can render a reconstruction of Mars at full scale. It allow users to navigate the model by simply walking and looking around.

Many potential applications exist for this technology, including Earth-based terrain visualization (e.g., caves, lava fields, remote field sites), as well as other planetary and asteroid surfaces.

OnSight was developed by a software team from NASA's Jet Propulsion Laboratory.



## 1st Runner Up

# LEWICE3D

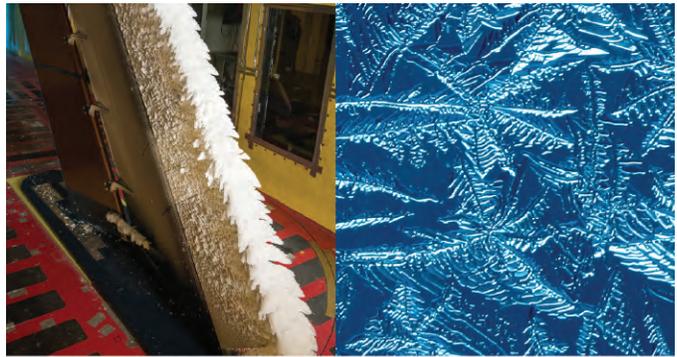
The 2018 runner-up for the NASA Software of the Year Award, LEWICE3D, is a software solution to predict ice accretion (ice accumulation) on 3D aircraft surfaces, given flight and meteorological conditions representing an icing cloud. This is the first time that 3D shapes have been modeled to analyze their propensity to experience icing conditions during flight.

The LEWICE3D software uses information about the airflow surrounding the body of interest to calculate trajectories of approaching water droplets, the mass and energy transfer processes at the surface of the body, and the resulting ice accretion shape.

By more comprehensively and accurately predicting ice accretion than any other modeling package available, the LEWICE3D software both improves safety and decreases time-to-market for aircraft design.

Boeing intends to use LEWICE3D for most, if not all, of its future designs. Other LEWICE3D software package licensees include Lockheed Martin, Northrop Grumman, Gulfstream, U.S. Army and Navy divisions, and Ohio State University.

The development of the LEWICE3D software was spearheaded by the late Colin Bidwell, and team members included Harold Addy, William Wright, Mark Potapczuk, and Christopher Porter of Glenn Research Center.



## Honorable Mentions

- Ames Research Center: NASA Task Load Index (TLX) iOS
- Goddard Space Flight Center: NASA Worldview and Global Imagery Browse Services (GIBS)
- Langley Research Center: Assured Geo-Containment for Unmanned Aircraft
- Johnson Space Center: JSC's General-Use Nodal Network Solver (GUNNS)

# Top 20 Software Codes

**1**

## **Debris Assessment Software (DAS), Version 2.1**

Operations

JSC MSC-26234-1 Page 62

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**2**

## **FUN3D, Version 13.3**

Aeronautics

LaRC LAR-19247-1 Page 190

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**3**

## **Schedule Test and Assessment Tool (STAT), Version 5.0**

Business Systems and Project Management

MSFC MFS-33362-1 Pages 2, 9

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**4**

## **Project Cost Estimating Capability, Version 2.2**

Business Systems and Project Management

MSFC MFS-33187-2 Pages 2, 8

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**5**

## **Earth Global Reference Atmospheric Model 2016 (Earth GRAM 2016)**

Environmental Science (Earth, Air, Space,  
Exoplanet)

MSFC MFS-32780-2 Pages 80, 84

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**6**

## **NASA Root Cause Analysis Tool (RCAT)**

Business Systems and Project Management

GRC LEW-19737-1 Page 8

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**7**

## **WinPlot Graphical Display System**

Data and Image Processing

MSFC MFS-31664-1 Pages 152, 183

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**8**

## **Failure Modes and Effects Analysis Tool (FMEA)**

Design and Integration Tools

JSC MSC-25379-1 Page 104

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**9**

## **Orbital Debris Engineering Model (ORDEM), Version 3**

Environmental Science (Earth, Air, Space,  
Exoplanet)

JSC MSC-25457-1 Pages 81, 92

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**10**

## **Chemical Equilibrium with Applications in MATLAB (CEAM)**

Propulsion

MSFC MFS-33320-1 Page 48

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# Are these in your toolbox?

**11**

## NASA Design and Analysis of Rotorcraft (NDARC)

Aeronautics

ARC ARC-16265-1 Page 193

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**12**

## TetrUSS Computational Fluid Dynamics Software (TetrUSS)

Design and Integration Tools

LaRC LAR-16882-1 Page 119

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**13**

## OVERFLOW 2: Overset Grid Computational Fluid Dynamics Flow Solver with Moving Body Capability (OVERFLOW)

Aeronautics

LaRC LAR-17079-1 Pages 187, 193

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**14**

## Aircraft NOise Prediction Program 2 (ANOPP2)

Aeronautics

LaRC LAR-18567-1 Page 188

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**15**

## Flight Optimization System (FLOPS) Software

Aeronautics

LaRC LAR-18934-1 Page 190

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**16**

## Chimera Grid Tools, Version 2.2

Design and Integration Tools

ARC ARC-16025-1B Page 101

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**17**

## Mars Global Reference Atmospheric Model 2010 (Mars GRAM 2010)

Environmental Science (Earth, Air, Space, Exoplanet)

MSFC MFS-33158-1 Pages 81, 90

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**18**

## Copernicus Trajectory Design and Optimization System, Version 4.6

Operations

JSC MSC-25863-1 Pages 60, 62

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**19**

## FUN3D — Generic Gas Path

Aeronautics

LaRC LAR-17778-1 Page 191

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**20**

## Automated Triangle Geometry Processing for Surface Modeling and Cartesian Grid Generation (Cart3D)

Design and Integration Tools

ARC ARC-14275-1 Pages 98, 100

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1

# Business Systems and Project Management

Acquisitions, Business Processes, Property  
Management, Risk Management, Scheduling



## Featured Software



### Closed-Loop Accounting Management System (CLAMS)

**KSC-12289**

The Closed-Loop Accounting Management System (CLAMS) is a Web-based application used to disseminate critical processing information to the workforce and provide feedback to management that the information was received. The tool allows management at any level to accurately track any critical information, and it also serves as a historical database of what information was sent out, to whom, and when it was received. CLAMS has potential application as shareware to companies using Cold Fusion Server software.

**U.S. Release Only**

### Electronic Timecard System

**KSC-12051**

The Electronic Timecard System can be utilized by any business or organization wishing to streamline its payroll department procedures. The automated system minimizes the consumption of paper and eliminates the need for weekly pick-up and delivery of time sheets. The tool also simplifies the daily recording of time worked by employees, and it allows employees to “sign” their “timecards” electronically at the end of each week. Supervisors can review employee electronic timecards daily and sign them electronically.

**U.S. Release Only**

### Goal Performance Evaluation System

**KSC-12036**

The Goal Performance Evaluation System is an innovative interactive software application that implements, validates, and evaluates an organization’s performance by the achievements of its employees. The tool has been used for strategic planning, employee performance management, and center-wide communication. The system is Web-based and uses a relational database to host information.

**U.S. Release Only**

### Project Cost-Estimating Capability, Version 2.2

**MFS-33187-2**

Used to develop cost estimates/models for space systems, this technology combines an Excel® add-in with a simple, robust, and transparent collection of NASA cost-estimating relationships (CERs), statistics, work breakdown structures, and cost-estimating algorithms. The approach’s use of native Excel® functionality to provide basic calculations limits the overhead required to maintain a model and affords more visibility to the user with regard to the calculations and equations involved in generating an estimate.

**General Public Release**

### Schedule Test and Assessment Tool (STAT), Version 5.0

**MFS-33362-1**

STAT is a schedule management software add-in developed to work specifically within the Microsoft® Project® scheduling application. The software provides the automated capability to quickly identify, quantify, and report numerous types of critical schedule assessment data for management use. Clear and objective reporting of key schedule assessment information includes: logic network integrity indicators, performance and trend metrics, schedule driver identification, data comparisons, margin and milestone tracking, and various other analysis data that can be used by project teams to assist in decision-making.

**General Public Release**



**Action Item System, Version 2.0****GSC-16768-1**

This Web application allows users to assign and track action items. Helpful emails are distributed when an action is created, updated, or closed, and reminder emails are sent to assignees when an action item deadline is approaching or has passed.

**U.S. Government Purpose Release****Application Information Logging Services (AILS)****KSC-13992**

AILS allows applications to log application events using a centralized set of services. Administrative and report functions are available to view logs.

**U.S. Government Purpose Release****Athena****NPO-47857-1**

This effort extended Athena from the county level to the global level, delivering a simulation tool for examining how populations and countries might respond to global climate change and/or new policies related to controlling climate change.

**Open Source****Audit Tracking Information System (ATIS)****MFS-33070-1**

The Audit Tracking Information System (ATIS) provides the audit manager and team with the tools/information needed to perform, manage, and close an audit. All affected personnel have centralized, timely access to system tools and data. The process is automated to the maximum extent practical, improving efficiency and providing information on all aspects of any particular audit.

**U.S. Government Purpose Release****Authorization Services (Authos)****KSC-13984**

Authorization Services (Authos) provides a suite of tools to authorize access to client applications. This includes application services and an end-user configuration module.

**U.S. Government Purpose Release****Automated Evaluation System (AES)****GSC-15477-1**

Used during the source evaluation board (SEB) process, the Automated Evaluation System (AES) is a database that assists users with organizing evaluations and generating final reports.

**U.S. Government Purpose Release****Automated Release Processing (ARP)****MSC-25494-1**

The Automated Release Processing (ARP) application supports the release of engineering documentation. It is a Documentum-based client/server application that uses an Oracle database and a database management system (DBMS) for data storage.

**U.S. Government Purpose Release****Brahms: A Multiagent Simulation/Execution Environment for the Brahms Multiagent Language****ARC-15654-1**

Brahms is a multiagent programming language for modeling people and systems in a conceptual world. Brahms language gives users the ability to model the behavior of human organization, communication, and teamwork, as well as human-machine interaction.

**U.S. Government Purpose Release**

**Cicero Configuration Management System****GSC-16583-1**

Cicero is a generic, customizable, Web-based database application designed to facilitate the document change process. In addition to providing a Web site from which approved personnel may download current versions of base-lined documentation for their projects, Cicero supports the creation and management of configuration change requests (CCRs). Through Cicero, configured documents may be modified in a controlled fashion.

**U.S. Government Purpose Release****Closed-Loop Accounting Management System (CLAMS)****KSC-12289**

The Closed-Loop Accounting Management System (CLAMS) is a Web-based application used to disseminate critical processing information to the workforce and provide feedback to management that the information was received. The tool allows management at any level to accurately track any critical information, and it also serves as a historical database of what information was sent out, to whom, and when it was received. CLAMS has potential application as shareware to companies using Cold Fusion Server software.

**General Public Release****Comments Export/Management Tool****MFS-33498-1**

This tool is a collection of macros that enable a user to export Microsoft Word comments into a pre-formatted Excel spreadsheet, serving as an official record of the disposition for each comment.

**U.S. Government Purpose Release****Conduit Content Management System****GSC-17730-1**

Conduit is a content management system and public Web site providing news, articles, and general information concerning NASA's Earth-Observing System's tools, capabilities, and data. It provides content authorship and editing capabilities to owners of Earthdata Web site content.

**Open Source****Configuration Auditing Tool (CAT)****GSC-15309-1**

CAT enables the generation of configuration information and the creation of baseline configurable items. Automated and remote interrogation scripts provide configuration information in the form of "as-built" reports. Specific CAT features include a change control tool, a baseline management tool, an auditing tool, a Web baseline information system tool, an automated code preparation and delivery tool, and process daemons.

**U.S. Government Purpose Release****Customer Survey****MFS-33069-1**

Customer Survey is a generic survey tool that affords the ability to construct, email, and manage surveys. The overhead cost of Customer Survey is extremely low, as the tool exists on a virtual server.

**U.S. Government Purpose Release****Data Service Provider Cost-Estimation Tool and Comparables Database****GSC-14905-1**

The Data Service Provider Cost-Estimation Tool (CET) and Comparables Database (CDB) package provides NASA's Earth Science Enterprise (ESE) the ability to make lifecycle cost estimates for the implementation and operation of the data service providers that are required to support its science and applications programs. The Data Service Provider CET and CDB package employs a cost-estimation-by-analogy approach. For more information on the package, please visit: <http://opensource.gsfc.nasa.gov/projects/CET/index.php>

**Open Source**

### **Info Services (EIS)**

**KSC-13991**

EIS is a Web service used to provide employee information to Web applications. The tool is composed of an API service. Using this service, developers can create service calls within a given application, passing the established parameters to retrieve specific employee information as needed.

**U.S. Government Purpose Release**

### **Electronic Guest Operations (EGO)**

**MSC-25083-1**

Electronic Guest Operations (EGO) has been used as an all-encompassing electronic guest management system for tracking guest invitations/RSVPs to space shuttle launches, landings, and receptions. The tool serves as a single application that will maintain guest and mission information, run standard reports, email guests, produce mailing labels, and export data. Via the Internet, invited guests can access EGO Web pages from all over the world to register their attendance intentions, access relevant mission data, and update their contact information. After guest registration, administrative support personnel have used EGO to maintain guest-seating assignments, send email communications, maintain attendance to special receptions, and gather security information for foreign guests. EGO replaces a very paper-intensive process, saves a significant amount in postage costs, and reduces error-prone data entry. The tool has been built with flexibility and customization in mind. Its initial scope was broadened to also serve as the login for people invited to view an International Space Station Friends and Family Web site created by Wyle Life Sciences. The Constellation program also used EGO to invite guests to attend the Pad Abort (PA-1) test flight in 2010.

**U.S. Government Purpose Release**

### **Electronic Timecard System**

**KSC-12051**

The Electronic Timecard System can be utilized by any business or organization wishing to streamline its payroll department procedures. The automated system minimizes the consumption of paper and eliminates the need for weekly pick-up and delivery of time sheets. The tool also simplifies the daily recording of time worked by employees, and it allows employees to “sign” their “time cards” electronically at the end of each week. Supervisors can review an employee’s electronic time cards daily and sign them electronically.

**General Public Release**

### **Employee Health and Safety System**

**KSC-14081**

This Web application was built to facilitate the process of employees completing their health and safety requirements. Supervisors can record progress, and employees have the ability to certify they have completed their required training, JHA, and certifications.

**U.S. Government Purpose Release**

### **Engineering Status Reporting Tool (ESRT)**

**GSC-17110-1**

The purpose of this tool is to provide a common system across the Code 500 Directorate for reporting and tracking engineering issues/concerns in a timely manner. This system is divided into four modules: flight project MSR issues/concerns originating from a joint Code 400/500 meeting to review flight project status; directorate issues/concerns originating from center/AETD chief engineers and directorate managers; division issues/concerns originating from the division chief engineer and division managers; and branch issues/concerns originating from PDL, MSE, engineers, branch managers.

**U.S. Government Purpose Release**

### **Goal Performance Evaluation System**

**KSC-12036**

The Goal Performance Evaluation System (GPES) is an innovative interactive software application that implements, validates, and evaluates an organization’s performance by the achievements of its employees. The tool has been used for strategic planning, employee performance management, and center-wide communication. The system is Web-based and uses a relational database to host information.

**General Public Release**



**Goddard Opportunities Bulletin Board System (GOBBS) Web Application****GSC-15514-1**

GOBBS is a Web-based application that enables managers and supervisors to advertise special employment opportunities to a broader audience. Employees can be grouped organizationally (e.g., all of Division 1) or by skills/experience bases (e.g., engineering, administrative, etc.). Parties interested in a given employment announcement can apply online with minimal effort. GOBBS does not replace Competitive Placement Plan vacancy announcements that require competition-through-merit promotion procedures.

**U.S. Government Purpose Release****Google Sift****MSC-25403-1**

This NASA Online Directives Information System (NODIS) application interfaces with the Johnson Space Center (JSC) search appliance to display a listing of all documents derived from NASA Policy Directives (NPDs), NASA Procedural Requirements (NPRs), and NASA memos that contain the term “center director.” The tool allows the user to click on a document link and view a listing of all directives contained in the selected document and also view detailed information for each directive. The application provides an Excel report of “accepted” directives.

**U.S. Government Purpose Release****HORIZON 5: Framework for Distributed Data Management and Product Generation Workflow****NPO-49540-1**

HORIZON 5 is an extensible framework for data management systems. It is packaged with SIP/AIP.

**Open Source****Hubble Space Telescope (HST) Guide Star Catalog****GSC-15569-1**

This software tracks the distribution of the Hubble Space Telescope (HST) Guide Star Catalog.

**U.S. Government Purpose Release****ID Digit Widget Plug-in****LEW-19442-1**

This plug-in utilizes the open API of MagicDraw and allows the user to manage and validate requirement IDs simply and effectively. The user can do single or mass prefix ID changes and/or renumbering and see the results before the changes are executed. The tool also performs requirement number validation, informing the user if a requirement ID is missing or duplicated and provides an opportunity to correct the issue.

**U.S. Government Purpose Release****Johnson Space Center (JSC) Action-Tracking System (JATS)****MSC-25659-1**

JATS is an action-tracking tool that allows for attachments, multiple assignees, dependent and cloned actions, the export control filtering of attachments, and the delegation of responsibilities to another user. JATS utilizes “grouping” and “roles” so that the system can be tailored to fit an organization’s specific needs. Additional modules have been added to allow correspondence management/tracking and Space Station Review Board action tracking. The legal office action-tracking module can isolate legal documents from the general document repository. JATS also has a full ad hoc search and reporting capability. Reporting features allow hierarchical organizational managers to track and report on the actions of subordinates. The system uses NASA-approved authentication methods and is 508-compliant

**U.S. Government Purpose Release****JPL Unified Methodology (JUMP) Process****NPO-48401-1**

JUMP is a tailored version of the Rational Unified Process (RUP) and the Iterative Process. It is flexible, scalable, and manageable and contains four phases: inception, elaboration, construction, and transition. Each phase has a list of major requirements and minor requirements, checklists, produced artifacts, and review. The critical idea in JUMP is “iterative development,” successively adding to and refining a system through multiple iterations using feedback and adaptation.

**U.S. Government Purpose Release**

### **Kennedy Action Tracking System (KATS)**

**KSC-13968**

In the KATS application, a method of abstraction was used in a foundational Web site platform that liberated developers from the concern of having to manually generate entity framework calls to interact with the data layer of the application. The abstraction method/layer provided the ground work from that led to the development of a “project foundation” that has now become the basic starting block for a wide variety of Web-based development. This foundation drastically reduces project spin-up time and standardizes data layer and other service interactions to ensure consistently high-performing transactional solutions.

**U.S. Government Purpose Release**

### **Mission Operations Cost-Estimation Tool (MOCET)**

**LAR-18894-1**

MOCET is a model developed by the Aerospace Corporation in partnership with NASA’s Science Office for Mission Assessment (SOMA). It implements new cost-estimating relationships (CERs) that were derived from historical data for various mission operation stages as applicable to the Planetary Science, Earth Science, and Astrophysics/Heliophysics Explorer missions.

**General Public Release**

### **Move Director Site (MDS)**

**MSC-25587-1**

MDS primarily tracks flight hardware moves, providing a place for training coordinators and move directors to share information.

**U.S. Government Purpose Release**

### **NASA Aircraft Management Information System (NAMIS)**

**MSC-24723-1**

The NASA Aircraft Management Information System (NAMIS) is an enterprise resource planning/mission support software suite designed from the ground up to meet both the mission support requirements and the business management requirements of Johnson Space Center’s Aircraft Operations Division (AOD). The system features tools and processes that: (1) eliminate the risk of conducting flight operations in aircraft with overdue inspections, in aircraft with grounding discrepancies, and in aircraft not properly configured for the mission; (2) provide continuous and positive control of all assets including materials, parts, and equipment that exceed a customer-defined value; and (3) reduce material costs and labor hours. NAMIS includes the data, information, and metrics required to support flight operations management and business decisions, as well as the data required by other systems and external components to support consistent and accurate financial reporting and asset accounting.

**U.S. Government Purpose Release**

### **NASA Clause Finder**

**GSC-17875-1**

NASA Clause Finder assists in the review of procurement-related documents (e.g., solicitations, contracts, and modifications) by helping procurement personnel to identify appropriate clauses and provisions applicable to the document being reviewed based on user-selected inputs.

**U.S. Government Purpose Release**

### **NASA Hazard Management System (HMS)**

**MSC-25694-1**

The Web-based, access-controlled NASA Hazard Management System (HMS) provides a centralized repository for hazards regardless of origin and offers the ability to report and manage real-time hazards and controls. The primary mechanism for identifying and documenting hazardous conditions within HMS lies in the creation and management of two types of analysis documents: Hazard Analyses (HAs) and Job Hazard Analyses (JHAs). While these two document types offer different approaches for hazard identification and classification, they both offer controls for mitigating hazards. HMS provides a framework within which HA and JHA documents are created, reviewed, and approved. Once approved, the hazardous conditions identified within a document are considered active. More important, the controls associated with the hazards are then also considered active. HMS includes the mechanisms required to evaluate hazards using standard Risk Assessment Code (RAC) scoring.

**General Public Release**



**NASA Root Cause Analysis Tool (RCAT)****LEW-19737-1**

The NASA Root Cause Analysis Tool (RCAT) has been designed to facilitate the analysis of anomalies, close calls, and accidents and also identify the appropriate corrective actions to prevent recurrence. The software provides an analyst with a quick, easy-to-use, accurate, and repeatable method to perform and document root cause analysis, identify corrective actions, perform trending analysis, and generate usable data for probabilistic risk assessment. All possible causes of accidents (hardware, software, the environment, weather, natural phenomena, external events, human error) can be incorporated into the timeline and fault/causal factor trees. The software features an intuitive logic diagramming capability and uses standard terminology, definitions, and symbols.

**U.S. and Foreign Release****Next-Generation Integrated Network (NGIN), Version 2.0****GSC-17271-1**

NGIN 2.0 offers a consolidated product lifecycle management system including documentation management, configuration management, change control management, and risk management of product/project data. Specifically, NGIN manages: product/project governance data including requirements, product/project plans, product/project control plans, technical review preparation and results, action items, issues, risks, drawings, work order authorizations, photographs, and other documentation. In addition, NGIN 2.0 provides collaboration via the internet and a single repository for multiple projects to manage the lifecycles of their respective products.

**U.S. Government Purpose Release****Policy Base Management (PBEM) Natural Language Parser****NPO-45791-1**

PBEM is a rules-based approach to enterprise management that can be used to automate certain management tasks. The software simplifies the management of a given endeavor by establishing policies to deal with situations that are likely to occur. Such policies are a means of maintaining order, security, consistency, or other ways of successfully furthering a goal or mission.

**U.S. Government Purpose Release****Policy Base Management Natural Language Parser****NPO-45816-1**

This software, valuable to both manned and unmanned science gathering programs, can be applied to a vast variety of applications. PBEM is a rules-based approach to enterprise management that can be used to automate certain management tasks. The software simplifies the management of a given endeavor by establishing policies to deal with situations that are likely to occur. Policies are operating rules that can be referred to as a means of maintaining order, security, consistency, or other ways of successfully furthering a goal or mission.

**U.S. Government Purpose Release****Policy Process Editor for JPL Policy, Process, and Performance Based Management Tool Suite****NPO-45821-1**

This software automates the execution of natural language enterprise policies.

**U.S. Government Purpose Release****Project Cost-Estimating Capability, Version 2.2****MFS-33187-2**

Used to develop cost estimates/models for space systems, this technology combines an Excel add-in with a simple, robust, and transparent collection of NASA cost-estimating relationships (CERs), statistics, work breakdown structures, and cost-estimating algorithms. The approach's use of native Excel functionality to provide basic calculations limits the overhead required to maintain a model and affords more visibility to the user with regard to the calculations and equations involved in generating an estimate.

**General Public Release**

### **Project Risk Information Management Exchange (PRIMX)**

**GSC-14980-1**

The Project Risk Information Management Exchange (PRIMX) provides a centralized source for continuous risk management (CRM) information by combining risk identification, analysis, planning, tracking, control, and communication into a single comprehensive environment that meets the requirements of NASA Procedures and Guidelines (NPG) 7120.5B and 8000.4. The software permits project personnel access to current CRM documentation, gives the status of risk activities, and identifies emerging risks that may influence the formulation development of a given project/program. PRIMX is free-standing network software (not an add-on program) that runs on any Windows platform.

**U.S. Government Purpose Release**

### **RedShift: Mobile App for Following the Tactical and Strategic Operations Meeting Schedule**

**NPO-50256-1**

RedShift is an application for iOS and Android that presents the meeting agenda for MSL strategic and tactical meeting events that are a part of the operations workflow.

**Open Source**

### **Scenario Scheduler Timeline Execution Application Suite**

**GSC-16066-1**

Scenario Scheduler is a Java software application that is integrated with the Goddard Mission Services Evolution Center (GMSEC) application program interface for use in Mission Operations Centers. The application stores activity lists or “scenarios” for execution in a timeline- and/or event-driven nature. The application is set up via a flat file schedule of activities to perform. Scenario Scheduler is redundant and both execution nodes work together in a prime/backup mode with automatic failover.

**U.S. Government Purpose Release**

### **Schedule Test and Assessment Tool (STAT), Version 5.0**

**MFS-33362-1**

The Schedule Test and Assessment Tool (STAT) is a schedule management software add-in developed to work specifically within the Microsoft Project scheduling application. STAT 5.0 provides the automated capability to quickly identify, quantify, and report numerous types of critical schedule assessment data for management use. This software provides clear and objective reporting of key schedule assessment information, including logic network integrity indicators, performance and trend metrics, schedule driver identification, data comparisons, margin and milestone tracking, and various other analysis data that can be used by project teams to assist in management decision making.

**General Public Release**

### **Shipping Foam Designer Software**

**MSC-25515-1**

The Shipping Foam Designer Software is an easy-to-use design tool that allows the user to select the proper type and dimensions of shock-attenuating packing foam. A simple graphical user interface is provided. The software was developed in response to a large number of documented cases of critical hardware failures that resulted from drops during shipment.

**General Public**

### **Source Lines Counter (SLiC), Version 4.0**

**NPO-45962-1**

SLiC has been used in a variety of projects and missions at the Jet Propulsion Laboratory (JPL). It is the official code counter endorsed by the Software Quality Improvement Project for its metrics collections effort across JPL. SLiC provides data for cost models used during all major JPL pre-Phase A software estimation activities, as well as cost validation activities throughout project lifecycles.

**U.S. Government Purpose Release**

### **Spinoff 2015 iPad App**

**GSC-17366-1**

This tool is an iPad version of the Spinoff 2015 publication featuring shortened versions of Spinoff articles and multimedia.

**General Public Release**



**Stennis Space Center (SSC) Site Status Mobile Application****SSC-00424**

This application provides SSC civil servants, contractors, and tenants the ability to view the NASA center's weather radar and current site status bulletin from a mobile device. The application also alerts users via push notification when a new site status is posted. It is available at the Apple App Store.

**General Public Release****Supervisory Survey (Supervisory Feedback Tool)****GSC-15534-1**

This application consists of an online survey that collects feedback from employees regarding their supervisors. Employees can anonymously review their immediate supervisor, a supervisor above their own immediate supervisor, or a matrixed supervisor. Feedback topic questions cover human resource management, communication, diversity and equal opportunity, and teamwork. The reports function allows supervisors to compare current feedback to feedback from previous surveys.

**U.S. Government Purpose Release****Taxonomy Services for Google Search Appliance****MSC-25406-1**

The Taxonomy Services for Google were written for the purposes of injecting taxonomy metadata into the Google Search Appliance and utilizing it.

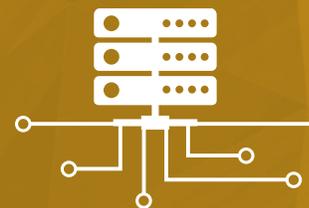
**U.S. Government Purpose Release**



# 2

## Data Servers Processing and Handling

Algorithms, Data Management, Routers,  
Servers, Storage





## Featured Software

### **Application Research Toolbox (ART)**

**SSC-00181**

Developed in MATLAB, the Application Research Toolbox (ART) is a collection of computer programs that implement algorithms and parametric mathematical models for simulating remote sensing systems. ART is especially useful for performing design-tradeoff studies and statistical analyses to support the rational development of design requirements for multispectral imaging systems. The toolbox affords the capability to synthesize coarser-spatial-resolution image data sets from finer-spatial-resolution data sets and multispectral image data products from hyperspectral image data products. ART is designed to run on a standard Windows® NT/2000 workstation and MATLAB version 6.5. A programmer's reference guide is included to provide additional detail on setting up the operational environment.

**General Public Release**

### **Engineering DOUG Graphics for Exploration (EDGE)**

**MSC-24663-1**

EDGE is a real-time 3D graphics rendering package based on the Dynamic On-board Ubiquitous Graphics (DOUG) engine. It combines key elements from software tools developed for the Space Shuttle Program and International Space Station (ISS) and adapts them for integration with other engineering simulations and facilities. The tool allows drop-in integration with the NASA Trick Simulation Environment and provides a fusion of 3D graphics and simulation outputs.

**General Public Release**



### **NASA UNIX Tool Kit**

**KSC-12269**

The NASA UNIX Tool Kit contains three components that all work together to form a single technology for UNIX administration: (1) secure, Web-based UNIX System administration tools (KSC-12269) ease the administration of a large, distributed UNIX system, providing a secure mechanism for creating, modifying, locking, and deleting users; (2) the client/server creates, modifies, and queries VERITAS file system quotas on an NFS-mounted file system with a secure Web-based interface (KSC-12268); and (3) the Web-based IP address tool (KSC-12271) provides an easy-to-use system for maintaining IP address information for a network of computers.

**U.S. Release Only**

### **Performance Logging Services (PLS)**

**KSC-12343**

Working in real time and using very little memory and CPU, Performance Logging Services (PLS) is an innovative software-performance monitoring tool that tracks statistics on timing and buffer usage. To assist in troubleshooting, PLS will start or stop other software tools when performance requirements are out of specification. The technology has been used in the Checkout and Launch Control System on NASA's Space Shuttle Program.

**U.S. Release Only**

### **Remote Memory Access Protocol Target Node**

**GSC-16467-1**

This NASA technology provides SpaceWire design users with support for executing remote memory access protocol (RMAP) read and write commands. The target IP core is a VHDL description suitable for implementation in a field-programmable gate array (FPGA) or an application-specific integrated circuit (ASIC).

**U.S. Release Only**



**Analog Input Data Acquisition Software****KSC-13203**

With the easy-to-use Analog Input Data Acquisition Software, a user can set up a system for monitoring up to five analog input channels. The software requires LabVIEW runtime engine 8.0 (a free download from ni.com) to run the executable.

**General Public Release****Application Program Interface (API) for the Orion Aerodynamics Database (Cap Aero)****MSC-24819-1**

Programmed in C, CAP Aero was developed to provide software developers an easily implemented, fully self-contained method for accessing the Crew Exploration Vehicle's Aerodynamic Database. No special functions (file read/write, table lookup, etc.) are required on the host system other than those included with a standard ANSI C installation. CAP Aero reads files of aero-data tables formatted as specified in the document, "Aerotab Data File Format." The aerodynamic coefficients and forces calculated by the program follow the equations cited in the document, "Formulation of the Orion Aerodynamic Database."

**U.S. Government Purpose Release****Application Research Toolbox (ART)****SSC-00181**

Developed in MATLAB, the Application Research Toolbox (ART) is a collection of computer programs that implement algorithms and parametric mathematical models for simulating remote sensing systems. The programs are especially useful for performing design-tradeoff studies and statistical analyses to support the rational development of design requirements for multispectral imaging systems.

**General Public Release****AR4JA LDPC Coded Modulation in C and MATLAB****NPO-47171-1**

The software supports the modulations of binary phase-shift keying (BPSK), quadrature PSK (QPSK), 8-PSK, 16-amplitude PSK (16-APSK), and 32-APSK. For each modulation type, the software modulator supports various bit-to-modulation symbol mappings, including the natural order, the Gray code, the anti-Gray code, and the ordering specified by the Digital Video Broadcast Satellite Second Generation standard for 16-APSK and 32-APSK.

**U.S. Government Purpose Release****Athena Software Platform****MFS-33036-1**

The Athena platform is designed to be a single-point source for acquiring, assessing, archiving, and disseminating scientific and technical information. The platform ensures successful performance, increases safety, and saves resources.

**U.S. Government Purpose Release****Ballast: Balancing Load Across Systems****ARC-16443-1**

Ballast is a tool for balancing user load across Secure Shell Handler (SSH) servers. The system includes a load-balancing client, a lightweight data server, scripts for collecting system load, and scripts for analyzing user behavior. Because Ballast is invoked as part of the SSH login process, it has access to user names. This capability, which is not available in traditional approaches, enables Ballast to perform user-specific load balancing. In addition, Ballast is easy to install, induces near-zero overhead, and has fault-tolerant features in its architectures that will eliminate single points of failure.

**Open Source****Bundle Protocol Software Library, Version 1.0****GSC-16816-1**

The Bundle Protocol Software Library implements the Bundle Protocol using a software architecture that is simple and fast enough to be attractive to Goddard mission designers. It has been developed for the Laser Communication Relay Demonstration (LCRD) mission and the Disruption-Tolerant Network (DTN) group, but it is useful to any organization (commercial or otherwise) that is interested in being a part of the Interplanetary Internet.

**U.S. Government Purpose Release**

### **Bundle Security Protocol for ION**

**NPO-47211-1**

The Interplanetary Overlay Network (ION) communication system is an implementation of Delay-Tolerant Networking (DTN) protocols for space flight operations. It enables reliable automatic data communication over a network of arbitrarily complex topology comprising both deep-space links and more Internet-like connections. The bundle protocol is used in DTNs that overlay multiple networks, some of which may be challenged by limitations such as intermittent and possibly unpredictable loss of connectivity, long or variable delay, asymmetric data rates, and high error rates. The purpose of the bundle protocol is to support interoperability across such stressed networks.

**U.S. Government Purpose Release**

### **CAPTools-Based Automatic Parallelizer Using OpenMP (CAPO)**

**ARC-14487-1**

CAPO analyzes a Fortran program and inserts OpenMP directives into the code to improve its performance on a parallel machine. The tool relies on accurate inter-procedural data-dependence information currently provided by CAPTools, which was developed at the University of Greenwich.

**General Public Release**

### **CFDP-ION: CFDP for Interplanetary Overlay Network**

**NPO-47084-1**

CFDP-ION is an implementation of CFDP that uses ION's DTN implementation as its UT layer. It can be used without modification in VxWorks 5.4, Solaris 9, OS/X, and various Linux distributions.

**U.S. Government Purpose Release**

### **Coarse-Grain Bandwidth Estimation Scheme for Large-Scale Network**

**NPO-48426-1**

In this effort, two versions of leveling schemes have been developed: (1) an inherently sub-optimal straight-forward version that simply spreads the data of each data type across the time horizon and does not take into account the interactions among data types within a pass nor between data types across overlapping passes at a network node; and (2) a State Markov leveling scheme that takes into account the second-order behavior of the store-and-forward mechanism, as well as the interactions among data types within a pass.

**U.S. Government Purpose Release**

### **Code for Working with .dta Format Files in the Python Programming Language**

**MSC-25658-1**

This NASA code helps users work with and manipulate .dta format files in the Python programming language.

**U.S. Government Purpose Release**

### **Contact Graph Routing**

**NPO-45488-1**

This software was developed to support the NASA DTN Technology Readiness program. The Interplanetary Overlay Network (ION) communication system is an implementation of Delay-Tolerant Networking (DTN) protocols for space flight operations. It enables reliable automatic data communication over a network of arbitrarily complex topology comprising both deep-space links and more Internet-like connections.

**U.S. Government Purpose Release**

### **Coordinated Data Analysis Workshop Web (CDAWeb)**

**GSC-14292-1**

The CDAWeb software and the CDAWeb service built on this software have been developed and continue to be enhanced and maintained by the Space Physics Data Facility. The technology has supported NASA/Office of Space Science programs dealing with the connections between the Sun and the Earth. CDAWeb software is essentially a set of Interactive Data Language (IDL) scripts that act as the engine of the system. Please visit: [http://cdaweb.gsfc.nasa.gov/cdaweb/istp\\_public/](http://cdaweb.gsfc.nasa.gov/cdaweb/istp_public/)

**Open Source**



**CriticalThreads: A Low-Level Parallelization Architecture for Critical Applications** MSC-25719-1

Critical Threads is a lightweight “pthreads” application interface that allows software developers to parallelize C++ segments without suffering the normally unavoidable operating system level context switching overhead.

**U.S. Government Purpose Release**

**Data Access Toolkit (DAT), Release 1.0** GSC-17291-1

DAT is a software application that performs trending, archive, and data management functions to analyze the performance of the observatory through state-of-health monitoring using all collected housekeeping data and to manage the storage and distribution of all mission data files.

**U.S. Government Purpose Release**

**Data Optimization Via Genetic Ordering (DOGO) System: A Replacement for Binary Quality Flags by Instead Ordering Data** NPO-49817-1

OCO-2 will be based on the previously launched Orbiting Carbon Observatory (OCO) satellite and will carry a single instrument consisting of three high-resolution grating spectrometers. This instrument will obtain the most precise measurements of atmospheric CO<sub>2</sub> ever made from space. OCO-2 will fly in a near-polar orbit, thus enabling it to observe most of the Earth’s surface at least once every 16 days.

**U.S. Government Purpose Release**

**DBI: Async, An Asynchronous Wrapper for the Perl 6 DBIish Database Interaction Subsystem** GSC-17824-1

Here is a simple asynchronous API wrapping of the existing Perl 6 DBIish Database interaction module. It manages a pool of database handles allocated as needed to perform database queries in a thread-safe manner. The tool can utilize promises to queue queries that will be performed asynchronously when a database handle becomes available, and it handles retries gracefully on database connection failures allowing the primary application to continue even when the database goes down and is restarted.

**Open Source**

**Deep Space Network (DSN) Config Converter** NPO-45423-1

This tool is used in operations by the MRO and Phoenix missions. It provides both time savings and risk reduction in the periodic updating of the dsn\_config modeling adaptation.

**U.S. Government Purpose Release**

**Delay- and Disruption-Tolerant Networking Licklider Transmission Protocol (LTP) MACHETE Model** NPO-43410-1

This software models the Delay-Tolerant Networking Licklider Transmission Protocol for the Jet Propulsion Laboratory’s MACHETE, which was developed at JPL to determine the performance of existing and emerging communications protocols and services in the context of space exploration. This protocol model can assist NASA network designers who wish to use Delay-Tolerant Networking protocols.

**U.S. Government Purpose Release**

**Delay-Tolerant Link State Routing MACHETE Model** NPO-47406-1

This software models the Delay-Tolerant Link State Routing Protocol.

**U.S. Government Purpose Release**

**Delay-Tolerant Networking Contact Graph Routing MACHETE Model** NPO-47405-1

This software models the Contact Graph Routing (CGR) system proposed for future NASA missions and used in DINET1 and DINET2 experiments.

**U.S. Government Purpose Release**



**DEMUD: Discovery through Eigenbasis Modeling of Uninteresting Data** **NPO-48877-1**

We have developed a machine learning solution called DEMUD (Discovery through Eigenbasis Modeling of Uninteresting Data). DEMUD works by building a model U of the uninteresting class and then identifying items that are maximally anomalous (and therefore likely to be interesting) with respect to that model.

**Open Source**

**Design and Construction of Protograph-Based LDPC Codes for Magnetic Recording and Other Channels with Finite-State Representation** **NPO-48408-1**

In this effort, developers computed the threshold over the joint graph between the LDPC decoder and trellis nodes.

**U.S. Government Purpose Release**

**Distributed System Integrated Labs Communications Adapter (DSILCA)** **GSC-15846-1**

Providing interoperability between Constellation systems at the hardline and baseband external interfaces, DSILCA is a communications adapter that converts non-C3I-compliant data and interfaces into C3I-compliant data and interfaces.

**U.S. Government Purpose Release**

**Distributed System Integrated Labs Interface User (DSILIU)** **GSC-15847-1**

DSILIU provides interface conversion to Ethernet to allow nationwide connectivity over the NASA Integrated Services Network (NISN) or another high-bandwidth interagency network.

**U.S. Government Purpose Release**

**Domain Name System (DNS) Graphical User Interface (GUI) Software** **MSC-25624-1**

Combining a client graphical user interface with a server process, this NASA software provides the capability for updating a system's DNS settings from an operator's console. It requires a LINUX system and a C compiler.

**U.S. Government Purpose Release**

**DTKA: A Prototype Implementation of Delay-Tolerant Security Key Distribution** **NPO-49413-1**

Unlike all Internet mechanisms for security distribution (e.g., certificate authorities), DTKA operates over the extremely long signal propagation times and interrupted links that characterize communication with inter-planetary spacecraft. It has no single point of failure and cannot be "spoofed" by an attacker's subversion of any single key authority machine (or even two key authority machines, in most configurations).

**Open Source**

**DTNTAP** **NPO-48906-1**

DTNTAP is a user space Ethernet driver with the potential to expedite DTN deployment by providing a transition mechanism for legacy IP applications to run alongside delay/disruption-tolerant applications in large-scale communication networks. By presenting an Ethernet-like interface, DTNTAP gives application developers access to many of the benefits of DTN without requiring to the user to become immediately proficient at a new programming API.

**Open Source**

**Dyper: Dynamic Perimeter Enforcement** **ARC-16444-1**

Dyper protects a site from unauthorized network flows. The tool offers dynamic perimeter enforcement by providing a general-purpose mechanism for maintaining least-privilege network security policies while still supporting the full utilization of multiport protocols. Dyper requires no changes to software or practices outside of the perimeter and only minimal changes inside.

**Open Source**



**Earth Observing System (EOS) Clearing House (ECHO)****GSC-14726-1**

The Earth Observing System Clearing House (ECHO) affords the Earth science community more flexibility in accessing and sharing data and services. As a metadata clearinghouse, ECHO supports iterative query data access. As a service broker, ECHO decentralizes data-manipulation tools and supports the interoperability of distributed functions. For more information, please visit: <http://ti.arc.nasa.gov/opensource/projects/echo/>

**Open Source****Earth Observing System (EOS) Data Gateway (EDG)****GSC-14938-1**

The Earth Observing System Data Gateway (EDG) provides the Earth science community with a single interface that will search for data granules from distributed data archives. The innovation enables users to explore, discover, and order available data from geographically distributed providers. For more information, please visit: <http://opensource.gsfc.nasa.gov/projects/edg/index.php#software>

**Open Source****EDGE: The Extensible Data Gateway Environment****NPO-49884-1**

EDGE uses Apache Solr for the fast-indexed search backend. To further ensure reliable serving of data, EDGE's Apache Solr uses the master and slave model.

**Open Source****EDRN Knowledge Environment****NPO-48644-1**

The Jet Propulsion Laboratory has provided the underlying infrastructure to share data, thereby increasing the study power associated with capturing and comparing information. The infrastructure provides software services including data processing and management (eCAS), biomarker data management (BMDB), specimen data management (ERNE), and a portal to link the system together and provide access.

**Open Source****EEPROM File System****GSC-16852-1**

EEFS provides a file system abstraction for EEPROM or PROM memories that is simple, efficient, and reliable.

**Open Source****Engineering DOUG Graphics for Exploration (EDGE)****MSC-24663-1**

EDGE is a real-time 3D graphics rendering package based on the Dynamic On-board Ubiquitous Graphics (DOUG) graphics engine. It combines key elements from graphics software tools developed for Space Shuttle and International Space Station (ISS) programs and adapts them for integration with other engineering simulations and facilities. The tool allows drop-in integration with the NASA Trick Simulation Environment and provides a fusion of 3D graphics and simulation outputs.

**General Public Release****Engineering Units Generator (EUGEN)****SSC-00151-1**

EUGEN converts digitized sensor output voltage data to engineering units. The tool creates individual processed data files (one file per transducer per test run), converting raw voltage to meaningful measurements such as pressure or temperature.

**General Public Release****Enhanced Contact Graph Routing (ECGR) MACHETE Simulation Model****NPO-47650-1**

These models allow simulation-based characterization of Enhanced Contact Graph Routing (ECGR) for Delay-Tolerant Networks.

**U.S. Government Purpose Release**

**Ensemble REST: Framework for RESTful Web Services in OSGI****NPO-45848-1**

Ensemble REST makes it easy for developers to write and deploy RESTful Web applications, and the HTTP protocol enables anyone to access and utilize the exposed services. Libraries are available in almost every programming language in order to connect a program in the language to an HTTP service.

**U.S. Government Purpose Release****File Exchange Interface (FEI 5)****NPO-40075-1**

The File Exchange Interface (FEI) service offers secure file transaction, storage, transportation, and management services. The tool is implemented with the latest Java technologies for maximum portability and supports a 64-bit file system for very large file transfers over secure socket connections. While data-base-driven for file transactions and user access management, FEI offers an interactive client software suite for managing administration and general use.

**U.S. Government Purpose Release****Fortran Unit Testing Framework (fUnit), Version 1****LAR-17081-1**

The fUnit software provides a framework for unit-testing Fortran 90, 95, and 2003 code.

**Open Source****Generic, Extensible, Configurable Push-Pull Framework for Large-Scale Science Missions****NPO-46185-1**

This generic protocol layer greatly aids the CAS Crawling Framework, allowing it to generically obtain content from remote sites using protocols such as FTP and others.

**U.S. Government Purpose Release****GRAVITE IPS****GSC-17261-1**

GRAVITE IPS is a core component for ingest, archive, distribution, and processing for GRAVITE. Ingest/archive denotes the ability to receive data from sources that are then validated and verified for long-term archiving. Distribution is the ability to supply data to stakeholders. Processing denotes the ability to routinely examine data by automatically running a set of specified algorithms for each instrument.

**U.S. Government Purpose Release****HDF-EOS2 and HDF-EOS5 Compatibility Library****GSC-15008-1**

This software library provides uniform access to HDF-EOS2 and HDF-EOS5 files through one set of application program interface (API) calls. Without the library, programs would have to be written twice to cover both HDF-EOS2 and HDF-EOS5 files. <http://opensource.gsfc.nasa.gov/projects/HDF-EOS2/index.php>

**Open Source****HDF-EOS5 Validator****GSC-15015-1**

This software allows generators of HDF-EOS data products to encode product requirement specifications in XML. The tool will then mechanically check product files against those requirements. For more information, please visit: <http://opensource.gsfc.nasa.gov/projects/Validator/index.php>

**Open Source****Hierarchical Data Format Earth Observing System (HDF-EOS) Data Extractor (HEEX)****GSC-15009-1**

The Hierarchical Data Format Earth Observing System (HDF-EOS) Data Extractor (HEEX) is a tool that enables users to extract HDF-EOS data to binary or ASCII data formats in HTML or XML index. The software can be used for both HDF-EOS2 and HDF-EOS5, and it automatically recognizes the two formats.

**Open Source**

**Hierarchical Data Format Earth Observing System (HDF-EOS) Metadata Updater (HEMU) GSC-15010-1**

HDF-EOS Metadata Updater (HEMU) enables users to modify metadata inside an HDF-EOS file (either HDF-EOS2 and HDF-EOS5). The tool can be used to extract metadata from a dataset to a text file that can then be modified with any text editor; replace metadata with text from an external file; or update metadata with text from an external file. For more information, please visit: <http://opensource.gsfc.nasa.gov/projects/hemu/index.php>

**Open Source**

**Hierarchical Data Format Earth Observing System (HDF-EOS) Web Server GSC-15011-1**

This shell script chains together existing data usability group tools to: extract ODL metadata from an HDF-EOS file; convert the metadata to XML; reformat the XML into HTML; publish the HTML and the original HDF-EOS file to a Web server and an OPeNDAP server; and reformat the XML and submit it to the Earth Observing System Clearing House (ECHO). For more information, please visit: <http://opensource.gsfc.nasa.gov/projects/heserve/index.php>

**Open Source**

**Hierarchical Data Format Earth Observing System (HDF-EOS) XML Document-Type Definitions and Schemas GSC-15016-1**

An XML standard has been developed for the HDF-EOS5 file format using document-type definitions and schemas. Users can transform HDF5 files into XML format and vice versa. For more information, please visit: [http://opensource.gsfc.nasa.gov/projects/XML\\_DTD\\_Schemas/index.php](http://opensource.gsfc.nasa.gov/projects/XML_DTD_Schemas/index.php)

**Open Source**

**High Data Rate Platform to Capture and Analyze Raw Baseband Clock/Data NPO-49911-1**

The RF4425 takes an S-band RF signal and converts it to an RS-422 differential baseband signal. The SyncLink samples the raw data stream and imports it over USB into Linux. From here, custom C++ functions (such as frame synchronization and file export, bit-error rate checking, etc.) can be written to analyze the data.

**U.S. Government Purpose Release**

**High-Performance CCSDS AOS Protocol Implementation in FPGA NPO-47166-1**

The CCSDS AOS in FPGA Implementation consists of both framing and de-framing features.

**U.S. Government Purpose Release**

**High-Performance CCSDS Encapsulation Service Implementation in FPGA NPO-47167-1**

The CCSDS Encapsulation Service in FPGA Implementation consists of both packetizing and de-packetizing features.

**U.S. Government Purpose Release**

**IND 2.1: Creation and Manipulation of Decision Trees from Data ARC-14529-1**

Decision trees are commonly used in artificial intelligence and statistical pattern recognition. A tree is “grown” from data using a recursive-partitioning algorithm. IND re-implements parts of existing standard prediction algorithms, offers experimental control suites, and also introduces new, more sophisticated methods for growing decision trees.

**Open Source**

**Information Sharing Protocol Logger (ISPLOGR) MSC-25610-1**

The Information Sharing Protocol (ISP) Logger (ISPLOGR) is a software program written in C that provides a capability to record ISP data into a Source Independent Telemetry Format (SITF) file. The ISPLOGR uses command-line arguments to specify output file names and other required parameters. Once the SITF file is defined, it can be used as input to other available ISP software available with for ISP data playback.

**U.S. Government Purpose Release**



### **Information Sharing Protocol VCR (ISPVCR)**

**MSC-25608-1**

The Information Sharing Protocol (ISP) VCR (ISPVCR) is a software program written in Tcl/Tk that provides a capability to record and playback ISP data via Source Independent Telemetry Format (SITF) files. The ISPVCR provides a graphical user Interface that allows for start/stop of the recording capability; specification of output file names; and start/stop of the playback of the SITF data file.

**U.S. Release Only**

### **InSight Software**

**MSC-25376-1**

The InSight application is designed to execute on Windows XP or later platforms. It provides a common command and data display graphical user interface (GUI) for data streams originating from an extensible set of data sources. A data source may be either a physical interface type (i.e., serial or GPIB buses) or a virtual interface represented by an application programming interface (API) provided by a vendor that abstracts the underlying physical interface (i.e., Trick simulations using the Trick API or NIDAQmx). Multiple devices/instruments under test (DUT) may be connected to a single data source depending upon what the underlying operating system interface (OSI) media layers allow. Each data source type is abstracted to the GUI through a dynamic link library (DLL) that provides a common programming interface. Multiple data sources of each type are allowed. By authoring a new DLL that adheres to the InSight API, new data source types can be added.

**U.S. Government Purpose Release**

### **Interactive Graphical SCADA System (IGSS) XML Adaptor for the James Webb Space Telescope (JWST)**

**GSC-15422-1**

Built for the James Webb Space Telescope (JWSP), this adaptor is a major component of the Interactive Graphical SCADA System (IGSS). The technology allows a database to be translated from XML into a variety of output products, including other XML files, ASCII files, and both HTML and/or Microsoft Access formats.

**U.S. Government Purpose Release**

### **Interface Software for Nivis ISA100.11a Gateway**

**MSC-25409-1**

This software implements an interface with the Nivis ISA100.11a gateway using the ISA100.11a Gateway Service Access Point (GSAP).

**U.S. Government Purpose Release**

### **JavaGenes Genetic Graphs**

**ARC-14293-1**

JavaGenes is a genetic algorithm code written in Java. It evolves graphs using genetic software techniques and has applications in designing drugs, circuits, or any other system that is easily represented by graphs.

**Open Source**

### **JavaGenes-Scheduler: Evolutionary Software for Earth-Observing Satellite Scheduling**

**ARC-15103-1**

JavaGenes-Scheduler is a general-purpose evolutionary system designed to compare techniques for scheduling observations. It was originally developed for scheduling observations made by Earth-observing satellites. JavaGenes-Scheduler uses a simple, earliest-first scheduler to insert observations into the timeline in permutation order.

**Open Source**

### **Jitter Controller Software**

**MSC-24814-1**

Developed for the Constellation program, Jitter Controller Software helps manage the relationships between phase jitter crest factor, frequency jitter crest factor, and cycle-to-cycle crest factor. Written in LabVIEW, the code calls Agilent drivers to write to generator hardware. Although not well documented and originally intended to be disposable, the software has been reused.

**U.S. Government Purpose Release**



**Juneberry Web Service Software****NPO-48378-1**

This software implements the open Webification API and provides ReSTful Web services for planetary image data in commonly used formats. It exposes content of planetary image data through meaningful URLs and enables the creation of applications on diverse platforms.

**Open Source****Juneplum: ReSTful Web Access of OPeNDAP Hyrax Back-End Server****NPO-49868-1**

Juneplum is implemented as a Java servlet Web app and can be directly deployed into the same servlet engine that Hyrax front-end occupies. With Juneplum, any data product served by OPeNDAP is made simultaneously accessible in a fully ReSTful way

**Open Source****Kameleon Software Suite: the Kameleon Converter****GSC-15440-1**

Developed at the Community Coordinated Modeling Center (CCMC), the Kameleon Software Suite addresses the difficulty in analyzing and disseminating the varying output formats of space weather model data. Employing a comprehensive standardization methodology, Kameleon allows heterogeneous model output to be stored uniformly in a common science data format. The converted files contain both the original model output, as well as additional metadata elements to create platform-independent and self-descriptive data files. Kameleon facilitates model data dissemination, data reuse, and code reuse.

**U.S. Government Purpose Release****libSPRITE****MFS-33231-1**

libSPRITE was specifically designed for real-time systems that operate on a single computational node (but may be multi-core) to systematically address common coding errors, provide for multi-threaded programming to produce the exact same results regardless of the number of cores on the host compute node, and offer support for in-operation reconfigurability (parameter and control flow modifications). Components include engineering unit encoders, math functions, a task scheduler built on top of pthreads, a publish/subscribe data distribution system, and a Lua scripting language interface.

**Open Source****MaROS: Web Visualization of Mars Orbiting and Landed Assets (Phase 1)****NPO-47413-1**

This new software application reduces complexity by presenting a visualization of the overpass time ranges, elevation angle, as well as other information. The user is able to select a specific overflight opportunity to receive further information about that particular pass. This software is unique in that it is the first of its kind to visually display the information.

**U.S. Government Purpose Release****MarsGIS Human Landing Site and Exploration Zone Viewer and Collaboration Tool****LAR-19183-1**

The innovation includes a GIS layer and a Web-based GIS service. The GIS layer includes the geospatial location and spatial extent of the Exploration Zones (EZs), regions of interest (ROIs), and data characterizing the science and resources purported to be available. These data were extracted from publicly available abstracts and presentations for the HLS2 EZ Workshop in October 2015 as proposals for the first human landing site on Mars. The Web-based service allows users to view and analyze this layer; verify, alter, and annotate data; add/edit/delete new EZ; and will support user collaboration on these data. The layer was developed under the auspices of a SACD investment fund opportunity.

**General Public Release****Metadata Check****GSC-15012-1**

Metadata Check is a command-line tool to check Earth Observing System (EOS) metadata with a metadata descriptor. For more information, please visit: <http://opensource.gsfc.nasa.gov/projects/metacheck/index.php>

**Open Source**

### **Method and Program Code for Improving Machine Efficiency in the Computation of Nearly Singular Integrals**

**MSC-25640-1**

This innovation provides a method for improving machine efficiency in the computation of nearly singular integrals. The code has been applied to computational electromagnetics (CEM) problems and could have application to a variety of computational modeling disciplines.

**U.S. Government Purpose Release**

### **Method of Error Floor Mitigation in Low-Density Parity-Check Codes**

**NPO-48076-1**

This modification of standard belief propagation message passing allows the new decoder to converge to the correct code word with a higher probability than was previously possible.

**U.S. Government Purpose Release**

### **Mini-Stamp as a Micro-Display for At-a-Glance Subsystem Information for DSN Links**

**NPO-49895-1**

Micro-displays are tools for mental model re-alignment, helping operators to keep their mental models of how the system works and behaves aligned with the changing state of the complex system. Data-driven micro-displays such as the Postage Stamp and Mini-Stamp display information about the system in a consistent way. Like a traffic light, the format of the micro-display never changes; the operator always knows where to look to find a specific piece of information. The Mini-Stamp always looks like the Mini-Stamp, and all of its data fields always lie in the same place on the micro-display. Real-time data flow through the Mini-Stamp to provide information to the operator.

**U.S. Government Purpose Release**

### **Mixed Integer Programming and Heuristic Scheduling for Space Communication Networks**

**NPO-48485-1**

This communication network consists of space and ground assets with the link dynamics between any two assets varying with respect to time, distance, and telecom configurations.

**U.S. Government Purpose Release**

### **Multi-Stage GOC/Neural Network System for Automatic Target Recognition**

**NPO-47012-1**

A multi-stage automated target recognition (ATR) system has been designed to perform computer vision tasks with adequate proficiency in mimicking human vision. The system is able to detect, identify, and track targets of interest. A feed forward back propagation neural network (NN) is then trained to classify each feature vector and remove false positives. The system parameter optimizations process has been developed to adapt to various targets and datasets.

**U.S. Government Purpose Release**

### **Multi-Threaded Copy Program (MCP)**

**ARC-16494-1**

MCP is a high-performance file copy utility that achieves performance gains through parallelization. Multiple files and parts of single files are processed in parallel using multiple threads on multiple processors. The program employs the OpenMP and MPI programming models.

**Open Source**

### **Multipurpose Display Tool (MDT)**

**MSC-26242-1**

The Multipurpose Display Tool (MDT) application is a general-purpose display/plot tool with editor capabilities for developing displays.

**U.S. Government Purpose Release**

### **NASA Technology Transfer System (NTTS)**

**ARC-16564-1**

The NASA Technology Transfer System (NTTS) is NASA's enterprise system that captures NASA technologies. NTTS supports various technology transfer related activities and business processes.

**U.S. Government Purpose Release**



**NASA UNIX Tool Kit****KSC-12269**

The NASA UNIX Tool Kit contains three components that all work together to form a single technology for UNIX administration: (1) Secure, Web-based UNIX System Administration Tools (KSC-12269) ease the administration of a large, distributed UNIX system, providing a secure mechanism for creating, modifying, locking, and deleting users. (2) The second component of the software kit is the Client/Server to Create, Modify, and Query VERITAS File System Quotas on an NFS-Mounted File System with a Secure Web-based Interface (KSC-12268). In this technology, the client (which exists on an internal secure platform with a secure interface) can be accessed from any authorized platform capable of running a Web browser. The server software exists on a UNIX platform configured with the VERITAS file system. (3) The Web-based IP Address Tool (KSC-12271) provides an easy-to-use system for maintaining IP address information for a network of computers.

**General Public Release****Netmark eXtensible DataBase, Data Access, and Retrieval Composition (XDB3-DARC) ARC-16119-1B**

This innovation will query using a suite of operators in the Netmark/XDB query language to retrieve elements based on the absolute value of tags in the XML source. In an earlier version of the software, element retrieval was based solely on “full-text” term searches of the tags and their values.

**Open Source****NETMARK, Version 3.0****ARC-15722-1A**

NETMARK 3.0 utilizes the same API as the previous versions but includes a rebuilt backend system utilizing NoSQL database technology. NETMARK 3.0 also introduces JSON output (in addition to the previously available XML output).

**U.S. Government Purpose Release****Netmeter: Multichannel Networked Phasemeter Readout and Analysis Software****NPO-45505-1**

Netmeter reads the outputs of several phasemeters and either displays the information on the screen, saves it to disk, or provides data to a graphical interface (LabView or Web) over the lab network.

**U.S. Government Purpose Release****Network Management and Monitoring System for Delay/Disruption-Tolerant Networks GSC-17596-1**

This software allows a user to manage and monitor a challenged network of remote nodes.

**Open Source****NEXUS: Deep Data Platform****NPO-50157-1**

NEXUS provides a bridge between science data and horizontal-scaling data analysis. It provides a workflow to divide science artifacts into small data tiles to store in a cloud-scaled database where they can be quickly retrieved through a high-performance spatial search registry. Through spatial index, NEXUS provides fast access to all relevant data tiles where each tile fits into RAM for fast in-memory computation.

**Open Source****Nivis ISA100.11a Radio Driver Software for TI Microcontroller****MSC-25408-1**

Through a serial peripheral interface (SPI) port, this software allows a microcontroller to interact with a Nivis VN210 radio running an ISA100.11a stack.

**U.S. Government Purpose Release****Non-binary Protograph-Based LDPC Codes for Short Block Lengths****NPO-48673-1**

The design method for short blocks is based on ensuring large enough girth and a suitable edge label assignment to achieve a good code minimum distance. This effort uses the circulant PEG algorithm such that the girth is as large as possible.

**U.S. Government Purpose Release**

## **Oceanographic Data Management and Archive System**

**NPO-47934-1**

The Physical Oceanography Distributed Active Archive Center (PO.DAAC) is the center for oceanographic data for the NASA Earth Science Data and Information System (ESDIS). The primary function of PO.DAAC is to ingest, validate, archive, and distribute oceanographic artifacts.

**Open Source**

## **Open GeoSocial Consumer Application**

**GSC-17162-1**

This software interface provides a social and collaborative environment to allow end-users to discover, visualize, and access Earth science information on demand from simple browsers and share the resulting products with their friends and/or community of interest through social networks.

**Open Source**

## **OS/Comet to ISP Bridge Software**

**MSC-25344-1**

This product provides a software interface to bridge the Harris OS/Comet command and telemetry system to the Information Sharing Protocol (ISP) tool.

**U.S. Government Purpose Release**

## **Performance Logging Services (PLS)**

**KSC-12343**

Working in real time and using very little memory and CPU, Performance Logging Services (PLS) is an innovative software-performance monitoring tool that tracks statistics on timing and buffer usage. To assist in troubleshooting, PLS will start or stop other software tools when performance requirements are out of specification. The technology has been used in the Checkout and Launch Control System on NASA's Space Shuttle program.

**General Public Release**

## **Perl 6 DBPg PostgreSQL Module**

**GSC-18031-1**

PostgreSQL is an open-source relational database management system. This module provides a rich interface to the PostgreSQL libpq library for Perl 6. It includes capabilities for prepared query caching, database connection caching, exception handling, flexible type conversion (including Boolean, date, date/time, byte arrays, etc.), bulk data copy in and out, listen/notify, transactions, and cursors for large query processing.

**Open Source**

## **Perl 6 Epoll**

**GSC-18030-1**

This simple wrapper exposes the Linux Epoll(7) I/O event notification facility within Perl 6.

**Open Source**

## **Perl 6 Eredis Bindings Module**

**GSC-17829-1**

These Perl 6 bindings and modules are for interacting with the Redis database system.

**Open Source**

## **Perl 6 GraphQL**

**GSC-17798-1**

A Perl 6 implementation of the Facebook GraphQL standard query language is described in detail at:

<http://graphql.org/>

**Open Source**

## **Perl 6 LibCurl**

**GSC-17847-1**

This module is a Perl 6 interface to the C LibCurl library. It includes Perl 6 native call bindings for accessing functionality and an object-oriented layer on top.

**Open Source**



**Protograph-Based Raptor-Like Codes****NPO-48128-1**

In many applications such as hybrid automatic repeat request (HARQ), rate-compatible family members must have the same information block size. These codes have this property.

**U.S. Government Purpose Release****Remote Memory Access Protocol Target Node****GSC-16467-1**

This NASA technology provides SpaceWire design users with support for executing remote memory access protocol (RMAP) read and write commands. The target IP core is a VHDL description suitable for implementation in a field-programmable gate array (FPGA) or an application-specific integrated circuit (ASIC).

**U.S. Release Only****Router Agent Technology for Policy-Based Network Management****NPO-47228-1**

A fully functional version of this standalone application has been implemented for the Windows operating system and for CISCO routers, and it has already been deployed in real world at APL and DISA test sites.

**U.S. Government Purpose Release****S-Band POSIX Device Driver for RTEMS****NPO-47496-1**

This device driver runs using the POSIX real-time operating system package to provide a FPGA interface to the S-Band hardware for the CoNNeCT experiment. Instead of interacting with hardware devices directly using direct-memory mapped access at the application level, the driver provides an API offering easy-to-use standard POSIX function calls.

**U.S. Government Purpose Release****Semantic Text Mining and Annotation for Information Extraction and Trend Analysis Tool (STAT)****MSC-24614-1**

The Semantic Trend Analysis Tool uses linguistic analysis software and an ontology to extract new dimensions in data records that contain natural language text fields. Text fields in problem report data records (e.g., discrepancy reports, problem reports, corrective-action reports, and software change reports) might contain information that is critical to finding trends and groupings of recurring problems. STAT overcomes problems with scoping by linking up meaningful phrases that could be separated by text (e.g., “not aligned” versus “not completely aligned”). STAT’s use of hierarchical ontologies overcomes the limitations of data codes, which are flat, closed, and have small sets of values that are often difficult to interpret. The ontology organizes aerospace terminology in hierarchies of types of problems, properties, objects, and functions. The tool identifies and tags types of problems and equipment mentioned in text fields, thereby providing new data files for record keeping. These new data files support text mining and clustering, report generation, browsing, and search at various levels of abstraction.

**U.S. Release Only****Shared Memory Framework for Distributed Processing of Models and Simulation on a Linux Host with Virtual Machines****MFS-32970-1**

This NASA innovation implements distributed model processes with shared memory data exchange across virtually hosted operating systems.

**U.S. Release Only****Simple Subset Wizard****GSC-16375-1**

The Simple Subset Wizard (SSW) makes searching for granules easier. The tool unites the search function with various subsetters to deliver a single, simple, seamless process. SSW uses OpenSearch to query the Earth Observing System Clearing House (ECHO) for granules and then employs individual subset agents to submit requests. The SSW currently has 11 agents to interface with different subsetters, which support the subsetting of 217 EOSDIS data sets. The SSW provides the capability to subset by either temporal range or spatial region, although not all subsetters have both of these capabilities.

**Open Source**

### **Simple, Scalable, Script-Based Science Processing Archive (S4PA)**

**GSC-15877-1**

Simple, Scalable, Script-Based, Science Processing (S4P) Archive (S4PA) is a disk-based archiving system for remote sensing data. The tool can be used for new data transfer, data preprocessing, metadata generation, and data archival. Services provided include data access control, data subscription, metadata publication, and data recovery. All data are archived on readily available disk drives, with FTP and HTTP being the primary modes of data access. S4PA includes a graphical user interface for monitoring and re-configuring system operation.

**Open Source**

### **Software Suite to Support In-Flight Characterization of Remote Sensing Systems**

**SSC-00393**

A software suite, developed to support NASA's in-flight characterization of commercial remote sensing systems, efficiently automates reproducible processing of ground truth data. It is unique in that it takes input from a number of disparate data sources and condenses and rapidly processes it to a form useable by the characterization process.

**General Public Release**

### **Space Station Research Explorer (SSRE), Version 5.0**

**MSC-26214-1**

The Space Station Research Explorer provides current information on ISS experiments and facilities/researches results. The Research Explorer consists of five different sections: Experiments, Facilities, Benefits, Interactive Media, and Links.

**General Public Release**

### **Spatial Query for Planetary Data**

**NPO-46637-1**

This software implements the R+ tree approach for searching databases. Conventional databases of planetary datasets are indexed and searchable by various metadata such as acquisition time, phase of mission, and target.

**U.S. Government Purpose Release**

### **SpF: A Software Framework for Pseudospectral Numerical Simulation at Extreme Scales**

**GSC-16918-1**

The goals of the Spectral Framework are to: (1) reduce complexity and duplication of effort across multiple investigation teams; (2) achieve near-optimal scalability on existing computing architectures; (3) provide automation for domain decomposition and load balancing that circumvent hardwired constraints in existing applications; (4) offer automated and optimized global data "transposes" that dominate compute time for large problems; (5) provide access to optimized numerical libraries including libraries implemented on hardware accelerators; and (6) deliver a flexible/optimized input/output layer.

**U.S. Government Purpose Release**

### **STAMiNA**

**NPO-45213-1**

Utilizing STAMiNA, a simulation tool for the Advanced Sensors Collaborative Technology Alliance Microsensor Network Architecture, users can define: (1) mission environment including terrain features; (2) a sensed object set including multiple threat objects; (3) sensor placements, their modalities, and their abilities to sense different object types; (4) threat object trajectories; (5) sensing and sensed data dissemination for information fusion; and (6) various network configurations and formations between sensors to examine the coupling of sensing and communication. With these features, STAMiNA provides an overall system-level performance of different sensor network architectures under different parametric conditions.

**U.S. Government Purpose Release**



**State Chart Autocoder****NPO-47810-1**

This NASA technology automatically generates code from UML/SysML state-machine models specified in the MagicDraw modeling tool. Input is saved as XML data files, and output is provided by the state-machine implementation code in C, C++, Python, or Promela. A test suite validates output products, and a test harness allows a developer to execute and animate a model with a graphical state-machine monitor. This monitor can run as either a standalone tool or as an Eclipse plug-in to MagicDraw.

**U.S. Government Purpose Release****Synchronization, Archival, Validation, and IP Exchange (Save)****ARC-16445-1**

Save is a high-availability framework that manages IP addresses shared between multiple servers. It also monitors the health of those servers to determine which one should be actively servicing requests at any given time. Synchronization mechanisms allow configuration files to be kept consistent between systems and also allow commands to be executed across all servers of a particular type. Archival mechanisms provide automatic version control of configuration files to aid in recovery in case of errant configuration.

**Open Source****Synchronous Communications Bus 1553****GSC-16265-1**

This application programming interface acts as a synchronous communications mechanism to pass data, allowing both sides of a transaction to communicate over the bus.

**U.S. Government Purpose Release****User-Friendly Metadata****GSC-15014-1**

The User-friendly Metadata (UFM) tool functions as a filter. The tool accepts an ODL file as input and generates a simple HTML representation of the ODL as output. Command-line options provide a user with the ability to modify the program's functionality. Please visit: <http://opensource.gsfc.nasa.gov/projects/UFM/index.php>

**Open Source****Visualizing Acquisition, Processing, and Network Statistics Through Database Queries****NPO-47889-1**

Given a date range and various other search criteria, this software queries the UAVSAR MySQL database for data acquisition, processing, and network statistics. These are visualized in a Web browser using HTML, CSS, JavaScript, Perl, and the Google Charts API. The data acquisition and processing information are automatically populated into the database once new data are acquired or processed.

**U.S. Government Purpose Release**



# 3

## Materials and Processing

Parts, Manufacturing, Production Processes,  
Composites





## Featured Software

### Acoustic Emission Analysis Applet (AEAA) Software

LEW-19032-1

This post-processing software tool has been tailored for the novel analysis of composite pressure vessels acoustic emission (AE) data. The software can be used with data acquired from Digital Wave, Inc., and Mistras Group (Physical Acoustics, Inc.) hardware.

**U.S. Release Only**

### Composite Damage (CompDam) Progressive Damage Analysis Software

LAR-18832-1

CompDam predicts damage onset, damage progression, and collapse of structures manufactured of fiber-reinforced plastic laminates. The modeling of damage progression is undertaken at the meso-scale, where each ply of a laminate is represented as a homogeneous orthotropic continuum. All of the composite damage mechanisms (matrix cracking, fiber breaking and kinking, and delamination) and their interactions are represented. The CompDam software is implemented as user-written subroutines for use with the Abaqus commercial finite element code.

**Open Source**

### Parallel Grand Canonical Monte Carlo Simulation Code (ParaGrandMC)

LAR-18773-1

ParaGrandMC is a highly parallelized code in FORTRAN for (1) simulating the thermodynamic evolution of metal alloy systems at the atomic level and (2) predicting their thermodynamic state, phase diagram, chemical composition and mechanical properties. The approach is based on evolving an initially given atomic system (defined through a list of atomic coordinates of all participating atoms) using a Monte Carlo algorithm. The algorithm is based on repeated random sampling of configuration space using the classical Boltzmann probability distribution.

**U.S. Release Only**

### Ray-Tracing Math Model

KSC-12835

The Ray-Tracing Math Model will predict the intensity of infrared heat energy that can be projected from a halogen lamp or a cluster of lamps. While NASA utilized the tool in the Space Shuttle Program, the application can be extended to accommodate other optical and acoustic ray-tracing applications. The current version of the technology assumes ideal parabolic surfaces and reflectors.

**General Public Release**

### Scalable Implementation of Finite Elements by NASA (SciFEN)

LAR-18720-1

The SciFEN package, a parallel finite element analysis code written in C++, enables scalable solutions to computational mechanics problems by leveraging several open-source high-performance computing libraries for numerical linear algebra routines and parallel input/output. SciFEN supports several different finite element types, nonlinear material models, and boundary conditions and contains both implicit (SciFEi) and explicit (SelfEx) time integration procedures.

**U.S. Release Only**



**Abaqus User Subroutine Verification (abaverify)****LAR-18938-1**

abaverify is a collection of Python scripts that is used for testing and verifying the behavior of user subroutines for the commercial finite element code Abaqus.

**Open Source****Acoustic Emission Analysis Applet (AEAA) Software****LEW-19032-1**

Post-processing software has been developed at NASA that is tailored for novel analysis of composite pressure vessel acoustic emission (AE) data. The software can be used with data acquired from Digital Wave, Inc., and Mistras Group (Physical Acoustics, Inc.) hardware.

**U.S. Release Only****Blackbody VBA Excel Functions****DRC-015-017**

In the analysis of radiation, it is helpful to be able to predict the heat transfer rate and the spectral distribution of emitted energy. This set of routines is written in Microsoft Visual Basic for Applications (VBA) and incorporates functions specific to Microsoft Excel that are useful for predicting the radiative behavior of heated surfaces. These routines include functions for calculating important engineering quantities of primary importance to engineers and scientists such as radiative flux and spectral distributions.

**Open Source****Composite Damage (CompDam) Progressive Damage Analysis Software****LAR-18832-1**

This software predicts damage onset, damage progression, and structural collapse of structures manufactured of fiber-reinforced plastic laminates. The modeling of damage progression is undertaken at the meso-scale, where each ply of a laminate is represented as a homogeneous orthotropic continuum. All composite damage mechanisms (matrix cracking, fiber breaking and kinking, and delamination) and their interactions are also represented. The software is implemented as user-written subroutines for utilization with the Abaqus commercial finite element code. Input for CompDam includes ply-level material properties and interface properties obtained from standard material characterization tests.

**Open Source****Floating Node Method Composites Simulation Toolbox (FNMCSST)****LAR-19000-1**

The FNMCSST toolbox is a research code used to investigate and develop a high-fidelity numerical approach and advanced physical models to simulate damage progression in composite materials in 3D with high fidelity.

**U.S. Release Only****Materials and Processes Technical Information System (MAPTIS-II)****MFS-32206-1**

The Materials and Processes Technical Information System (MAPTIS-II) is an information technology that offers a number of services for acquiring, processing, and disseminating information about materials, materials properties, materials processes, and manufacturing. Content includes materials test results from legacy systems, design allowables, and other online products. The MAPTIS-II technology provides ready access to accurate data using standard computers, software, and the Internet.

**U.S. Government Purpose Release**

**Parallel Grand Canonical Monte Carlo Simulation Code (ParaGrandMC)****LAR-18773-1**

ParaGrandMC is a highly parallelized code in Fortran for simulating the thermodynamic evolution of metal alloy systems at atomic level and predicting their thermodynamic state, phase diagram, chemical composition, and mechanical properties. The approach evolves an initially given atomic system (defined through a list of atomic coordinates of all participating atoms) using a Monte Carlo algorithm. The algorithm is based on repeated random sampling of the configuration space of the system using the classical Boltzmann probability distribution. In the process, internal variables of the system (i.e., system energy, internal pressure, and system size) are reported periodically. Atomic configurations, in terms of coordinates of all atoms, are stored periodically for a post-processing analysis. The algorithm uses MPI (message passing interface) to work on multi-core CPU platforms.

**U.S. Release Only****Porous Microstructure Analysis (PuMA)****ARC-17920-1**

Micro-tomography has become a very useful tool for material science applications, allowing for non-destructive characterization of a material micro-structure at a sub-micron scale. The PuMA software computes effective material properties and performs material response simulations on digitized microstructures of porous media. PuMA is able to import digital three-dimensional structures obtained from X-ray microtomography, generate artificial microstructures, and visualize the 3D microstructure. The software includes modules to compute porosity, volume fractions, surface area, tortuosity factor, effective thermal conductivity, and effective electrical conductivity, as well as perform representative elementary volume analysis.

**U.S. and Foreign Release****Scalable Implementation of Finite Elements by NASA (SciFEN)****LAR-18720-1**

The SciFEN package is a parallel finite element analysis code that enables scalable solutions to computational mechanics problems by leveraging several open-source high-performance computing libraries for numerical linear algebra routines and parallel input/output. SciFEN supports different finite element types, nonlinear material models, and boundary conditions and contains both implicit and explicit time-integration procedures called SciFEi and SciFEx, respectively.

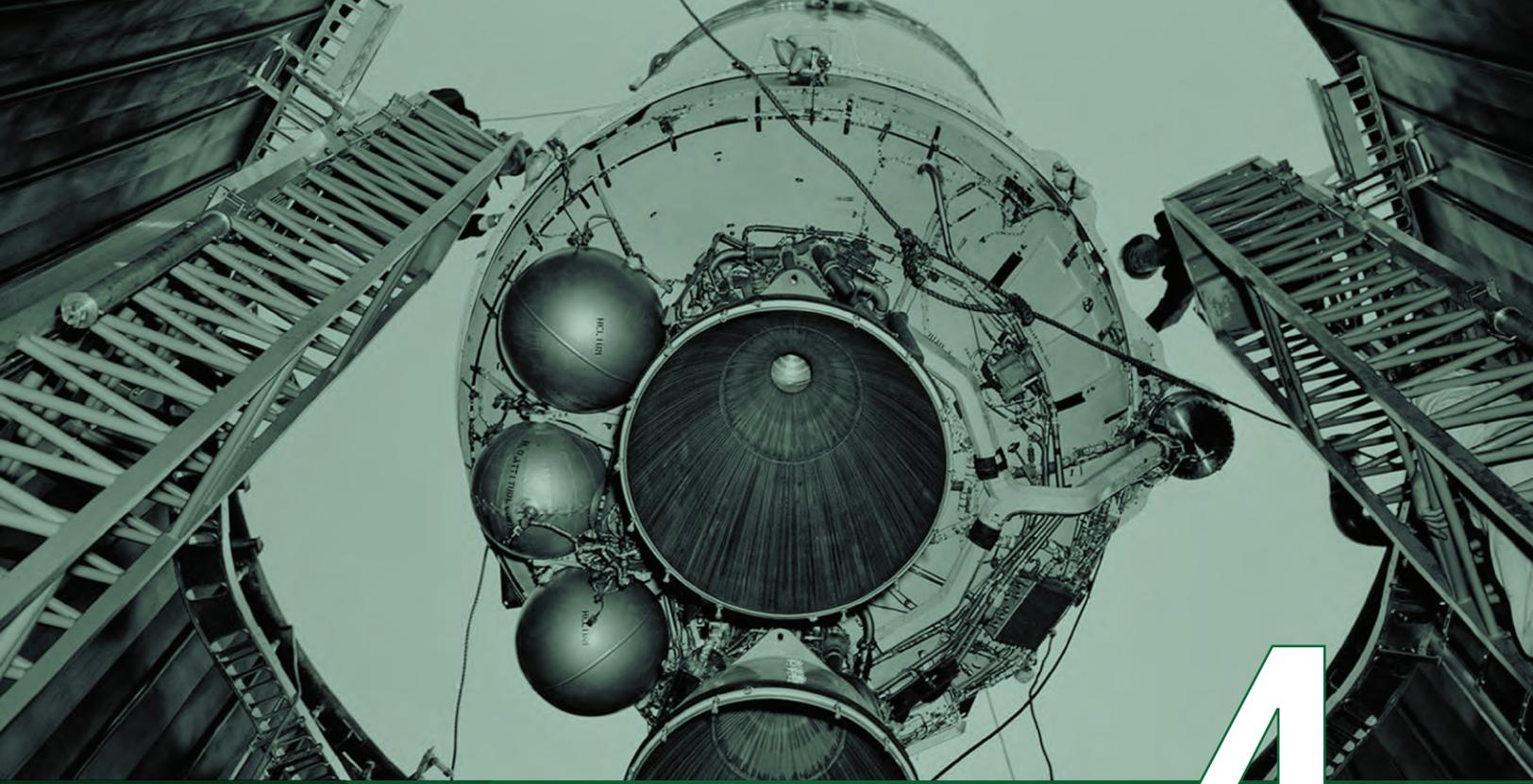
**U.S. Release Only****Surface Crack Potential Difference (SCPD) Software****MFS-32848-1**

The Surface Crack Potential Difference (SCPD) monitoring software provides the precise relationship between a crack measurement signal and the size of an arbitrary semi-elliptical crack.

**U.S. Government Purpose Release****Tool for Analysis of Surface Cracks (TASC)****MFS-33082-1**

Created using the commercial math analysis software MATLAB, TASC enables the easy computation of nonlinear J-integral solutions for surface-cracked plates in tension by accessing and interpolating between the 600 nonlinear surface crack solutions documented in NASA/TP-2011-217480. The only required inputs to the program are the surface crack dimensions, plate cross-section dimensions, and material properties. TASC provides a convenient and easy-to-use interface for the solution set that allows a novice user to obtain a fast and reliable fracture toughness solution.

**Open Source**



# 4

## System Testing

Acoustics, Shock, Vibration, Thermal Vacuum, Leak and Pressure Testing, Test Criteria, Test Management and Planning, Aerodynamic Testing





## Featured Software

### **LEWICE 3.2.2 Ice Accretion Software**

**LEW-18573-1**

LEWICE contains an analytical ice accretion model that evaluates the freezing process thermodynamics that occur when super-cooled droplets impinge on a body. Both atmospheric parameters (i.e., temperature, pressure, and velocity) and meteorological parameters (i.e., liquid water content, droplet diameter, and relative humidity) are used to determine the shape of the ice accretion.

**U.S. Release Only**

### **OTIS 4: A Trajectory Optimization Computer Code**

**LEW-18319-1**

OTIS 4 is a Fortran program designed to simulate and optimize trajectories of launch vehicles, aircraft, satellites, and interplanetary vehicles. The software is restricted by export control, specifically ITAR.

**U.S. Government Purpose Release**

### **RTD Radial-Inflow Turbine Conceptual Design Code**

**LEW-17453-1**

The RTD code executes a conceptual design for a single-stage radial-inflow turbine. A mean-line analysis is performed for the locations having constant radius over the blade span. Constant span-fraction sectors are used at the rotor exit. The analysis can account for stator end-wall clearance flow and swept rotor blades. The loss model includes stator and rotor passage losses, trailing-edge losses, vaneless space loss, disk-friction loss, and rotor-exit clearance loss.

**U.S. Release Only**

### **System Identification Programs for AirCraft (SIDPAC)**

**LAR-16100-1**

Written in MATLAB, SIDPAC is a collection of over 300 programs that perform a wide variety of tasks related to system identification applied to aircraft. SIDPAC includes tools for experiment design, data analysis, kinematic consistency checking, static and dynamic modeling, simulation, numerical integration and differentiation, smoothing, filtering, finite Fourier transformation, statistical modeling and evaluation, optimization, parameter estimation, model accuracy quantification, model validation, and more.

**General Public Release**

### **TCGRID**

**LEW-17635-1**

TCGRID is a three-dimensional grid-generation code for turbomachinery blades. The software can generate single- or multi-block grids that are compatible with several computational fluid dynamics (CFD) analysis codes, including SWIFT and ADPAC.

**U.S. Release Only**



### **Acoustic Propagation and Emulation Toolset (APET)**

**LAR-17761-1**

The Acoustic Propagation and Emulation Toolset (APET) is a framework code uniting several acoustic methodologies for the propagation and measurement of source noise audibility at farfield observers, accounting for the effects of the atmosphere, weather, terrain, and spherical spreading. Currently, APET consists of a modified version of the Rotorcraft Noise Model (RNM, Version 7) coupled with the newly developed Spectral Attenuation Method (SAM) that contains the Ray Tracing Program (RTP) and two versions of a Greens Function Parabolic Equation (GFPE) code. A third component of APET is an audibility prediction scheme based on the work of Abrahamson, initially called ICHIN (I Can Hear It Now) and further developed by Wyle Labs as AUDIB.

**U.S. Release Only**

### **Advanced Acoustic Model, Version 2 (AAM2)**

**LAR-19004-1**

AAM is a computer program that calculates community noise from aircraft flight operations. It is a simulation model computing time histories of noise for arbitrary vehicle flight operations. The model can accommodate multiple noise sources (rotors, engines, airframe, etc.), each represented by a sphere of spectral data at a reference distance. Propagation to the ground accounts for spherical spreading, atmospheric absorption, ground impedance effects, and weather effects. Spectral levels and a variety of community noise metrics are computed and can be plotted on a flat ground or non-flat terrain.

**General Public Release**

### **Advanced Subsonic and Supersonic Propeller Induced Noise (ASSPIN) Prediction Program**

**LAR-17590-1**

ASSPIN is a computer program that predicts the noise generated by propellers operating at subsonic, transonic, or supersonic helical tip speeds in either single-rotation or counter-rotation mode. The format of blade surface pressure data obtained from aerodynamic codes for ASSPIN input is generally not compatible with that required by ASSPIN. The ASP\_Tools suite provides the capability to manipulate blade geometry and surface pressure data to produce proper ASSPIN input. In addition, the ability to parse ASSPIN output files and obtain specific output variables is provided.

**U.S. Release Only**

### **AirShow 1.1.1**

**LEW-17228-1**

The AirShow software package enables 3D visualization of computational meshes and computed flow-field data associated with computational fluid dynamics (CFD). The program displays structured grid blocks and computational grid planes.

**U.S. Release Only**

### **Arbitrary Accuracy Nonlinear Euler Solver**

**LEW-17465-1**

This NASA-developed code is the first in the world to solve the nonlinear Euler equations to at least 15th-order accuracy in space and time in two dimensions. It is capable of even higher order accuracy if sufficient computer precision is available.

**U.S. Release Only**

### **Automated Camera Calibration Software (ACCS)**

**NPO-41312-1**

Using collected metrology data, the ACCS system significantly increases the efficiency of the entire camera calibration process, resulting in reduced costs and turnaround time. Even in extreme conditions, the tool performs calibrations with minimal user input.

**U.S. Government Purpose Release**



**Booster Launch Operations Center (BLOC) Custom Software****MSC-25367-1**

The Booster Launch Operations Center provided NASA with real-time monitoring of the space shuttle's integrated testing while it was in the Vehicle Assembly Building (VAB) or on the launch pad. USA Design Engineering manned the facility and used this software to monitor the solid rocket booster subsystems (i.e., range safety, electrical and instrumentation, and thrust vector control) using a data feed from the main firing room.

**U.S. Government Purpose Release****CARES/LIFE****LEW-16018-1**

This NASA software was developed to predict the reliability and life of structures made from advanced ceramics and other brittle materials (e.g., glass, graphite, and intermetallics).

**U.S. Release Only****Channel Emulator****LEW-19351-1**

The Channel Emulator (CE) is a software-based network testing tool. Its primary functions include providing data framing services, acting as a flexible protocol gateway, and providing network emulation capabilities.

**Open Source****Coldfire SDN Hardware Diagnostics****GSC-15478-1**

The Coldfire SDN Diagnostics Software is a flexible framework used to exercise, test, and debug custom hardware. The tool can be used on multiple NASA projects and can be customized using different processors and interfaces. This version of the technology is configured for the Coldfire processor on the SDO SDN processor boards.

**U.S. Government Purpose Release****Coupled Structural, Thermal, Acoustic, Electromagnetic (CSTEM) Analysis****LEW-17052-1**

CSTEM is a UNIX executable for coupled structural, thermal, acoustic, and electromagnetic analysis and optimization.

**U.S. Release Only****Data Viewer for Handheld Device/Computer for 3-Axis Acceleration and Attitude Measurements During Spaceflight****MSC-26185-1**

This software/program allows data retrieval, viewings, and analysis from a commercial-off-the-shelf (COTS) handheld device/computer that measures 3-axis accelerations during flight testing. Data and analysis of accelerations are important for phenomena and systems that are sensitive to gravity, such as multiphase fluid flow (e.g., gas and liquid concurrent flows). These data measurements are required for parabolic, suborbital, and/or space testing and operations to evaluate research and hardware under the dynamic and different test/operational environments in zero- and/or low-gravity. The current data viewer configuration was developed using the COTS Labview Runtime Engine executable available for free download from the National Instruments Web site: <http://www.ni.com/download/labview-run-time-engine-2012/3433/en/>

**U.S. Government Purpose Release****Defect Detection and Prevention (DDP)****NPO-20741-1**

DDP evaluates criticality by generating a tree of failure modes and a tree of requirements and then evaluating the impact of each failure mode on each requirement.

**U.S. Government Purpose Release**

### **Development of Automated Structural Health Monitoring and Qualification Methods and Software for Composite Overwrapped Pressure Vessels**

**MSC-25421-1**

NASA has integrated industry-standard and new, novel analysis methods for assessing the structural health of composite overwrapped pressure vessels (COPV). By significantly increasing throughput, the software has the ability to provide real-time assessments. Adaptive analysis methods have been incorporated into the technology to provide modal analyses at specified points of a structure's life (e.g., loading, unloading, and dwells), thereby increasing the tool's utility and ease of use for acoustic emission testing.

**U.S. Government Purpose Release**

### **Fan Broadband Noise Prediction Code**

**LEW-17279-1**

This NASA-developed technology predicts the dipole and quadruple noise that results from the interaction of anisotropic homogeneous turbulence with a rotor or stator.

**U.S. Release Only**

### **Fast Scattering Code (FSC), Versions 3.1 and 3.2**

**LAR-17828-1**

The Fast Scattering Code (FSC) is a computer program designed to predict the scattered acoustic field that results from the interaction between a known incident sound and arbitrary three-dimensional surfaces immersed in a potential background flow. The technology is based on the equations of time-harmonic, linearized acoustics and employs equivalent sources for solving an exterior Helmholtz equation boundary value problem (BVP). The incident sound can be generated by the FSC using a collection of simple point multipoles (monopoles and dipoles), or it can be provided by the user from other prediction codes. Predictions for high-frequency/large-scale combinations yield linear systems with millions of unknowns and memory requirements beyond the capabilities of most advanced computer systems to date. The computational engine of the FSC has been totally redesigned to alleviate the frequency limitations of the code by employing numerical algorithms that drastically reduce computer resource utilization and take advantage of multiprocessor platforms.

**U.S. Release Only**

### **Formal Interactive Verification Environment for the Plan Execution Interchange Language (PLEXIL5)**

**LAR-19339-1**

PLEXIL is an open-source synchronous language developed by NASA for commanding and monitoring autonomous systems. PLEXIL5 is a tool that implements the formal executable semantics of PLEXIL. PLEXIL5 includes a graphical interface that enables access to formal verification techniques such as model-checking, symbolic execution, theorem proving, and static analysis of plans. The graphical environment supports formula editing and visualization of counter examples, interactive simulation of plans at different granularity levels, and random initialization of external environment variables.

**Open Source**

### **GRAPE.107**

**LEW-16851-1**

GRAPE is a two-dimensional elliptic grid generation code to be used with isolated airfoils. This modified version of the software (with application for turbomachinery blades) can generate grids for the RVCQ3D turbo-machinery analysis code.

**U.S. Release Only**

### **HemoDose Software, Version 2.0**

**MSC-26186-1**

HemoDose estimates the absorbed dose of radiation in adults by using single or serial counts of granulocytes, lymphocytes, leukocytes, or platelets after exposure.

**General Public Release**



### High-Performance Modeling and Simulation of Anchoring in Granular Media for NEO Applications

**NPO-48332-1**

In this effort, using Chrono::Engine, a simulation package capable of utilizing massively parallel GPU hardware, several validation experiments were performed. NEO regolith interactions were modeled, followed by the performance and analysis of anchor tests. The ultimate outcome of the task: a study that includes an analysis of one helical anchor, along with a recommendation on which design is better suited for anchoring on a NEO.

**U.S. Government Purpose Release**

### IceVal DatAssistant

**LEW-18343-1**

This NASA-developed technology provides an improved mechanism for managing the large volume of data generated and utilized in performing icing research.

**U.S. Release Only**

### International Space Station (ISS) Systems Integration Laboratory (ISIL)

**MSC-24341-1**

This NASA-developed software provides an open-source framework that consolidates ISS laboratory test functions. The technology automates the start-up process of the large ISIL test rig (including configuration validation) and provides test engineers with Web access to recorded test data for post-test analysis.

**U.S. Government Purpose Release**

### Jet Noise Prediction Code (JeNo 2.5D)

**LEW-18199-2**

JeNo is a Fortran 90 computer code that evaluates the far-field turbulence-generated noise in non-axisymmetric jets. The propagation Green's function is calculated along a user-specified azimuthal angle (line of sight), but source volume integration is carried out in 3D. The user must provide a structured computational grid in a polar coordinate system and also input a mean flow solution from a Reynolds-averaged Navier Stokes (RANS).

**U.S. Release Only**

### Jet Noise Prediction Code (JeNo)

**LEW-18199-1**

JeNo is a Fortran 90 computer code that calculates the far-field sound spectral density produced by axisymmetric jets at user-specified observer locations and frequency ranges. The user must provide a structured computational grid and also input a mean flow solution from a Reynolds-Averaged Navier Stokes (RANS).

**U.S. Release Only**

### JPF-NAS: An Extension of Java Pathfinder Supporting Model-Checking Distributed Systems

**ARC-17301-1**

JPF-NAS is implemented as a JPF extension that models interprocess communication mechanisms. It uses a form of partial-order reduction to explore all possible executions of a distributed Java application. JPF-NAS provides the functionality to check a given distributed application under test against possible network failures that can occur at the operating system or the hardware layer.

**Open Source**

### Lag Model: A Turbulence Model for Attached and Separated Flows

**ARC-14645-1**

This NASA-developed technology includes a set of partial differential equations that augment the Reynolds-averaged Navier-Stokes equation. By providing a mechanism that allows flow history to affect turbulence stresses, Lag Model mimics underlying physical processes to provide an improved turbulence model for flows with separation.

**U.S. Government Purpose Release**



**LEWICE 3.2.2 Ice Accretion Software****LEW-18573-1**

LEWICE contains an analytical ice accretion model that evaluates the freezing process thermodynamics that occur when super-cooled droplets impinge on a body. Both atmospheric parameters (i.e., temperature, pressure, and velocity) and meteorological parameters (i.e., liquid water content, droplet diameter, and relative humidity) are used to determine the shape of the ice accretion.

**U.S. Release Only****LINFLUX: 3D Linearized Unsteady Aerodynamic Analysis****LEW-17346-1**

LINFLUX is a three-dimensional, linearized, unsteady aerodynamic analysis (and code) that can be used to predict the aero-acoustic/aero-elastic responses of axial-flow turbo-machinery blade rows to aerodynamic/structural excitations.

**U.S. Release Only****Memory Circuit Fault Simulator****NPO-48591-1**

In this effort, an initial and final logical pattern are compared and any possible errors are noted. Memory performance is based on the output pattern either matching or being a deterministic result of the input pattern.

**U.S. Government Purpose Release****MERIDLN****LEW-16369-1**

MERIDLN is a Fortran program for calculating velocities/streamlines of axial-, radial-, or mixed-flow turbo-machinery or annular ducts on the hub-shroud mid-channel stream surface.

**U.S. Release Only****MGBK Jet Noise Prediction Code****LEW-17062-1**

The physics-based MGBK code predicts subsonic and low-supersonic jet mixing noise and shock noise. Predictions are in the form of far-field sound pressure level (SPL) and frequency spectra on an arc or a sideline.

**U.S. Release Only****Multiple Kernel Anomaly Detection (MKAD) Algorithm****ARC-16462-1**

In offline mode, MKAD performs automated anomaly detection on large heterogeneous data sets that contain both discrete symbols and continuous data streams.

**Open Source****Multiple Pure Tone (MPT) Noise Code****LEW-17386-1**

The MPT noise prediction procedure is based on uniform-rotor computational fluid dynamics (CFD) analysis of BPF tonal content in conjunction with engineering (statistical) correlation information of blade-to-blade non-uniformity effects.

**U.S. Release Only****NASA Auralization Framework (NAF)****LAR-18541-1**

NAF is an open architecture for auralization components. It is structured as a set of common building blocks in the form of dynamically linked libraries and will serve as the basis for future auralization capabilities. Libraries for each of the following are provided as part of the framework: the core, Pathfinder, scene generator, synthesis, signal processing, and scheduling. Each library contains a usable but simple set of capabilities.

**General Public Release**

**NASA Auralization Framework Advanced Plugin Libraries (NAF APL)****LAR-19278-1**

NAF is an open architecture for auralization components. It is structured as a set of common building blocks in the form of dynamically linked libraries. Each library contains a usable but simple set of capabilities. The NAF APL provides additional means for source noise synthesis, propagation effects, and interfaces to NASA's Aircraft Noise Prediction Program 2 (ANOPP2).

**General Public Release****NDE Wave & Image Processor (NDEWIP), Version 3.0****LEW-18640-1**

The NDE Wave & Image Processor software application has been created to provide a state-of-the-art, comprehensive, integrated science-based tool for the advanced visualization, processing, and analysis of NDE and health-monitoring waveform- and image-based data. With NDEWIP, the user has access to a complete post-processing capability in a single tool. Although the software has been developed for the NDE professional, the technology could be used for any other RF signal or image processing and analysis application.

**U.S. Release Only****NESSUS 6.2C****LEW-18229-1**

The NESSUS 6.2c computer program is a set of separate but related modules for solving a wide range of component and system probabilistic and reliability problems, including finite element analysis, heat transfer analysis, geometry generation, and ceramic material property generation.

**U.S. Release****OnlyOXIMAP: A Model for the Oxidation of C/SiC Composite Structures****LEW-18212-1**

The OXIMAP software has been used to analyze the oxidation behavior of carbon-fiber-reinforced composite structures.

**U.S. Release Only****PathDroid****ARC-17293-1**

PathDroid is an extension of the open-sourced Java Pathfinder (JPF) verification framework that supports checking binary Android applications for the absence of software defects such as unhandled exceptions and deadlocks. PathDroid lets users run applications on development platforms without the need for hardware-in-the-loop or availability of sources.

**Open Source****Payloads and Components Real-Time Automated Test System (PACRATS)****MFS-31383-1**

The PACRATS data acquisition program allows test engineers to acquire, display, store, and retrieve test data.

**U.S. Release Only****PCSTAGE****LEW-16325-1**

PCSTAGE is simple computational simulation of multi-stage turbo-machinery blade-to-blade flows on a surface of revolution.

**U.S. Release Only****PMES****LEW-18402-1**

The PMESH grid-generation program produces three-dimensional blade-passage meshes for the computational fluid dynamics (CFD) modeling of advanced single- or counter-rotation turboprops and propfans.

**U.S. Release Only**

### **Propulsion Diagnostic Method Evaluation Strategy (ProDiMES), Version 1.0**

**LEW-18371-1**

The Propulsion Diagnostic Method Evaluation Strategy (ProDiMES) provides a standard benchmarking problem and a set of evaluation metrics to enable comparison of candidate aircraft engine gas-path diagnostic methods. The MATLAB-based tool enables users to develop and evaluate diagnostic methods independently.

**General Public Release**

### **Quick Charge-Coupled Device (CCD) Design Code for Centrifugal Compressor**

**LEW-17452-1**

This NASA-developed technology provides a rapid preliminary assessment of the design geometry and the design-point performance of centrifugal compressors. The analysis is based on a one-dimensional flow model with correlations for the following losses: inlet guide vane, rotor inlet shock, incidence, clearance, blade loading, skin friction, disk friction, recirculation, vaneless diffuser skin friction, and vaned diffuser. With input performance, the code can operate in design mode; with input geometry, the code can operate in analysis mode.

**U.S. Release Only**

### **Radial Turbine Off-Design (RTOD) Performance Code**

**LEW-14060-1**

The RTOD code predicts the performance of a single-stage radial-inflow turbine (with either radial or swept rotor blades) as a function of pressure ratio, speed, and stator setting.

**U.S. Release Only**

### **RAT-EDA**

**LEW-18321-1**

This NASA-developed technology is a MATLAB-language computer program for exploratory data analysis. Through the fast post-processing of measured time-series Raman spectral data, RAT-EDA reveals thermo-chemical properties and turbulent-chemistry interactions in combustion. The computer program deduces probability density functions of combustion temperatures using user-selected super-pixel regions for each major species (e.g., O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>, or H<sub>2</sub>O).

**U.S. Release Only**

### **Rotor-Stator Interaction (RSI) Broadband Noise Prediction Code**

**LEW-18131-1**

RSI is a Fortran computer code for calculating the spectrum of broadband noise produced by the interaction of fan-rotor wake turbulence with fan-exit guide vanes (i.e., the stator). Provided with incident-turbulence characteristics, the code computes the spectra of acoustic power upstream and downstream of the stator on a mode-by-mode basis at each frequency of interest. Target frequencies are arbitrary and need not be harmonics of a fan's blade-passing frequency.

**U.S. Release Only**

### **Rotorcraft Noise Model (RNM), Version 7**

**LAR-17753-1**

The RNM simulation model calculates community noise, computing time histories of noise for arbitrary vehicle flight operations. The technology accommodates multiple noise sources (e.g., rotors and engines), each represented by a sphere of spectral data at a reference distance. Propagation to the ground accounts for spherical spreading, atmospheric absorption, ground impedance effects, and limited weather effects.

**General Public**

### **RTD Radial-Inflow Turbine Conceptual Design Code**

**LEW-17453-1**

The RTD code executes a conceptual design for a single-stage radial-inflow turbine. A mean-line analysis is performed for the locations having constant radius over the blade span. Constant span-fraction sectors are used at the rotor exit. The analysis can account for stator end-wall clearance flow and swept rotor blades. The loss model includes stator and rotor passage losses, trailing-edge losses, vaneless space loss, disk-friction loss, and rotor-exit clearance loss.

**U.S. Release Only**



**RVCQ3D.406****LEW-16851-2**

RVCQ3D is a two-dimensional computational fluid dynamics (CFD) analysis code for turbo-machinery (e.g., compressors, turbines, and mixed-flow machines). The technology solves Navier-Stokes equations on a blade-to-blade surface of revolution using explicit finite-difference techniques. Three differencing schemes are available: central differences, AUSM+, and H-CUSP. Three turbulence models are also available: Baldwin-Lomax, Cebeci-Smith, and Wilcox 2006 K-Omega.

**U.S. Release Only****SCISEAL****LEW-16330-1**

This computer program has been used to study the fluid dynamic forces in SEALS.

**U.S. Release Only****Smagglce UNIX, Version 2.0****LEW-17399-2**

The Smagglce software toolkit can be used to create structured grids for single- or multi-element 2D iced airfoils in preparation for computational fluid dynamics (CFD) analysis. Software tools will measure ice shape characteristics, add artificial ice shapes, prepare an ice surface for gridding, perform domain decomposition, create and modify grids, analyze grid quality, and output grids for subsequent input into flow solvers.

**U.S. Release Only****Smagglce Windows, Version 2.0****LEW-17399-1**

The Smagglce software toolkit can be used to create structured grids for single- or multi-element 2D iced airfoils in preparation for computational fluid dynamics (CFD) analysis. Software tools will measure ice shape characteristics, add artificial ice shapes, prepare an ice surface for gridding, perform domain decomposition, create and modify grids, analyze grid quality, and output grids for subsequent input into flow solvers.

**U.S. Release Only****Solar Array Verification and Analysis Tool (SAVANT)****LEW-17681-1**

The powerful, yet easy-to-use SAVANT quick-engineering code calculates the expected radiation damage to solar cells in Earth orbit. The tool contains ten types of solar cells and four types of cover glass. Radiation damage calculations are based on the Displacement Damage Dose method developed at the Naval Research Laboratories.

**U.S. Release Only****Station Power and Energy Evaluation Determiner (SPEED)****MSC-23621-1**

The SPEED application is an analysis tool for the International Space Station electrical power system. Given various scenarios, SPEED produces analysis data for ensuring sufficient power generation for ISS operations. This tool runs on any platform that supports Java Runtime Environment 1.4 or later.

**U.S. Government Purpose Release****SWIFT v.400****LEW-17635-2**

SWIFT is a multi-block computational fluid dynamics (CFD) analysis code for turbo-machinery. The software, which solves Navier-Stokes equations using explicit finite-difference techniques, can be used for linear cascades, isolated blade rows, or multistage machines. Three differencing schemes are available: central differences, AUSM+, and H-CUSP. Three turbulence models are also available: Baldwin-Lomax, Cebeci-Smith, and Wilcox 2006 K-Omega.

**U.S. Release Only**

### **System Identification Programs for Aircraft (SIDPAC)**

**LAR-16100-1**

Written in MATLAB, SIDPAC is a collection of over 300 programs that perform a wide variety of tasks related to system identification applied to aircraft. SIDPAC includes tools for experiment design, data analysis, kinematic consistency checking, static and dynamic modeling, simulation, numerical integration and differentiation, smoothing, filtering, finite Fourier transformation, statistical modeling and evaluation, optimization, parameter estimation, model accuracy quantification, model validation, and more.

**U.S. and Foreign Release**

### **Systematic Sensor Selection Strategy (S4) Software**

**LEW-18815-1**

The Systematic Sensor Selection Strategy (S4) optimally selects a sensor suite from a larger pool of candidate sensors based on their performance in a diagnostic system. S4's user-defined fault-diagnostic approach considers conflicting objectives including cost, weight, and reliability.

**U.S. Release Only**

### **TCGRID v.400**

**LEW-17635-1**

TCGRID is a three-dimensional grid-generation code for turbo-machinery blades. The software can generate single- or multi-block grids that are compatible with several computational fluid dynamics (CFD) analysis codes, including SWIFT and ADPAC.

**U.S. Release Only**

### **TD2 Axial Turbine Design and Performance Code**

**LEW-11029-1**

TD2 performs a streamline analysis that can use meridional velocity gradients to control the radial distribution of work and flow for multistage, multishaft, cooled/uncooled axial-flow turbines. The effects of streamline slope and curvature are included in the radial equilibrium. Hub and tip radii are specified at inlet, at exit, and between each blade row, and velocity diagrams for each stage can be individually controlled. An internal loss correction determines blade-row total-pressure-loss coefficients along the streamlines.

**U.S. Release Only**

### **Tempest**

**LEW-17294-1**

Tempest was created to provide Internet/Intranet connectivity to real-time embedded applications.

**U.S. Release Only**

### **The DEBRIS Code for Tracking Particles with Mass and Drag Through Computational Fluid Dynamics Solutions on Overset Grids**

**MSC-23945-1**

The DEBRIS software performs particle tracking within an overset grid system from a computational fluid dynamics (CFD) solution. The tracking is based on the particle's mass properties and local aerodynamic characteristics within the flowfield. The software allows the user to specify the location and initial conditions for the release of the particle. The code then traces the particle's ballistic trajectory (any lift force is ignored) through the grid system. The resulting trajectory is output to a file that can be viewed/processed as needed.

**U.S. Government Purpose Release**

### **Time-Accurate, Sected, One-Dimensional Reactive Code for Simulation, Prediction, and Control of Combustion Instabilities**

**LEW-17677-1**

This sectored one-dimensional model utilizes a simplified computational fluid dynamics (CFD) algorithm to simulate combustion and acoustic processes (including instabilities) in combustors with complex shapes. Utilizing modest computational resources, the code produces realistic results and is well suited for controls development.

**U.S. Release Only**



**Tone Fan Noise Design/Prediction System (TFaNS), Version 1.4**

**LEW-17063-1**

TFaNS predicts tone noise emanating from a fan stage, including the effects of reflection and transmission by the rotor and stator and by the duct inlet and nozzle.

**U.S. Release Only**

**Tone Fan Noise Design/Prediction System (TFaNS), Version 1.5**

**LEW-17063-2**

TFaNS predicts tone noise emanating from a fan stage, including the effects of reflection and transmission by the rotor and stator and by the duct inlet and nozzle. Version 1.5 upgrades include: the SOURCE3D subprogram's ability to perform transmission-loss calculation for modes scattering into themselves; the inlet and aft radiation codes' use of infinite envelope elements in the far-field; and the AWAKEN subprogram's use of a new Acoustic Wake/Turbulence File format.

**U.S. Release Only**

**TSOINIC**

**LEW-16851-3**

The TSONIC Fortran program calculates the transonic velocity on the blade-to-blade stream surface of a turbo-machine.

**U.S. Release Only**

**uShell: A minimalist Shell for the Xilinx Virtex PPC-Class  
and Microblaze Microprocessors**

**NPO-47495-1**

This software simplifies testing, verification, and validation of future air- and space-based instrument electronics designs.

**U.S. Government Purpose Release**

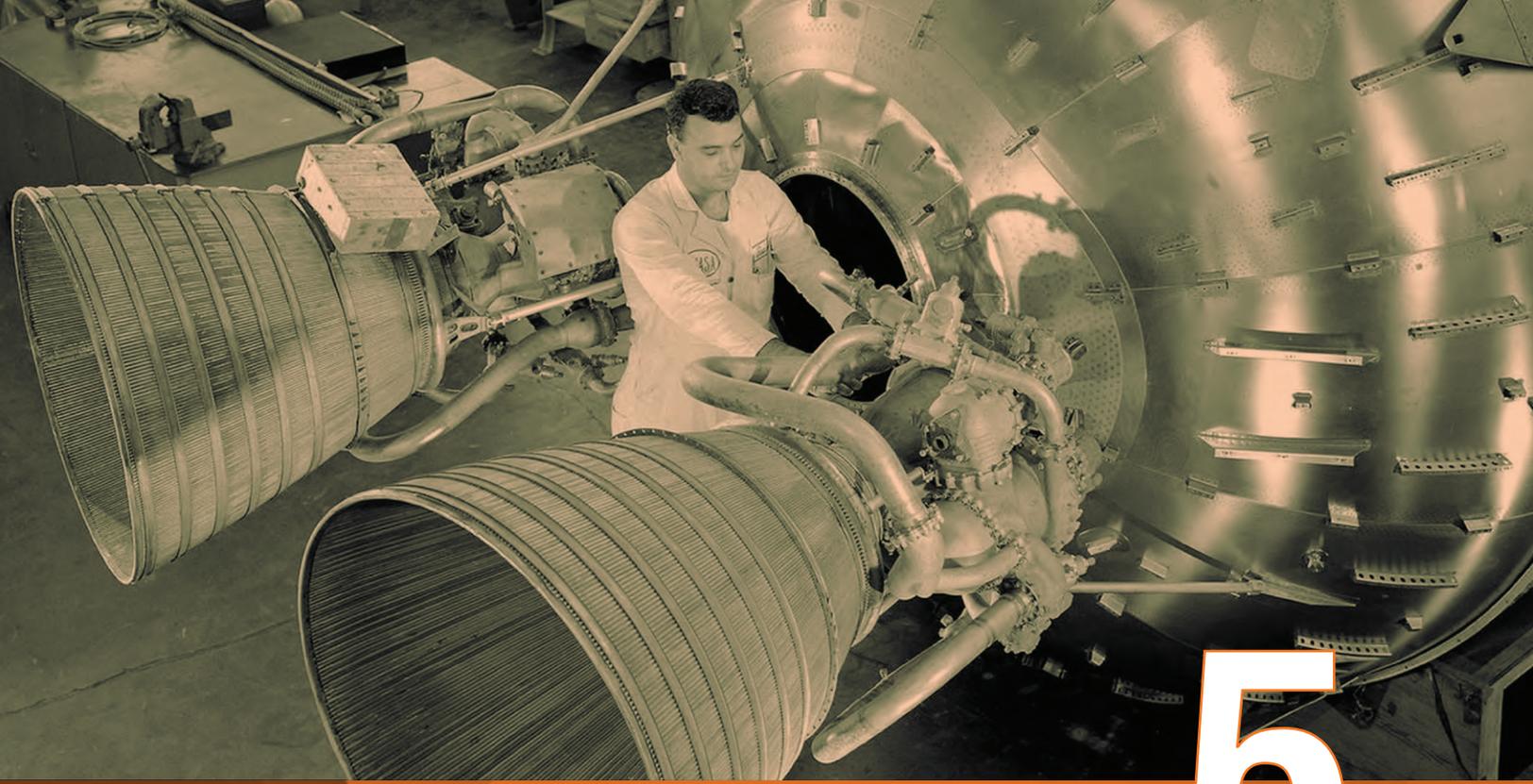
**WOPWOP**

**LAR-16680-GS**

WOPWOP is used for helicopter main-rotor noise prediction. The user must input measured air loads.

**U.S. Release Only**





# 5

## Propulsion

Propellants, Cryogenics, Engine and Motor Performance Analysis



## Featured Software

### **ACD Aerodynamic Design of Multistage Axial-Flow Compressors**

**LEW-17448-1**

ACD is an analysis code used for the aerodynamic design of multistage axial-flow compressors. The technology provides velocity diagrams on the streamlines at the blade-row edges. Blade elements are defined by centerline curve and thickness distribution, and blade-element inlet and outlet angles are established through empirical incidence and deviation-angle adjustments to the velocity diagrams. Blade elements can be stacked to provide the full blade design.

**U.S. Release Only**



### **Aerospike Design and Performance Tool (ADAPT)**

**MFS-33098-1**

The ADAPT computer code designs and analyzes the performance of linear, annular, or plug-cluster aerospike engines. ADAPT can automatically evaluate aerospike nozzle performance over a wide variation of independent design variables, and it can be used in concert with other built-in analysis techniques to optimize aerospike nozzles over an entire flight envelope. Any propellant system can be modeled. Outputs of the code include files that contain the thruster/spike contour and a summary output file for each thruster/spike design point, as well as vacuum and delivered performance data for the thruster and the entire thruster/spike module. One-dimensional performance data are also included for both the thruster and aerospike so that efficiencies and comparisons may be made.

**U.S. Release Only**

### **Aerotherm Chemical Equilibrium (ACE)**

**MFS-32300-1**

The Aerotherm Chemical Equilibrium (ACE) code was developed for predictive thermal/ablative analysis of rocket nozzle liner materials. The tool offers versatility in calculating quantities of importance to a broad variety of thermochemical processes.

**U.S. Release Only**

### **Chemical Equilibrium Applications (CEA)**

**LEW-17687-1**

The CEA program calculates chemical equilibrium product concentrations from any set of reactants and determines thermodynamic and transport properties for the product mixture. Built-in applications account for theoretical rocket performance, Chapman-Jouguet detonation parameters, shock-tube parameters, and combustion properties.

**U.S. Release Only**

### **Generalized Fluid System Simulation Program (GFSSP), Version 6.0**

**MFS-33019-1**

The Generalized Fluid System Simulation Program (GFSSP) is a general software tool that can perform complex fluid flow analysis in a wide variety of applications, including those related to chemical processing, gas processing, power plants, hydraulic control circuits, and various kinds of fluid distribution systems. The tool models liquid fuel phase changes that include compressibility and mixture thermodynamics and allows the user to apply and vary “what-if” effects of external influences.

**U.S. Government Purpose Release**

### **Rocket Engine Transient Simulation Software (ROCETS)**

**MFS-31858-1**

The Rocket Engine Transient Simulation (ROCETS) software consists of a library of rocket engine component software modules for combustion chambers, nozzles, turbines, pumps, valves, lines, etc. The tool can be used to analyze both steady-state and transient performance under various operating conditions in a variety of environments.

**U.S. Release Only**



**ACD Aerodynamic Design of Multistage Axial-Flow Compressors** **LEW-17448-1**

ACD is an analysis code used for the aerodynamic design of multistage axial-flow compressors. The technology provides velocity diagrams on the streamlines at the blade-row edges. Blade elements are defined by centerline curve and thickness distribution, and blade-element inlet and outlet angles are established through empirical incidence and deviation-angle adjustments to the velocity diagrams. Blade elements can be stacked to provide the full blade design.

**U.S. Release Only**

**ACOD Multistage Axial-Flow Compressor Off-design** **LEW-17449-1**

A companion tool to Glenn Research Center's ACD software, ACOD is streamline analysis code for predicting the off-design performance of multistage axial-flow compressors. Flow, blading, and loss are modeled similarly to ACD.

**U.S. Release Only**

**Advanced Ducted Propfan Analysis Code (ADPAC)** **LEW-16768-1**

Developed by the Allison Engine Company under contracts with Glenn Research Center, ADPAC solves tightly coupled internal/external flows through future-concept short-duct turbofan engines.

**U.S. Release Only**

**Axial-Flow Turbine Off-Design (AXOD) Performance** **LEW-16323-1**

AXOD computes the flow and efficiency of multistage axial-flow turbines as functions of speed and pressure ratio. The technology uses a span-line analysis with simple radial equilibrium. The loss model includes blade-row inlet losses, blade-row losses, and stage-test losses. Coefficients are selected to match the known design-point performance, and the internal model provides the off-design performance.

**U.S. Release Only**

**BLAYER** **LEW-16851-4**

BLAYER is a Fortran program used for calculating compressible laminar and turbulent boundary layers in arbitrary pressure gradients.

**U.S. Release Only**

**Broadband Fan Noise Prediction System (BFaNS)** **LEW-17307-1**

BFaNS computes the broadband noise generated by a turbofan engine's fan stage. Noise sources can include turbulence impingement and boundary-layer turbulence convection.

**U.S. Release Only**

**Centrifugal Off-Design Performance (CCODP) Compressor** **LEW-17450-1**

CCODP is a one-dimensional off-design performance prediction code used for centrifugal compressors. Correlations account for the following types of loss: inlet guide vane, impeller incidence, shock, skin friction, blade loading, trailing edge, clearance, vaneless and vaned diffuser friction, recirculation, and disk friction.

**U.S. Release Only**

**Chemical Equilibrium Applications (CEA)** **LEW-17687-1**

The CEA program calculates chemical equilibrium product concentrations from any set of reactants and determines thermodynamic and transport properties for the product mixture. Built-in applications account for theoretical rocket performance, Chapman-Jouguet detonation parameters, shock-tube parameters, and combustion properties.

**U.S. Release Only**

**Chemical Equilibrium with Applications in MATLAB (CEAM)****MFS-33320-1**

This software is an adaptation of the Fortran-based Gordon-McBride Chemical Equilibrium with Application (CEAM) computer program developed 50 years ago. It incorporates modern programming techniques and data management and adds unique user features.

**U.S. Release Only****CMPSTK Multi-Stage Axial-Flow Compressor Off-Design****LEW-17451-1**

Developed for studying variable geometry effects at the conceptual design level, CMPSTK is a combination of the STGSTK and CMPGEN computer codes. STGSTK predicts multistage axial-flow compressor off-design performance using mean-line stage stacking, and CMPGEN estimates design-speed flow range and efficiency ratios.

**U.S. Release Only****Commercial Modular Aero-Propulsion System Simulation (C-MAPSS)****LEW-18315-1**

Written in a combination of MATLAB and Simulink, C-MAPSS provides a realistic simulation of a large commercial turbofan engine. The technology includes a number of graphical user-interface screens that allow point-and-click operation.

**U.S. Government Purpose Release****Commercial Modular Aero-Propulsion System Simulation (C-MAPSS), Version 2****LEW-18315-2**

Version 2 of C-MAPSS provides a transient simulation of a large commercial turbofan engine with a realistic engine control system. Written in a combination of MATLAB and Simulink, the software supports easy access to health, control, and engine parameters through a graphical user interface. Retaining the convenience and user-friendliness of the original, Version 2 includes three actuators (as compared to one) and offers an improved controller, as well as added actuator and sensor dynamics.

**U.S. Government Purpose Release****Commercial Modular Aero-Propulsion System Simulation 40k (C-MAPSS40k)****LEW-18624-1**

Developed in the MATLAB/Simulink environment, C-MAPSS40k is a high-fidelity transient simulation of a generic commercial turbofan engine with a 40,000-pound thrust. The nonlinear physics-based component-level model operates up to Mach 0.8 over a wide ambient temperature range and executes faster than real time. The model can be run from the command line or by using a graphical user interface.

**U.S. Government Purpose Release****Comprehensive C++ Controller for a Magnetically Supported Vertical Rotor, Version 1.0****LEW-17293-1**

FATMaCC a versatile code that possesses many desirable features that were not available in previous in-house controllers. Using a 1-GHz processor, the software controls a five-axis system in either a decentralized or a more elegant centralized (model control) mode at a loop time of 56  $\mu$ s. In addition, it levitates and controls (with only minor modification to the input-output wiring) a two-axis and/or a four-axis system.

**U.S. Release Only****Compressible Flow Toolbox****LEW-17898-1**

The Compressible Flow Toolbox is a set of algorithms that solve classical compressible equations for isentropic flow, fanno flow, Rayleigh flow, normal shock, oblique shock, and expansion. Implemented in the MATLAB programming language, the technology can be used in the analysis of one-dimensional steady flow with constant entropy, with friction, with heat transfer, or with supersonic Mach numbers.

**U.S. Release Only****Computational Fluid Dynamics (CFD) Seal Analysis Code****LEW-16582-1**

This technology is a computer program designed for the study of fluid dynamic forces.

**U.S. Release Only**

**Computed Tomography Cylinder Unwrapper/Re-slicer Software (CT-CURS), Version 2** LEW-19031-1

CT-CURS is a dedicated unwrapping/re-slicing software tool for computing tomography data from cylindrical and partially cylindrical structures. The technology can be used as a complement to vendor software or can be utilized as a completely standalone visualization program.

**U.S. Release Only**

**CORBA Sec** LEW-17214-1

This technology has been used for distributed aerospace propulsion simulations.

**U.S. Release Only**

**Cryogen Storage Integrated Model (CryoSIM)** MFS-33071-1

CryoSIM provides input power and dry mass estimates for insulation and hardware used in in-space applications to maintain cryogenics in storage. System heat load estimations and associated propellant loss masses can also be generated.

**U.S. Government Purpose Release**

**CSPAN Axial-Flow Compressor Conceptual Design Code** LEW-16074-1

This span-line analysis technology uses isentropic simple radial equilibrium to determine a flow path.

**U.S. Government Purpose Release**

**Dynamic Vacuum Analysis Software (DVAS)** MSC-26223-1

This software models the behavior of a dynamic vacuum to provide performance predictions for test articles.

**General Public Release**

**EADIN Communication Protocol** LEW-19264-1

This communication protocol allows microcontrollers to talk to each other in a structured fashion. As such, it is embodied in C++ code that runs on the microcontroller. The software is not mission certified and is being used for demonstration and testing purposes only.

**Open Source**

**G-DYN: A Multibody Dynamics Engine, Version 2** NPO-47195-1

This software is used in simulating touch and go maneuvers of a robotic sampling system from a comet or asteroid. The algorithm is based on a primal-dual formulation of the dynamics that captures the interaction forces (dual-formulation variables) between bodies, which is particularly useful for control and estimation analysis and synthesis. Furthermore, the dynamics model for each body can easily be replaced by a new model without re-deriving the overall equations of motion, and the assembly of the equations of motion is done automatically.

**U.S. Government Purpose Release**

**Gaseous Nitrogen (GN2) Orifice Mass-Flow Calculator** MSC-24873-1

This calculator has been used to determine GN2 high-pressure tank-source depletion rates for the Space Shuttle Orbiter Water Spray Boiler (WSB), and it has also been used to gauge the ability of GN2 consumables to support APU lubrication cooling during entry.

**U.S. Government Purpose Release**

**Generalized Fluid System Simulation Program (GFSSP), Version 701****MFS-33019-1**

The Generalized Fluid System Simulation Program (GFSSP) is a general software tool that can perform complex fluid flow analysis in a wide variety of applications, including those related to chemical processing, gas processing, power plants, hydraulic control circuits, and various kinds of fluid distribution systems. The tool models liquid fuel phase changes that include compressibility and mixture thermodynamics and allows the user to apply and vary “what-if” effects of external influences.

**U.S. Government Purpose Release****Generalized Fluid System Simulation Program (GFSSP), Version 701  
(Educational Version)****MFS-32929-1**

The Generalized Fluid System Simulation Program (GFSSP) is a general software tool that can perform complex fluid flow analysis in a wide variety of applications, including those related to chemical processing, gas processing, power plants, hydraulic control circuits, and various kinds of fluid distribution systems. Example problems can be used effectively as a teaching aid to students as part of their senior undergraduate or graduate coursework.

**U.S. Release Only****Inversion Method for Early Detection of ARES-1 Case Breach Failure****NPO-47285-1**

In this effort, the ARES 1 side-thrust torque has been reconstructed as a difference between the total torque and the engine torque. SRB field joint and breach location is found with the inversion algorithm.

**U.S. Government Purpose Release****ML\_POGO Stability Analysis Software****MFS-33024-1**

This technology models the coupled structural/propulsion (pogo) stability of a liquid-propellant rocket.

**U.S. Release Only****Modular Aero-Propulsion System Simulation (MAPSS)****LEW-17674-1**

MAPSS is a flexible turbofan engine simulation environment that provides easy access to health, control, and engine parameters through a graphical user interface. The technology can be used as a simulation environment for developing and testing advanced control algorithms, or it can run transient simulations or generate state-space linear models for creating a piecewise linear controller.

**U.S. Release Only****Momentum Management for Low-Thrust Missions (MomProf)****NPO-46435-1**

MomProf was developed to operate in the MATLAB environment providing an easy user interface. All data are loaded into MATLAB as a structure to provide consistent access to all inputs by individual functions within the tool. A configuration file provides infrequently changed parameters such as RWA inertia, S/C inertia, and the rotation matrix defining the alignment of each RWA in the body frame.

**U.S. Government Purpose Release****Multidimensional, Multiphysics Computational Heat Transfer Analysis Software (UNIC)****MFS-32554-1**

The Multidimensional, Multiphysics Computational Heat Transfer Analysis Software (UNIC) solves transient, coupled, and simultaneous conjugate heat transfer solutions commonly encountered in rocket engine and launch vehicle component design and analysis.

**U.S. Release Only**

**“NASA Flywheel” for iPad****LEW-19133-1**

This augmented reality application highlights NASA Glenn’s research efforts in the area of flywheel energy storage systems. The app utilizes a printed optical target, available on the GRC Flywheel Program brochure and through the NASA Glenn Web portal, to present users with 3D views of flywheel hardware and space applications. Additional video and imagery are also included in the application package. The software has been compiled and bundled as an iOS app for the iPad and intended for release through the Apple App Store.

**Open Source****Propellant Feed System Analytical Tool (PFSAT)****MSC-25181-1**

The PFSAT parametric analytical tool predicts heat leaks into cryogenic propellant distribution lines. The technology can also be used to determine the optimum orifice diameter for an optional thermodynamic vent system.

**U.S. Government Purpose Release****ROCet Engine Transient Simulation (ROCETS) Software****MFS-31858-1**

The Rocket Engine Transient Simulation (ROCETS) software consists of a library of rocket engine component software modules for combustion chambers, nozzles, turbines, pumps, valves, lines, etc. The tool can be used to analyze both steady-state and transient performance under various operating conditions in a variety of environments.

**U.S. Release Only****Simplified Quasi-Two-Dimensional Computational Fluid Dynamic Simulation for Rotating Detonation Engine Analysis****LEW-19488-1**

A quasi-two-dimensional, computational fluid dynamic (CFD) simulation of a rotating detonation engine (RDE) has been developed. The simulation operates in the detonation frame of reference and utilizes a relatively coarse grid such that only the essential primary flow field structure is captured. This construction and other simplifications yield rapidly converging, steady solutions that can be obtained on a modern single-processor computer. Viscous effects and heat transfer effects are modeled using source terms.

**U.S. Government Purpose Release****SNAP, Version 2.3****LEW-17816-1**

SNAP is an N-body high-fidelity propagation program that can model the trajectories of the planets, the Sun, and virtually any natural satellite in the solar system.

**U.S. Release Only****STAN5****LEW-13009-1**

This computer program computes general two-dimensional turbulent boundary-layer flow using finite difference techniques. Without requiring any modifications to the program code, STAN 5 can handle a wide range of boundary-layer problems. The technology has been used extensively at Stanford University.

**U.S. Release Only****Toolbox for the Modeling and Analysis of Thermodynamic Systems (T-MATS)****LEW-19165-1**

T-MATS is a Simulink toolbox intended for use in the modeling and simulation of thermodynamic systems and their controls. It contains generic thermodynamic and controls components that may be combined with a variable input iterative solver and optimization algorithm to create complex systems to meet the needs of a developer. Development of this tool was completed on behalf of the NASA Aviation Safety Program’s Vehicle Systems Safety Technologies (VSST) project located at the Glenn Research Center.

**Open Source**

**TURBAN Turbomachine Design Code****LEW-17454-1**

TURBAN analysis is performed at the arithmetic mean diameter. The stage velocity diagrams are either all similar (therefore have the same work factor) or are determined from an input stage work split. All stages have the same stator exit angle. Stage-by-stage tailoring of the velocity diagrams is not allowed.

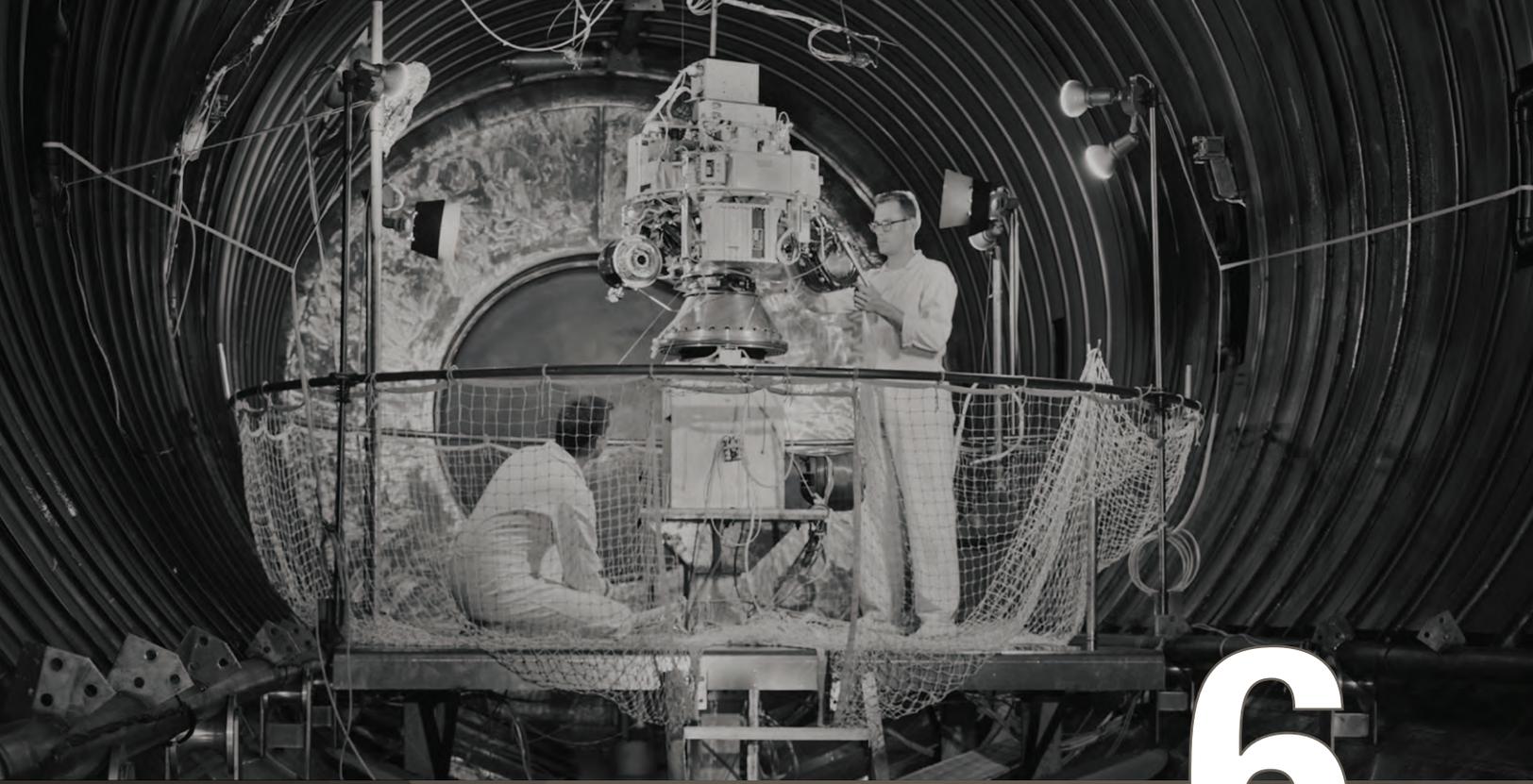
**U.S. Release Only****V072 Rotor Wake/Stator Interaction Noise Prediction****LEW-17065-1**

The V072 computer code predicts noise from rotor wake/stator interactions. The technology can perform compressor rotor wake prediction only, rotor/stator or fan/FEGV interaction only, fan/core stator interaction only, and both fan/FEGV and fan/core stator interactions.

**U.S. Release Only****WOBBLE****LEW-17325-1**

This technology computes the tone noise associated with propellers and predicts axial and circumferential directivity. The acoustic model is exact and accounts for all unsteady sources.

**U.S. Release Only**



# 6

## Electronics and Electrical Power

Solar Arrays, Batteries, Cabling, Grounding,  
Converters, Electrical Analysis





## Featured Software

### **Capture Test Waveform for the SCaN Testbed Harris SDR**

**LEW-19286-1**

The Capture Test Waveform is a software application designed for space-based reconfigurable radios. The innovation allows snapshots of a radio's receiver environment for any number of objectives, including interference mitigation or radio frequency mapping. Digital samples are acquired and stored in the radio's memory for processing. Depending on a radio's resources and architecture, the application could be run in parallel with a standard communications link waveform application. (The software is labeled "test waveform" because it does not perform any standard communication link functions, e.g., carrier recovery or demodulation.)

**U.S. Release Only**

### **Power Quality Impedance Tester Software**

**MSC-25353-1**

The Power Quality Impedance Tester Software and the Frequency-Response Analyzer (FRA) combined deliver a complete frequency-response measurement system. The software runs on any personal computer using Microsoft® Windows® XP/2007. Data, displayed on a graphical user interface, can be saved to a text file.

**U.S. Government Purpose Release**

### **Solenoid Inductance Calculator**

**KSC-12253**

The Solenoid Inductance Calculator can be used to compute the inductance approximation of a cylindrical solenoid of arbitrary dimensions. The technology's calculation method (1) uses magnetic vector potential to provide a more precise estimate of inductance and (2) is not limited to a specific range of coil geometry values.

**U.S. Release Only**



**An Efficient, Highly Flexible Multi-Channel Digital Downconverter Architecture** **NPO-47431-1**

The algorithm was developed to run in an FPGA at input data sampling rates of up to 1280 MHz. The current implementation takes a 1280 MHz real input and first breaks it up into seven 160 MHz complex channels, each spaced 80 MHz apart. (The eighth channel at baseband was not required for this implementation.) Afterwards, four channels with independently tunable center frequencies and bandwidth settings are implemented.

**U.S. Government Purpose Release**

**Capture Test Waveform for the SCaN Testbed Harris SDR** **LEW-19286-1**

The Capture Test Waveform is a software application designed for space-based reconfigurable radios. The innovation allows snapshots of a radio's receiver environment for any number of objectives, such as interference mitigation or radio frequency mapping. Digital samples are acquired and stored in the radio's memory for processing, be that on-board the spacecraft or after download to the ground. The application is labeled "test waveform" because it does not perform any standard communication link functions, such as carrier recovery or demodulation. Depending on the radio's resources and architecture, this application could be run in parallel with a standard communications link waveform application.

**U.S. Release Only**

**CoNNeCT Baseband Processor Module Boot Code SoftWare (BCSW)** **NPO-47778-1**

NASA desires to advance the state of the art in software-defined radios in order to reduce dependency on specific hardware implementations geared to a specific application. It is preferable that a single software-defined radio can be reconfigured based on a particular need during flight as communication needs arise. This reduces size and weight in that a single radio performs the tasks that once required 2-3 different radios depending on the phase of a mission. This software within the new generation BPM for CoNNeCT allows these requirements to be fulfilled by vetting out the features as future SDRs become more than simply radios and evolve into providing enhanced capabilities.

**U.S. Government Purpose Release**

**Fault-Tolerance Middleware for a Multi-Core System** **NPO-47806-1**

In the multi-core system for which it was designed, the FTM resides on a single dedicated core, separate from the cores used by the application. This isolates the FTM from application faults and allows it to swap out any application core for a substitute. The structure of the FTM consists of an interface to a fault-tolerant strategy module, a responder module, a fault manager module, an error factory, and an error mapper that determines the severity of an error.

**U.S. Government Purpose Release**

**Flexible Architecture for FPGAs in Embedded Systems** **NPO-48424-1**

This technology adds a separate small device to FPGA boards in embedded systems, replacing the PROMs, FPGA, and additional circuitry previously used for loading SRAM-based FPGAs. The device added is currently a small FPGA, and the primary advantage of this technology is that the design of the device does not change regardless of the application in which it is being used. This means that the device needs to be qualified for flight only once. An application programming interface is included, reducing the development time needed to use it in a system.

**U.S. Government Purpose Release**

**FPGA Code Development for the iPAS STRS Radio** **LEW-19389-1**

This innovation is FPGA VHDL code written as part of the iPAS STRS radio development. The FPGA design receives and processes commands and provides command control and data to the test waveform. It also receives and transmits streaming data from/to the embedded processor.

**U.S. Government Purpose Release**



## JPL Space Telecommunications Radio System Operating Environment

NPO-47766-1

This software forms the basis of experimentation on the SCaN testbed launched to International Space Station in 2012.

**U.S. Government Purpose Release**

## Modular and Portable QPSK Transceiver Waveform for Software-Defined Radios

LEW-19723-1

A QPSK transceiver waveform has been developed and implemented on a commercially available ground-based software-defined radio platform. The waveform utilizes legacy NASA forward-error correction codes and Consultative Committee for Space Data Systems (CCSDS) data framing standards. It is controlled via a Web interface and allows the user to multiplex between test (pseudo-random) and network-sourced data. The product consists of two main components: (1) the digital logic (VHDL) implementation for the field-programmable gate array (FPGA) that does the required signal processing functionalities and (2) the command-and-control software portion that leverages the open-source Core Flight Executive (cFE) software suite and provides a graphical user interface to the waveform.

**U.S. Release Only**

## Packet to Electrical Ground Support Equipment (EGSE) Interface Converter, Version 4.0

GSC-16586-1

Developed using platform-independent language, this interface converter packet allows already-existing EGSE equipment to be supported on Windows and UNIX operating systems. The software is set up and controlled using XML-formatted files that define interface connections and data content.

**U.S. Government Purpose Release**

## Pattern Generator for Bench Test of Digital Boards

NPO-48231-1

In this effort, the first board to be tested was the ADC digital processor board (ADP). The ADP needed a complex xilinx configuration data stream to operate at all, plus timing signals. The IO card is wired directly to the configuration and timing inputs of the board through VME connectors. A slower pattern maker program combines the xilinx configuration and desired timing into a large data file. This data file is clocked out at 40 MHz/32 bits of data into 28 inputs of the ADP to make it run.

**U.S. Government Purpose Release**

## Physics-Model-Based Wiring Fault Detection Toolbox for MATLAB

ARC-17046-1

Providing a toolbox of functionality for MATLAB, this NASA-developed software detects precursor wiring faults (e.g., chafing) in shielded impedance-controlled cabling using measurements from off-the-shelf, time-domain reflectometry or vector-network analyzer hardware. The technology combines high-fidelity analytical physics models for signal propagation with fast Bayesian inference algorithms for intrinsic cable and fault-parameter retrieval.

**Open Source**

## Power-Quality Impedance Tester Software

MSC-25353-1

The Power Quality Impedance Tester Software and the Frequency-Response Analyzer (FRA) combined deliver a complete frequency-response measurement system. The software runs on any personal computer using Microsoft Windows XP/2007. Data, displayed on a graphical user interface, can be saved to a text file.

**U.S. Government Purpose Release**



### **Single-Receiver GPS Phase Bias Resolution**

**NPO-47149-1**

It has long been the practice to fix double-differenced integer phase ambiguities when processing GPS data from multiple receivers. When the double-differenced combination of phase biases can be fixed reliably a significant improvement in solution accuracy is obtained. The procedure is complicated and compute intensive, due to the need for multiple receivers to form the double difference. The constraint on the integers is added to the solution as a measurement with infinite precision. This software introduces a new method. First the process, uses a large global set of GPS receivers (40-80 receivers) to solve for the GPS satellite orbits and clocks (along with many other parameters ).

**U.S. Government Purpose Release**

### **SOLAR: A Rapid International Space Station (ISS) Power Availability Simulator**

**MSC-24623-1**

SOLAR is a Java-based tool that leverages commercial off-the-shelf software (Satellite Toolkit) and an existing ISS electrical power system model (SPEED) to rapidly perform thousands of power availability simulations.

**U.S. Government Purpose Release**

### **Solenoid Inductance Calculator**

**KSC-12253**

The Solenoid Inductance Calculator can be used to compute the inductance approximation of a cylindrical solenoid of arbitrary dimensions. The technology's calculation method (1) uses magnetic vector potential to provide a more precise estimate of inductance and (2) is not limited to a specific range of coil geometry values.

**General Public Release**

### **Space Telecommunications Radio System (STRS) Reference Implementation (RI)**

**LEW-19083-1**

The STRS Reference Implementation is a demonstration of the STRS architecture. The STRS architecture standard for software defined radios is an open architecture for NASA space and ground radios. The standard provides a common, consistent framework to develop, qualify, operate, and maintain complex reconfigurable and reprogrammable radio systems. The reference implementation allows verification of capabilities and provides lessons learned for the improvement of STRS Architecture Standard 1.02.

**U.S. Government Purpose Release**

### **STRS SpaceWire FPGA Module**

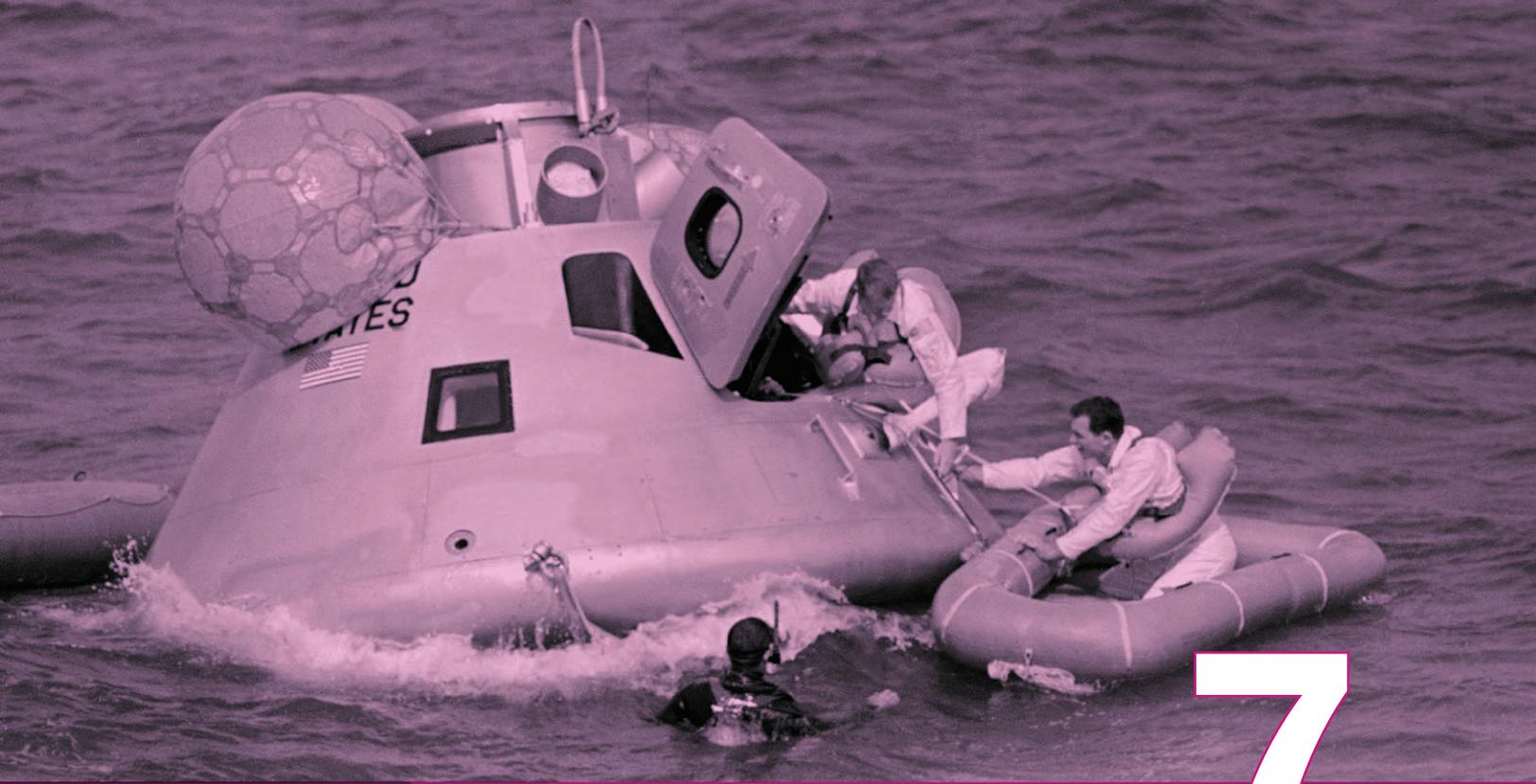
**NPO-47434-1**

The STRS SpaceWire FPGA Module is written in the Verilog Register Transfer Level (RTL) language and encapsulates an unmodified GSFC core (which is written in VHDL). The module has the necessary inputs/ outputs and parameters to integrate seamlessly with the SPARC I/O FPGA Interface module. This allows software running on the SPARC processor to access the configuration and status registers within the SpaceWire module.

**U.S. Government Purpose Release**







# 7

## Operations

Ground Software, Telemetry, Command and Control, Global Positioning Systems, Extra-Vehicular Activity, Radio, Communications





## Featured Software

### **Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP) Software Library, Version 3.1** **GSC-14993-1**

This library provides for the reliable transfer of large data blocks to and from spacecraft. It implements the international standard CFDP protocol, can be used from mission to mission, and supports both ground and flight software.

**U.S. Government Purpose Release**

### **Copernicus Trajectory Design and Optimization System, Version 4.6** **MSC-25863-1**

Copernicus 4.3 includes updates to the plugin interface, a new differential corrector solution method, updated SPICE SPK files, updates to the Python interface, some new training videos, and numerous other refinements and bug fixes.

**U.S. Government Purpose Release**

### **GNSS-Inferred Positioning System and Orbit Analysis Simulation Software (GIPSY-OASIS)** **NPO-19636-1**

GIPSY-OASIS is widely used for geophysical and global positioning system research.

**U.S. Government Purpose Release**

### **Integrated Test and Operations System (ITOS), Release 8** **GSC-16025-1**

This ITOS modification features a new-events system that includes tools to allow the user to create old-style log files and manage the log database.

**U.S. Government Purpose Release**

### **SCaN Optical Link Assessment Tool, Version 2** **LEW-19313-1**

A calculation procedure has been designed and implemented in software that enables the specification and design of a space-based optical communications system. The resulting optical link budget essentially accounts for the communication power flow through the entire optical communications channel from the transmitter to the receiver and yields design specifications for the optical system necessary to assure reliable data transmission with desired operational metrics such as data rate, link margin, etc. The link assessment tool takes into account all the sources of deleterious noise that enters into the communications process such as electronically generated noise in the optical detector and stray optical irradiance from external sources. The link budget has the capability of being interfaced with the orbital element calculations of the Satellite Tool Kit (STK) to allow the dynamic description and evolution of optical link operation from any space-borne satellite within the solar system to and from the Earth. The current version implements PPM and DPSK modulation types that can use PIN, APD, or nanowire optical detectors in the presence of atmospheric turbulence. Coded and un-coded link power margins are provided.

**U.S. Release Only**



**Advanced Spacecraft Integration and System Test Software (ASIST), Front-End Data Systems/Digital History Data Store Software (FEDS/DHDS), Updated** **GSC-15832-1**

From component development to integration, testing, and mission operations, this NASA technology provides a single spacecraft ground system for processing spacecraft telemetry and command data throughout the lifecycle of a program. The technology is applicable to all missions with telemetry that (1) conforms to the AOS recommendations of the Consultative Committee for Space Data Systems (CCSDS) and (2) meets CCSDS telecommand standards.

**U.S. Government Purpose Release**

**Advanced Technology Microwave Sounder (ATMS) Antenna Beam Analysis Software** **GSC-16784-1**

The ATMS software calculates instrument beam pointing and polarization state. Input is taken in the native MI Technologies MI-3000 antenna measurements system database format and should include sets of azimuth/elevation RF radiation pattern cuts (at multiple phi rotations) or discrete frequencies.

**U.S. Government Purpose Release**

**Autonomous eXplorer Control System (AXCS)** **ARC-16721-1**

AXCS enables smartphones and other mobile devices to be utilized as a ground-based test bed for operations in extreme environments. For NASA, the technology is currently being used to evaluate hardware for balloon launches. The software's tool kits provide environmental and situational measurements, command and data handing (CD&H) functions, events timing, data logging, and communications with external devices.

**Open Source**

**Autonomous Precision Landing Navigation (APLNav) System** **MSC-24721-1**

The APLNav system provides a simple, cost-effective, reliable, and proven optical terrain navigation tool for planetary landing applications. Passive optical digital cameras are used to create surface images that are rendered against a digital elevation model. The system is derived from the digital scene-mapping and area correlation navigation method that has been employed by cruise missiles for decades.

**U.S. Government Purpose Release**

**CalSimHydro** **NPO-48235-1**

This Web-based, Google Earth-enabled interactive interface provides a tool for configuring, running, viewing, and downloading the results of a CalSim 3.0 Hydrology Preprocessor program. The software allows the user to (1) interact with a map of water budget areas (WBAs) and display data for a selected WBA in tabular form or as a time series plot; (2) edit input and run a CalSim 3.0 Hydrology Preprocessor; and (3) compare results with base-run output and download the output file. CalSimHydro will be delivered to the California Department of Water Resource (DWR) and released as a part of the CalSim 3.0 system.

**U.S. Government Purpose Release**

**Class A Core Flight Software (SBN653)** **MSC-25998-1**

This software provides a communication pass-through between NASA's Core Flight Software (CFS) framework's software bus and the ARINC-653 standard sampling port mechanisms. It adapts the CFS framework to run within ARINC-653 partitioned operating environments.

**U.S. Government Purpose Release**

**Command, Control, Communications, and Intelligence (C3I) Delay/Disruption-Tolerant (DTN) Networking Software** **LEW-18493-1**

This code is a DTN implementation of the Constellation Program's C3I software.

**U.S. Government Purpose Release**

**Command, Control, Communications, and Intelligence (C3I) Networking Software** LEW-18494-1

This implementation of the Constellation Program's C3I software has provided an environment for the prototype testing of a variety of networking protocols.

**U.S. Government Purpose Release**

**Command, Control, Communications, and Intelligence (C3I) Voice Exchange Software** LEW-18495-1

This implementation of the Constellation Program's C3I software has provided an environment for the prototype testing of a variety of voice exchange components.

**U.S. Government Purpose Release**

**Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP) Software Library, Version 3.1** GSC-14993-1

This library provides for the reliable transfer of large data blocks to and from spacecrafts. It implements the international standard CFDP protocol, can be used from mission to mission, and supports both ground and flight software.

**U.S. Government Purpose Release**

**Copernicus Trajectory Design and Optimization System, Version 4.6** MSC-25863-1

This new release of the Copernicus Trajectory Design and Optimization System includes the following changes: a new cross-platform JSON kernel file format, various new reference frame features including new capabilities for user-defined reference frame plugins, and numerous bug fixes and other minor enhancements. Copernicus is capable of solving a wide range of trajectory optimization problems. These include trajectories centered about any planet or moon in the solar system, trajectories influenced by two or more celestial bodies such as libration point trajectories (halo orbits) and distant retrograde orbits, Earth-Moon and interplanetary transfers, asteroid and comet missions, and more. The software is available for Windows, Linux, and Mac.

**U.S. Government Purpose Release**

**Core Command and Data Handling (CC&DH) Library** GSC-15197-1

Containing no source code, this library is a binary, executable release of the Core Command and Data Handling (CC&DH) Component.

**U.S. Government Purpose Release**

**Debris Assessment Software (DAS), Version 2.1** MSC-26234-1

The Debris Assessment Software (DAS) is computer code for assessment of debris risk from satellite programs.

**General Public Release**

**Description and User Instructions for the "quaternion\_to\_orbit\_v3" Software** NPO-47701-1

This software has been designed for simulation of the calibration maneuvers performed by the two spacecraft comprising the GRAIL mission to the Moon, but has potential use for other applications.

**U.S. Government Purpose Release**

**DF Library (DFLIB), Version 1.X** MSC-25683-1

The DF Library (DFLIB) is a collection of software application programming interfaces (APIs) that provide convenience-function capabilities unique to a mission control center (MCC). These APIs allow the conversion of the DDD:HH:MM:SS time format to/from a floating point number; provide an X Windows pop-up message generator and an X Windows file-selection interface; and include ISP computation interface functions and macros.

**U.S. Government Purpose Release**

### **DRAT: A Distributed Release Audit Tool**

**NPO-49562-1**

DRAT directly overcomes RAT's limitations and brings code auditing and open-source license analysis into the realm of "big data" using scalable open-source Apache technologies. DRAT was funded by DARPA XDATA and is already being applied and transitioned into the government.

**U.S. Government Purpose Release**

### **Ensemble**

**NPO-49104-1**

Ensemble is a sophisticated mission operations software suite that has had a dramatic breadth of impact across the agency. It has been used by six NASA missions, four NASA mission analogs, and numerous technology development projects in nearly every NASA mission directorate over its lifetime while also enabling the agency to reach out and inspire the public on an unprecedented scale. Ensemble provides powerful and intuitive user interfaces for all aspects of space mission operations including activity planning/scheduling, command generation, telemetry monitoring, and 2D/3D data visualization. These user interfaces are supported by an extensible and scalable service-oriented backend providing cloud-enabled data processing, secure collaboration, resource modeling, and efficient content delivery.

**U.S. Government Purpose Release**

### **Ensemble Eclipse: A Process for Pre-Fab Development Environment for the Ensemble Project**

**NPO-47677-1**

The open-source integrated development environment (IDE) Eclipse is a powerful and useful tool that is at the heart of the Ensemble Project, a cross-center collaboration between the Jet Propulsion Laboratory, Ames Research Center, and Johnson Space Center, with 20 to 40 active participants at any given time. Setting up an Eclipse environment to be compatible with Ensemble code development is both time consuming and error-prone. In this effort, a process has been developed for building and distributing each new version of "Ensemble Eclipse" to the members of the Ensemble project. Ensemble Eclipse is a prebuilt Eclipse environment that contains all of the necessary plugins, preferences, and other settings in order to be able to build and run Ensemble-based software.

**U.S. Government Purpose Release**

### **Flexible Docking Tool for Real-Time Planning Missions**

**MSC-24801-1**

This flexible software tool improves rendezvous planning for a vehicle visiting the International Space Station (ISS). Features include a telemetry processing function, a relative motion function, a targeting function, a vector view, and two- and three-dimensional graphics. The technology's modeling capability ensures that a vehicle stays within desired coordinates.

**U.S. Government Purpose Release**

### **Global Positioning System (GPS) Enhanced Onboard Navigation System (GEONS)**

**GSC-14687-1**

GEONS processes data from standard GPS receivers, communication equipment, and/or attitude sensors to produce accurate, absolute, relative onboard navigation solutions in real time. Navigation products from GEONS support additional autonomous functions, including onboard maneuver control, science viewing, and relative navigation for formation keeping.

**U.S. Government Purpose Release**

### **Global Precipitation Measurement (GPM) Spacecraft Flight Software (FSW), Version 4.7.2**

**GSC-16669-1**

The Global Precipitation Measurement (GPM) Spacecraft Flight Software (FSW) controls and coordinates all aspects of the spacecraft's operation in nominal and anomalous conditions. It distributes commands to, and collects data from, all spacecraft subsystems and the science instruments. The FSW controls high-gain antenna pointing to TDRSS satellites and manages communications with the ground controllers in real time to receive commands (during SSA contacts) and send housekeeping telemetry data during SSA and MA contacts. It sends science data using the Class-2 CCSDS File Delivery Protocol (CFDP). The GPM FSW monitors the health of most orbiter subsystems and takes corrective actions when necessary.

**U.S. Government Purpose Release**

**GMSEC Alert Notification System Router (ANSR), Version 4.0****GSC-17233-1**

ANSR is an alert notification system providing paging and email services. Using call chains and call trees, ANSR supports call acknowledgment and call escalation allowing for multiple contingencies. As a central point of alarm configuration, notification, and reporting, it also provides a graphical configuration tool, a console-based monitoring tool, and a Web-based log viewer.

**U.S. Government Purpose Release****GMSEC API Performance Testing Utility, Version 3.0****GSC-16168-1**

This statistical performance testing tool is used to test and measure the GMSEC middleware systems by recreating test scenarios under various configurations. The benchmarks run simulations at increasing loads, measuring the performance in terms of message transmission delay. The results can be visually inspected in Microsoft Excel graphs or raw numerical data. The utility features the ability to compare performance of middleware-based systems against raw TCP socket-to-socket communications, providing a better perspective on the relative worth of GMSEC-compliant middleware systems.

**U.S. Government Purpose Release****GNSS-Inferred Positioning System and Orbit Analysis Simulation Software (GIPSY-OASIS)****NPO-19636-1**

GIPSY-OASIS is widely used for geophysical and global positioning system research.

**U.S. Government Purpose Release****Goddard Mission Service Evolution Center (GMSEC) System Agent, Version 3.1****GSC-17483-1**

This GMSEC-compliant software component provides health information about the computer hosting the agent to other GMSEC components utilizing a middleware-based architecture. It also provides the capability for executing commands received from a GMSEC directive message, as well as the capability for monitoring specified log files.

**U.S. Government Purpose Release****Goddard Mission Services Evolution Center (GMSEC) Compliance Test Suite****GSC-16074-1**

The Compliance Test Suite includes both message publisher and message validator applications. The publisher feature provides a variety of predefined, displayable, and selectable messages. The validator reads a selected message and validates it against a corresponding XML schema. Detailed warnings and errors can be accessed with a double-click on any specific message.

**U.S. Government Purpose Release****Goddard Mission Services Evolution Center (GMSEC) Core, Version 4.0****GSC-17570-1**

The GMSEC architecture is a comprehensive flight and ground system architecture that spans the full mission lifecycle. Software components use the GMSEC Architecture API to connect to a middleware software messaging bus that in turn is responsible for message routing and delivery. The API and middleware combine to free the components from having to know where other components exist and what data they need. The API combined with the GMSEC message standards allow a component to be GMSEC-compliant and help it achieve plug-and-play capability. Using standard messages for functionality helps the GMSEC environment achieve the goal of application interchangeability, where standardized components can be exchanged easily without affecting other GMSEC components.

**Open Source**

## **Goddard Mission Services Evolution Center (GMSEC)**

### **Criteria Action Table (CAT), Version 5.5**

**GSC-17185-1**

The Criteria Action Table is a real-time decision-making component. Using predefined criteria (rules), CAT ingests messages in real-time, analyzes the content and context, and determines if the predefined criteria has been met. If so, an associated set of predefined actions is automatically triggered. Pre-defined actions can also be disabled. A decision-making, action-triggering component such as CAT can contribute to system-wide situational awareness, provide system-wide process orchestration, and enable system automation.

**U.S. Government Purpose Release**

## **Goddard Mission Services Evolution Center (GMSEC) Environmental**

### **Diagnostic Analysis Tool (GEDAT), Version 2.0**

**GSC-16276-1**

Version 2.0 of GEDAT features: a new tree-table display with selective filtering to support large-scale environments; added displays for CPU, memory, network resource graphing/plotting, server configuration, and message statistics; filtered search capabilities; improved menu-bar navigation capabilities; automatic elevation of errors or critical events; and user-configurable notification timeout monitoring.

**U.S. Government Purpose Release**

## **Goddard Mission Services Evolution Center (GMSEC) Parameter Display Tool**

**GSC-16073-1**

This technology is a GMSEC-compliant software component that enables users to create and view a display page consisting of parameter and telemetry mnemonic values. Both text and color are used to delineate status.

**U.S. Government Purpose Release**

## **Goddard Mission Services Evolution Center (GMSEC)**

### **Reusable Events Analysis Toolkit (GREAT), Version 3.0**

**GSC-17234-1**

GREAT is a toolkit for event/log messages supporting single and multiple satellite systems. It provides real-time message display and message archival and retrieval. It is useful as a debugging tool for monitoring real-time activity as reported by all other components and retrieving and analyzing historical events.

**U.S. Government Purpose Release**

## **Ground Hardware Management Tool Web Application**

**KSC-13923**

The Ground Systems Development and Operations (GSDO) Program requires a Web-based application to effectively manage and coordinate the various components of ground support equipment (GSE) used at Kennedy Space Center (KSC) throughout the spacecraft and launch vehicle processing and integration flow, as well as for launch pad operations. This integrated GSE tracking and management tool tracks and manages GSE data used in support of KSC\GSDO operations planning and launch campaigns.

**U.S. Release Only**

## **In-Situ Mosaic Brightness Correction**

**NPO-47726-1**

The software is part of the OPGS Operational Product Generation Subsystem (OPGS) software suite. It performs correction of brightness/contrast differences at seams between images in mosaics. In-situ missions, such as Mars Exploration Rover (MER), Phoenix (PHX), and Mars Science Laboratory (MSL)-NASA Planetary Exploration Mission, typically have pointable mast-mounted cameras, which are capable of taking panoramic mosaics composed of many individual frames.

**U.S. Government Purpose Release**

**In-Situ Surface Characterization****NPO-47724-1**

The three programs contained in this software (marsuvw, marsrough, and marsslope) are part of the Operational Product Generation Subsystem (OPGS) automated pipeline, which analyzes images returned by in-situ spacecraft and creates higher-level products to assist in operations, science, and outreach. These specific programs take the XYZ data derived from stereo analysis and create higher-level products such as surface normals, roughness maps, and various kinds of slope maps. These products are used by rover planners and other operations team personnel to help drive the vehicle or operate the arm. The secondary programs are used for special processing requests in operations.

**U.S. Government Purpose Release****Input Device Framework (IDF)****MSC-25810-1**

This framework is for mapping physical input devices (joysticks, gaming controllers, custom control panels, etc.) to application-specific virtual controller interfaces.

**Open Source****Inspire Connect Explore (ICE)****KSC-13772**

The Inspire Connect Explore (ICE) application is an inspiration tool utilized by the Education and External Relations organization to increase STEM participation. In addition to static content such as biographies and career information, the Web site allows dynamic (approved) content where students may post questions to specific employees about their degree experience and career advancement. This new application was developed utilizing ASP.Net, HTML, and SQL Server 2008 technologies. Access is controlled through role-based security at the application level. Employees are provided automated log-in capability after which they may create and edit their inspirational biographies and career information or respond to questions posted by the public.

**U.S. Release Only****Integrated Test and Operation System (ITOS), Version 9.0****GSC-17915-1**

The Integrated Test and Operations System (ITOS) is a satellite telemetry and command system. It has been used on more than 30 NASA projects, from CubeSats to Great Observatories. It is appropriate for use during the entire mission lifecycle, from development in the labs to on-orbit operations. ITOS is also a very capable closed-loop, scripted tool that can simulate an entire observatory or a particular subsystem.

**U.S. Government Purpose Release****Integrated Trending and Plotting System (ITPS)****GSC-15532-1**

ITPS is a comprehensive trending and plotting tool for the storage, extraction, and analysis of spacecraft housekeeping telemetry data.

**U.S. Government Purpose Release****Integrated View (IView), Version 1.1.2****MSC-25625-1**

The Integrated Viewer (IView) is a Web-based electronic tool used to execute Onboard Short-Term Plan Viewer (OSTPV) activities. The software serves as a consolidated user interface, integrating information from OSTPV, the International Procedure Viewer (IPV), and the Automated Stowage Note (ASN) tool.

**U.S. Government Purpose Release****Interoperable Remote Component (IRC)****GSC-14308-1**

IRC provides robust interactive and distributed control/monitoring of remote instruments. The IRC architecture combines the processing capabilities of Java with the power of XML to express hierarchical data in a human-readable, platform-independent format. For additional information, please visit: <http://opensource.gsfc.nasa.gov/projects/IRC/index.php>

**Open Source**

### **Java Astrodynamics Toolkit (JAT)**

**GSC-14912-1**

The Java Astrodynamics Toolkit (JAT) is a collection of Java components that aid flight dynamics engineers in performing space mission design; trajectory optimization; and spacecraft navigation, attitude-determination, and control systems analysis. Current capabilities include orbit propagation, orbit determination, maneuver planning, spacecraft attitude simulation, and 3D orbit and attitude visualization.

**Open Source**

### **Joint-Execution Package Development and Integration (JEDI) Application**

**MSC-25099-1**

JEDI is the primary tool used by all International Space Station control centers to create and approve messages for astronauts and flight control teams. JEDI messaging enables ground and crew personnel to update specific tasks or procedures quickly and efficiently.

**U.S. Government Purpose Release**

### **Maestro Science Activity Planner for Mars**

**NPO-45871-1**

The Maestro Science Activity Planner (Maestro) provides an intuitive interface to the Mars Exploration Rovers Mission, combining cutting-edge visualization with sophisticated planning and simulation capabilities.

**U.S. Government Purpose Release**

### **MaROS: Information Management Service (Phase 1)**

**NPO-47454-1**

This software is provided by the Mars Relay Operations Service (MaROS) task to a variety of Mars projects for the purpose of coordinating communications sessions between landed spacecraft assets and orbiting spacecraft assets at Mars.

**U.S. Government Purpose Release**

### **Mars Relay Lander and Orbiter Overflight Profile Estimation**

**NPO-47722-1**

This software estimates for the geometric relationship between a lander and an orbiter based upon the orbital conditions of the orbiter at the moment the it rises above the horizon from the perspective of the lander. It utilizes two-body orbital equations to propagate the trajectory through the duration of the view period, and it returns profiles that represent the range between the two vehicles and the elevation and azimuth angles of the orbiter as measured from the landers position.

**U.S. Government Purpose Release**

### **Method for Automatic Optimization of Yaw Maneuvers for Orbiting Space Vehicles**

**MSC-25656-1**

This software provides a simplified analytical solution for yaw maneuver optimization. The approach is applicable to the International Station (ISS), as well as other orbiting space vehicles.

**U.S. Government Purpose Release**

### **Mission Display (MDX) System**

**NPO-35238-1**

The Mission Display (MDX) System can be used to visualize a wide variety of raster scan data, including IFSAR images and DEM. The technology enables the user to view very large data sets (greater than 2 gigabytes per image) and offers several ways to combine information from different data sets into a single display window.

**U.S. Government Purpose Release**

### **Modeling-Error-Driven Performance-Seeking Direct Adaptive Control**

**ARC-16235-1**

This software uses a novel, stable, discrete, time-adaptive law that implements flight control to target damages/modeling errors in a direct adaptive-control framework. The baseline controller uses dynamic inversion with proportional integral augmentation. This methodology will investigate conditions for stability, as well as performance.

**U.S. Government Purpose Release**

**Modular Integrated Solution Toolkit (MIST)****GSC-15337-1**

The Modular Integrated Solutions Toolkit (MIST) is a software system designed to provide low- and medium-fidelity simulation of spacecraft telemetry and commands for ground system testing. The technology consists of a simulation architecture, simulation middleware, a user interface, and a library of functional elements.

**U.S. Government Purpose Release****MPST Software: MoonKommand****NPO-47693-1**

MoonKommand has been used by The Gravity Recovery and Interior Laboratory mission as part of NASA's Discovery Program. The software coordinates and automates the interface between the SRS instrument command files and the spacecraft commanding files.

**U.S. Government Purpose Release****MSLICE Sequencing****NPO-47292-1**

Developed for the NASA Mars Science Laboratory (MSL) mission, MSLICE Sequencing is a graphical tool for writing sequences and integrating them into RML files, as well as producing SCMF files for uplink. When operated in a testbed environment, it also supports uplinking these SCMF files to the testbed via Chill.

**U.S. Government Purpose Release****Multi-Mission Power Analysis Tool, MMPAT, Version 2****NPO-47290-1**

MMPAT simulates a spacecraft power subsystem including the power source (solar array and/or radioisotope thermoelectric generator), bus-voltage control, secondary battery (lithium-ion or nickel-hydrogen), thermostatic heaters and power-consuming equipment. It handles multiple mission types including heliocentric orbiters, planetary orbiters, and surface operations.

**U.S. Government Purpose Release****Multipath TCP (MPTCP) Tools, Analytics, and Configurations****LEW-19620-1**

This collection of tools, scripts, and configurations allows the use of Multipath Transmission Control Protocol (TCP) across multiple point-to-point interfaces such as those commonly used for satellite and optical links.

**Open Source****Multi-Purpose Attitude and Pointing System (MAPS), Version 7.1****MSC-25522-1**

The Multipurpose Attitude and Pointing System (MAPS) has been used for attitude development and line-of-sight analysis since 1991. Version 7.1 of the software allows the user to model any motion-control system without post-processing or manually modifying data.

**U.S. Government Purpose Release****NOSS: NDAS One-Stop Shop****SSC-00529**

NOSS is a Web-based central configuration interface for the NASA Data Acquisition System (NDAS), or it can be used additionally as a front-end for other types of data acquisition systems. NOSS is accessed using a Web browser and allows for concurrent multi-user access. After configuration is complete, a user can export an XML that can be used in the configuration of a data acquisition system.

**U.S. Government Purpose Release****Open Mission Control Technologies (Open MCT)****ARC-15256-1D**

Open MCT is an open-source and Web-based mission control framework for visualization of data on desktop and mobile devices. Open MCT is designed for analysis, visualization, operation, and support of spacecraft missions. It provides an extensible plugin system allowing it to be integrated with existing ground systems and adapted to support multiple missions, as well as non-space applications.

**Open Source**

### **Orbital Communications Adaptor (OCA) Management System (OCAMS)**

**MSC-24833-1**

OCAMS is a simulation-to-implementation, multi-agent system-development methodology that combines ethnography, participatory design, multi-agent simulation, and agent-based systems integration. Employing the Brahms programming language, the technology automates tasks, leverages network infrastructure to distribute information, and links arbitrary hardware and software systems to teams of people on Earth and in space.

**U.S. Government Purpose Release**

### **Planning Products Change Request (PPCR) Application**

**MSC-24807-1**

For the International Space Station (ISS) mission plan, this comprehensive change-request management tool offers built-in workflow processes to track condition-related information and thousands of tasks and activities. The technology allows planners to view a summary of all of the changes for any one mission day, even though the changes may have been received via multiple PPCRs and from various other flight controllers and disciplines.

**U.S. Government Purpose Release**

### **Positional Login (POSLOGIN)**

**MSC-25483-1**

In the Mission Control Center at Johnson Space Center, the operational support of International Space Station missions requires around-the-clock monitoring by flight controllers and support staff. POSLOGIN has been developed to ensure that processes remain in place and continue to be executed during shift changes.

**U.S. Government Purpose Release**

### **Real-Time Projection to Verify Plan Success During Execution**

**NPO-47734-1**

The Mission Data System software framework provides modeling tools to support the development of goal-oriented control systems through the adaptation of software base classes that represent the relevant state variables of the target system and their associated models of behavior. MDS also includes a goal scheduler, goal executive, and fault-response mechanism that provide the necessary runtime support to make these models executable. The demonstration system in which this new capability was developed is an onboard energy management system for the Multi-Mission Exploration Vehicle (also known as the Lunar Electric Rover).

**U.S. Government Purpose Release**

### **ROBUS-2 Fault-Tolerant Broadcast Communication System for Modular Avionics**

**LAR-17264-1**

ROBUS-2 is a time-division, multiple-access broadcast communication system that uses a time-indexed communication schedule for medium-access control. The technology provides guaranteed fault-tolerant services that include: message broadcast (Byzantine Agreement), dynamic communication schedule update, time reference (clock synchronization), and distributed diagnosis (group membership).

**Open Source**

### **Sasquatch Footprint Predictor**

**MSC-25513-1**

Sasquatch is used to predict flight paths and landing regions (i.e., footprints) to ensure that an aircraft's payload will land in a safe, obstacle-free region of a drop zone.

**U.S. Government Purpose Release**

**SCaN Optical Link Assessment Tool, Version 2****LEW-19313-1**

A calculation procedure has been designed and implemented in software that enables the specification and design of a space-based optical communications system. The resulting optical link budget essentially accounts for the communication power flow through the entire optical communications channel from the transmitter to the receiver and yields design specifications for the optical system necessary to assure reliable data transmission with desired operational metrics such as data rate, link margin, etc. The link assessment tool takes into account all of the sources of deleterious noise that enters into the communications process such as electronically generated noise in the optical detector and stray optical irradiance from external sources. The link budget has the capability of being interfaced with the orbital element calculations of the Satellite Tool Kit (STK) to allow the dynamic description and evolution of optical link operation from any space-borne satellite within the solar system to and from the Earth. The current version implements PPM and DPSK modulation types that can use PIN, APD, or nanowire optical detectors in the presence of atmospheric turbulence. Coded and un-coded link power margins are provided.

**U.S. Release Only****Scheduling and Planning Interface for Exploration (SPIFe)****ARC-15795-1A**

The SPIFe interface allows plans to be generated under complex constraints and reduces the number of team members necessary to achieve mission goals. The technology, consisting of a set of plugins built using the Java Eclipse Rich Client Platform (RCP), complies with the standards of the Ensemble project. SPIFe software offers several novel controls and visualizations for task planning and a generalized application interface for communicating with planning engines.

**U.S. Government Purpose Release****Simple Scalar Estimator of Residual CO2 Atmospheric Absorption (ATMO) for CRISM/MRO Hyperspectral Images of the Martian Surface****NPO-47670-1**

Any hyperspectral imager of the Martian surface will encounter atmospheric absorption that must be corrected. The Advanced Multimission Operations System enables principal investigators to directly, immediately, flexibly and seamlessly interact with their instruments and their data from wherever they are located.

**U.S. Government Purpose Release****Space Link Extension Return Channel Frames (SLE-RCF) Service Software Library (User Side)****GSC-15458-1**

This software library enables a mission control center to receive telemetry frames from a ground station. The technology implements the SLE-RCF protocol as defined by the Consultative Committee for Space Data Systems (CCSDS). Software routines can be reused from mission to mission.

**U.S. Government Purpose Release****Space Telecommunications Radio System (STRS) Compliance Tools****LEW-18562-1**

These tools are used to help verify software compliance to the NASA-developed Space Telecommunications Radio System (STRS) architecture. The goal of STRS is to support waveform application portability, upgradability, and reduce the cost and risks of using software-defined radios for NASA. ComplianceTool.sh is a Bourne shell script that tests an STRS application for the appropriate method signatures. The output is a Web page containing the results. The command and compliance application, WFCCN, is ported, compiled, and linked with an STRS infrastructure to verify static compliance such that all required STRS infrastructure-provided methods are implemented, as well as the named constants, typedefs, and structs. WFCCN may also be executed for dynamic compliance testing.

**U.S. Release Only****Telemetry and Science Data Software System****GSC-15793-1**

The Telemetry and Science Data Software System was designed to ease testing verification, assist in debugging system anomalies, and perform both trending data analysis and advanced science analysis.

**U.S. Government Purpose Release**

### **Telemetry and Science Data Software System, Updated**

**GSC-16035-1**

The Telemetry and Science Data Software System was designed to ease testing verification, assist in debugging system anomalies, and provide both trending data analysis and advanced science analysis.

**U.S. Government Purpose Release**

### **Thermal Insulation System Analysis Tool (TISTool)**

**KSC-13561**

The Thermal Insulation System Analysis Tool has been updated with more test data from the Cryogenics Test Laboratory and has been converted to Fortran 95 to allow for easier distribution.

**U.S. Release Only**

### **Timeline Builder Assistant (TBA)**

**LAR-18726-1**

Timeline Builder Assistant is intended to support initial surface operations planning by quickly building mission timelines with the “building blocks” method. The result produces a possible approach to completing all mission requirements and is intended for basic feasibility analysis. To build a new timeline, the user is prompted to enter the name of each building block and the number of times it is to be used. The program builds an EVA timeline to complete science and exploration objectives while complying with current human spaceflight limits on the number of hours of EVA allowed per day and week. At completion, the program displays the timeline, number of days to complete all requirements, number of rest days, and number of sites visited. The database keeps a record of activities and building blocks used in all surface missions and is easily searchable by the user or the program.

**U.S. Release Only**

### **Tracking and Data Relay Satellite (TDRS) Simulator (TSIM)**

**GSC-16845-1**

TSIM provides a ground-based capabilities simulation of the first-generation Tracking and Data Relay Satellite (TDRS).

**U.S. Government Purpose Release**

### **Web-Based Customizable Viewer for Mars Network Overflight Opportunities**

**NPO-47581-1**

This software provides a unique view of overflight opportunities between landers and orbiters. Unlike the traditional use of comma-separated value (CSV) files, this new application presents more information than what is traditionally carried in the CSV file in a layout that is both visually easy to follow while still being dense with information.

**U.S. Government Purpose Release**

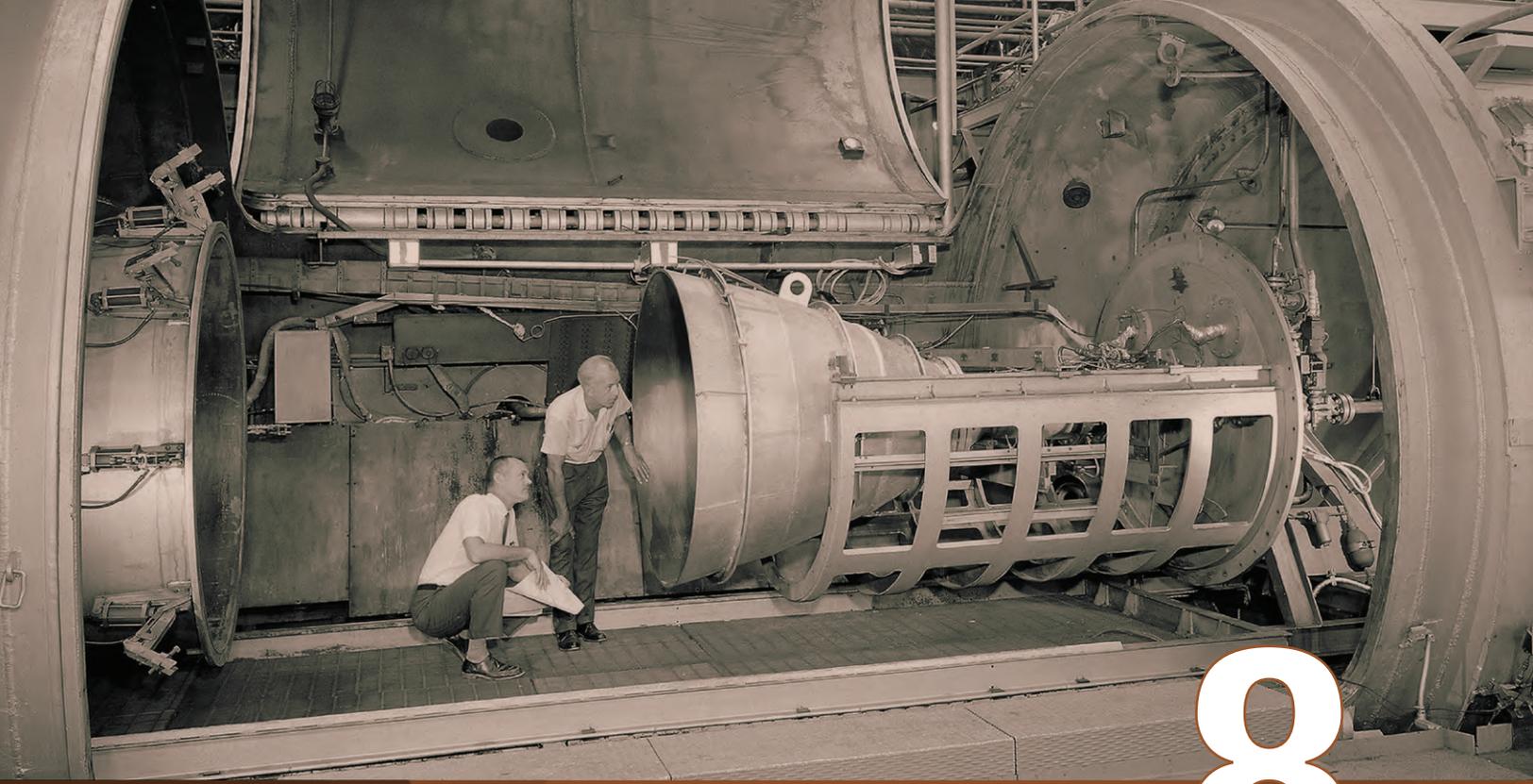
### **Visiting Vehicle Ground Trajectory Tool**

**MSC-24763-1**

This targeting tool provided the ability to perform planning and real-time operations for the visiting International Space Station (ISS) vehicle group.

**U.S. Government Purpose Release**

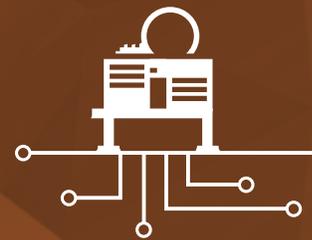




# 8

## Structures and Mechanisms

Deployables, Structural Loading  
Analysis and Design



## Featured Software



### **Beyond Low-Earth Orbit (LEO) Architecture Sizing Tool**

A user-friendly, configurable spacecraft sizing tool, BLAST provides a shareable, re-creatable and rigorous end-to-end multi-element architecture framework that has been used to generate mass data for in-space, beyond low-Earth orbit (LEO) transportation vehicles and architectures. Offering a novel approach to modeling, BLAST couples extensive MER research with the ability to assess mission changes instantaneously by analyzing sensitivity sweeps of several parameters at once.

**U.S. Government Purpose Release**

**(BLAST)**

**MSC-25505-1**

### **CCGEOM**

CCGEOM is a Fortran computer code developed to facilitate the rapid generation of flow passage and blading for various turbomachinery components.

**U.S. Release Only**

**LEW-17450-1A**

### **Data Transfer Between Dissimilar Meshes (DTBDM), Version 2.0**

Designed to automate an otherwise labor-intensive process, DTBDM puts the aerodynamic loads output of a computational fluid dynamics (CFD) package into the structural model of an aircraft to allow for deflection calculations.

**U.S. Release Only**

**LAR-16371-1**

### **Launch Vehicle Analysis (LVA) Tool**

The Launch Vehicle Analysis (LVA) Tool is a software program that integrates ground and flightload analysis with direct-solution structural and thermal analysis. A typical solution can be obtained, starting from scratch, in thirty to sixty minutes, and subsequent runs can be done in less than two minutes.

**U.S. Government Purpose Release**

**MFS-31694-1**

### **Piping Stress Analysis Software**

The Piping Stress Analysis Software calculates the stress, working pressure, or required pipe-wall thickness for a given application in a simple, straightforward manner. The program allows the user to select a specific material from a database of commonly used materials or create a customized database for an unlisted material. Pipes can be analyzed according to several sets of requirements, including the ASME/ANSI B31.1 and B31.3 piping codes and the JIC hydraulics code. Both standard and SI metric versions are available.

**U.S. Release Only**

**KSC-11692-1**

### **Software Platform for Post-Processing Waveform-Based Non-destructive Evaluation, Version 2**

As the name suggests, this tool provides a software platform for post-processing waveform-based non-destructive evaluation (NDE).

**General Public Release**

**LEW-18460-1**



**Active Mirror Predictive and Requirements Verification Software (AMP-ReVS) NPO-47667-1**

This software will be used for the future development of NASA space telescope mirrors including TPF, ATLAST, and the International Space Station Observatory. The tool blends together finite element model predictions and laboratory-measured data for large (1-m class) optical-quality mirrors with figure control actuators. It computes phenomenological contributions to the surface figure error using various built-in optimization techniques.

**U.S. Government Purpose Release**

**Automated Cryocooler Monitor and Control System Software NPO-47247-1**

This software is used in an automated cryogenic control system developed to monitor and control the operation of small-scale cryocoolers. The system was designed for cryogenically cooled low-noise-amplifier systems used in the NASA Deep Space Network (DSN). It automates the entire operation of the system including cool down, warm-up, and performance monitoring.

**U.S. Release Only**

**CCGEOM LEW-17450-1A**

CCGEOM is a Fortran computer code developed to facilitate the rapid generation of the flow passage and blading for various turbomachinery components.

**General Public Release**

**Data Transfer Between Dissimilar Meshes (DTBDM), Version 2.0 LAR-16371-1**

Designed to automate an otherwise labor-intensive process, DTBDM puts the aerodynamic loads output of a computational fluid dynamics (CFD) package into the structural model of an aircraft to allow for deflection calculations.

**U.S. Release Only**

**Half-Cycle Crack Growth DRC-010-044**

This NASA-developed software program predicts the operational flight life of critical aero-structural components. The tool offers a reliable method for calculating theoretical fatigue crack growths that could lead to catastrophic structural component failures. The program builds upon and integrates Armstrong's proven half-cycle and closed-form aging theories and is especially accurate because it considers every half-cycle of loading spectra for specific structural components. The program works by reading test data files and determining maximum and minimum loads of each half-cycle of random loading spectra in order to calculate theoretical crack growth. The innovation is an improvement on traditional prediction software (and in particular on visual inspections) because it considers mini-amplitude stress loading and half-cycles based on the duty cycle of a particular component or structure.

**General Public Release**

**HCDstruct LAR-18313-1**

This MATLAB routine generates a scalable finite element model suitable for hybrid wing-body (HWB) structural analysis and optimization. HWB geometry structure is based on a vehicle sketch-pad (VSP) surface model of an aircraft and a FLOPS-compatible parameterization of the center body and wing structure. Optimization and weight calculation are based on a Nastran finite element analysis of the primary structural components.

**U.S. Release Only**

**Monocoque Tank Analysis Spreadsheet System (MonTASS), Version 2.0 MFS-31223-1**

The Monocoque Tank Analysis Spreadsheet System (MonTASS) computer program enables rapid analysis and preliminary design of structural domes and truncated sections of cones. MonTASS performs both design and analysis functions and can be used to analyze nonpressurized conical structures.

**U.S. Release Only**



### **New Techniques for Down-Sampling a Measured Surface Height Map for Model Validation**

**NPO-47711-1**

The MATLAB software of this new method has been fully developed and is currently being used in the Advanced Wavefront Control Testbed at the Jet Propulsion Laboratory. This contribution can be used in any NASA space optics system, such as TPF. Because this contribution reduces validation errors dramatically in any model involving optical surfaces, cost savings can be significant.

**U.S. Government Purpose Release**

### **Object-Oriented Optimization Tool, Version 2.0**

**DRC-014-024**

This object-oriented framework integrates the analysis codes for multiple disciplines, instead of relying on one code to perform the analysis for all disciplines. Optimization can take place within each discipline module or in a loop between the central executive module and the discipline modules (or both). This version uses a public-domain optimization code, Automated Design Synthesis (ADS) instead of using the DOT code.

**U.S. Release Only**

### **Open IsoEFIT**

**LAR-19306-1**

This is an ultrasound solver for an arbitrary geometry in isotropic materials.

**U.S. Release Only**

### **Reduced Order Analysis Using a Nonlinear STiffness Evaluation Procedure (RANSTEP)**

**LAR-17262-1**

A new implementation of reduced order finite-element-based analysis for solving geometrically nonlinear random vibration problems of complex structures has been developed. The implementation is given the acronym RANSTEP for Reduced Order Analysis using a Nonlinear STiffness Evaluation Procedure. The nonlinear stiffness evaluation procedure allows computation of otherwise inaccessible modal nonlinear stiffness terms from commercial finite element programs. Some operations are performed outside the commercial codes and utilize in-house-developed Fortran codes. Additionally, Direct Matrix Abstraction Program (DMAP) alters and Python scripts are used to facilitate implementations written about MSC. NASTRAN and ABAQUS, respectively. Two solutions procedures of different fidelity and computational cost are offered in each implementation. They are equivalent linearization and time numerical simulation. Aerospace uses include aircraft and spacecraft structural analysis.

**U.S. Release Only**

### **SciFEN Solver Mini-App (HPCI)**

**LAR-19417-1**

This technology is a stripped-down version of a previously released code (SciFEN) that creates an open-source mini-app for LaRC's High-Performance Computing Incubator (HPCI). The app isolates the linear solver that SciFEN uses and loads an example system from file as a test case. It represents roughly 1% of the total source code.

**Open Source**

### **Software Platform for Post-Processing Waveform-Based NDE, Version 2.0**

**LEW-18460-1**

This software platform is for post-processing Waveform-based NDE.

**U.S. Release Only**

### **Stochastic Reduced Order Models with Python (SROMPpy)**

**LAR-19359-1**

The SROMPpy software package is a code written in Python to help solve uncertainty quantification and propagation problems. Stochastic Reduced Order Models (SROMs) are low-dimensional, discrete representations of a given random vector being modeled that facilitate efficient stochastic calculations. SROMs can be viewed as a smart Monte Carlo method. Using the concept for uncertainty propagation is similarly straightforward, but can significantly reduce computation time.

**Open Source**



**Tool for Generation of MAC/GMC Representative Unit Cell for CMC/PMC Analysis****LEW-19522-1**

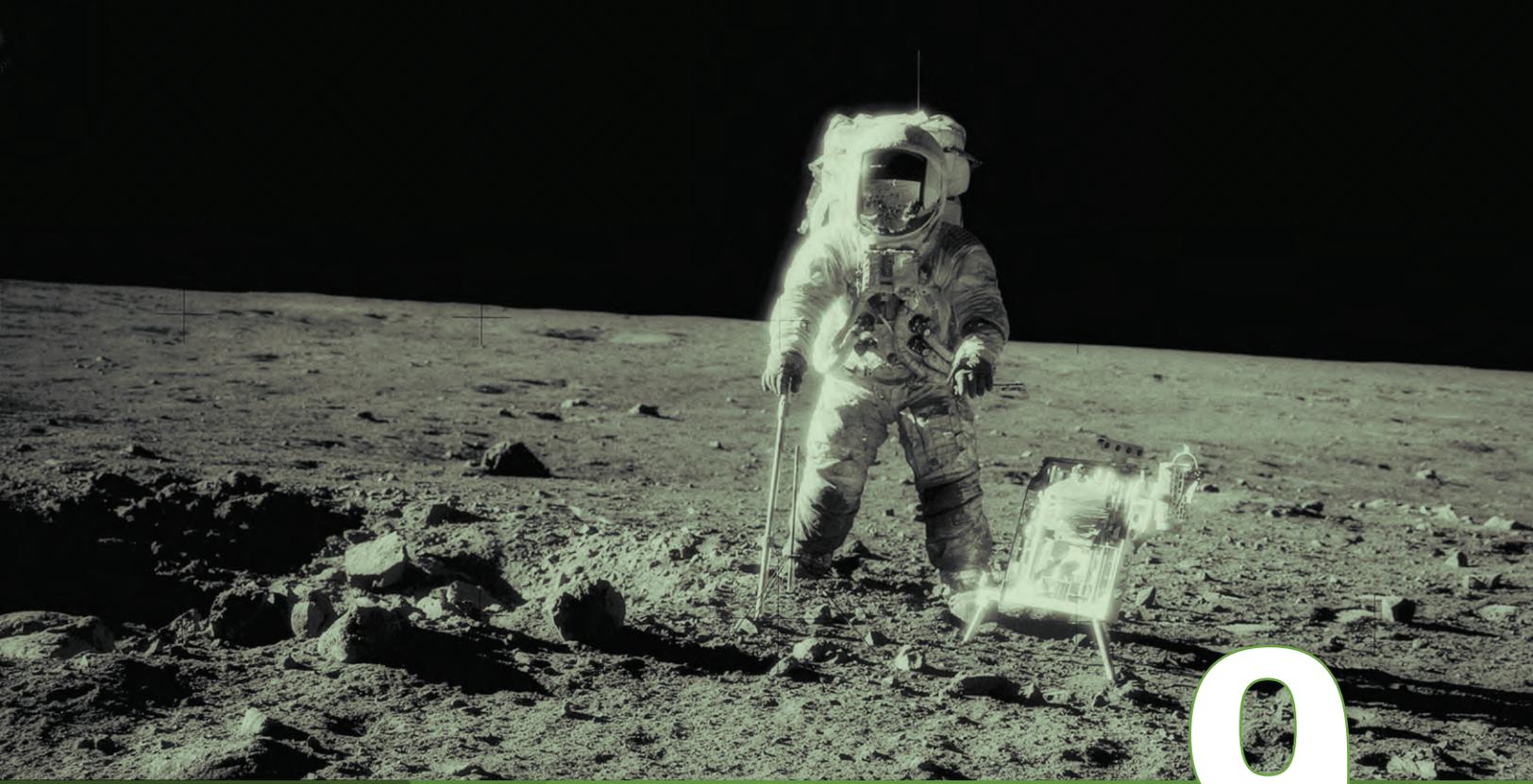
This is a GUI-based tool that generates a number of different user-defined repeating unit cells (RUCs) interactively that can be used in conjunction with MAC GMC and HF GMC, composite micromechanics-based analysis tools. In addition, the code has provisions for generation of a MAC/GMC-compatible input text file that can be merged with any MAC/GMC input file tailored to analyze composite materials. Although the primary intention was to address the three different constituents and phases that are usually present in CMCs (fibers, matrix, and interphase), the software can be easily modified to address two-phase polymer matrix composite (PMC) materials where an interphase is absent.

**U.S. Release Only****VLOADS: Launch Vehicle Loads Analysis for Preliminary Design, Version 1.4****MFS-27332-1**

The VLOADS program calculates launch vehicles' in-flight structural loads for preliminary design. The program may also be used to calculate structural loads for upper stages and planetary transfer vehicles. Launch vehicle information and input data such as aerodynamic coefficients, mass properties, propellants, engine thrusts, and performance data are compiled and analyzed by VLOADS to produce distributed shear loads, bending moments, axial forces, and vehicle line loads as a function of X-station along the vehicle's length. Translational accelerations and interface loads, if the launch vehicle has boosters or wings, are also computed.

**General Public Release**





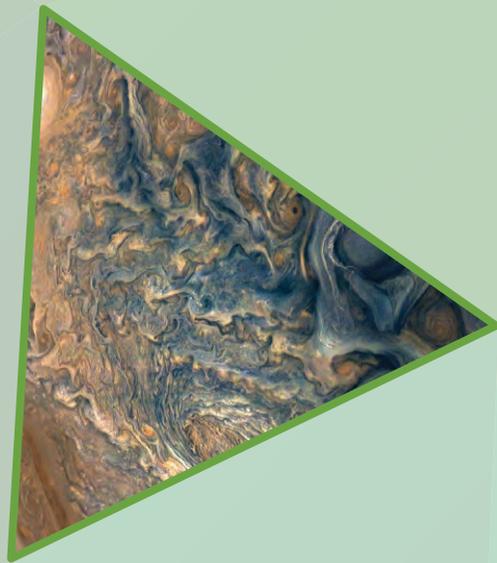
# 9

## Environmental Science

Earth • Air • Space • Exoplanet

Terrestrial Environments, Planetary Atmospheric Modeling, Radiation Shielding





## Featured Software

### **Earth Global Reference Atmospheric Model 2016 (Earth GRAM 2016)**

**MFS-32780-2**

Earth-Gram 2016 is a computer code that can run on a variety of platforms including PCs and UNIX stations. The model provides values for atmospheric parameters such as density, temperature, winds, and constituents for any month and at any altitude and location within the Earth's atmosphere. Earth-Gram 2010 is also currently supported.

**U.S. Release Only**

### **Electric Propulsion Interactions Code (EPIC)**

**MFS-32165-1**

EPIC is an interactive computer toolset that enables the construction of a 3D spacecraft model and the assessment of a variety of interactions between the model's subsystems and the plume from an electric thruster. EPIC unites different computer tools to address the many complexities associated with spacecraft/plume interaction processes.

**U.S. Release Only**

### **Interactive Spacecraft Charging Handbook With Integrated, Updated Spacecraft Charging Models (ISCCH), Version 3.1**

**MFS-31675-1**

The ISCCH is an interactive, Web-based multimedia product that offers updated and integrated spacecraft charging models. The software guides the non-expert using the power of sophisticated analysis tools.

**U.S. Release Only**



**Mars Global Reference Atmospheric Model 2010 (Mars GRAM 2010)**

**MFS-33158-1**

Mars-GRAM is an engineering-level atmospheric model widely used for diverse mission applications, including systems design, performance analysis, and operations planning for aerobraking, entry descent and landing, and aerocapture.

**General Public Release**

**NASA/Air Force Spacecraft Charging Analyzer Program (NASCAP-2K), Version 4.1**

**MFS-32056-1**

NASCAP-2K is the next-generation spacecraft charging analysis code. The technology is a comprehensive update to the original NASCAP spacecraft charging codes written twenty years ago. Resulting from a collaboration between NASA and the U.S. Air Force Research Lab (AFRL), the software builds upon the Air Force's DynaPAC charging algorithms and will replace 3D spacecraft charging codes for all environments.

**U.S. Release Only**

**Orbital Debris Engineering Model (ORDEM), Version 3**

**MSC-25457-1**

ORDEM offers flux as a function of debris size and year. The technology can be operated in spacecraft mode or telescope mode. An upgraded user interface uses project-oriented organization and provides graphical representations of numerous output data products.

**General Public Release**

**Titan Global Reference Atmospheric Model (Titan-GRAM), Version 1.0**

**MFS-32297-1**

Titan-GRAM is a program that provides engineering estimates of density, temperature, pressure, and winds for Titan's atmosphere. More information on the Space Environments & Effects (SEE) Program can be found at <http://see.msfc.nasa.gov/>

**U.S. Release Only**

**Venus Global Reference Atmospheric Model (Venus-GRAM) 2005, Version 1.0**

**MFS-32314-1**

Venus-GRAM 2005 is a program that provides engineering estimates of density, temperature, pressure, and winds for the atmosphere of Venus.

**General Public Release**



**3D Orbit Visualization for Earth-Observing Missions****NPO-47316-1**

This software application was developed to visualize orbit paths for the Orbiting Carbon Observatory (OCO). It enables interactive exploration of spacecraft orbit paths and ground footprint paths in a 3D environment. Detailed information about any particular observation frame is available through a point-and-click “drill-down” capability.

**U.S. Government Purpose Release****3D Visualization Software for Mission Science Operations (Viz)****ARC-14933-1**

The Viz package provides situational awareness, science analysis, and data understanding capabilities for planetary exploration mission science operations. Affording a modular and extensible visualization environment, the technology couples network and plug-in interfaces with a 3D scene graph database and an interactive 3D viewer.

**U.S. Government Purpose Release****Advanced Land Image Assessment System (ALIAS)****GSC-15185-1**

ALIAS supports radiometric and geometric multispectral image processing for the Advanced Land Imager (ALI) instrument onboard NASA’s Earth Observing-1 (EO-1) satellite. The radiometric subsystem characterizes and (where possible) corrects: detector operability; gain; bias; coherent, impulse, and random noise; signal-to-noise ratios; saturation levels; striping and banding; and the stability of detector performance. Geometric processing functions support sensor alignment calibrations; sensor chip assembly alignments; modulation transfer function characterizations; image-to-image characterizations; and geodetic accuracy assessments. Please visit the following URL for more information: <http://opensource.gsfc.nasa.gov/projects/Alias/index.php>

**Open Source****Advanced Rapid Imaging and Analysis for Monitoring Hazards (ARIA-MH)****NPO-49479-1**

Advanced Rapid Imaging and Analysis for Monitoring Hazards (ARIA-MH) is a science data system (SDS) built upon a hybrid cloud computing environment to enable rapid generation of geodetic data products as input for hazard assessment and the basis for improved situational awareness and damage estimates following an event.

**U.S. Government Purpose Release****Airborne Radar Interferometric Repeat Pass Processing****NPO-46093-1**

This code is integral to generating products for the currently active UAVSAR sensor/program, as repeat-pass radar interferometry provides the only technique possible of obtaining highly accurate (millimeter level) and spatially dense surface deformation measurements. This technique is also important to the planned DESDynI mission that will employ L-band repeat pass radar interferometry to make surface deformation measurements over all the tectonically active regions of the Earth’s surface.

**U.S. Government Purpose Release****Algorithm for Automated Sargassum Detection for Landsat-8 OLI Imagery****SSC-00505**

This methodology and software were implemented to automatically detect Sargassum spp. (a floating aquatic seaweed) in 30-meter LANDSAT-8 Operational Land Imager (OLI) imagery. This Sargassum spp. detection is an extended form of Hus approach to derive a floating algae index (FAI), which is defined as the difference between the reflectance at the near infrared band (NIR, 859 nm) and the linear baseline between the red band (645 nm) and short-wave infrared band (SWIR, 1240 or 1640 nm).

**General Public Release**

### **Automatic Data Filter Customization Using a Genetic Algorithm**

**NPO-47788-1**

This software predicts whether a retrieval algorithm to recover CO<sub>2</sub> concentration from the input spectra of GOSAT (Greenhouse Gases Observing Satellite) will converge or diverge. The algorithm could be used to help predict and filter unneeded runs in any computationally expensive regime.

**U.S. Government Purpose Release**

### **Autonomous Hyperspectral Data Processing, Product Generation, and Dissemination for Rapid Response in Volcanic Emergencies**

**NPO-48123-1**

This software rapidly processes hyperspectral data, correcting for incident sunlight where necessary. Atmospheric transmission detects thermally anomalous pixels, fits data with model black-body thermal emission spectra to determine radiant flux, calculates atmospheric convection thermal removal, and then calculates total heat loss. From these results, an effusion rate estimation is made.

**U.S. Government Purpose Release**

### **Centralized Alert Processing and Asset Planning for Sensor Webs**

**NPO-46468-1**

This NASA Earth Science sensor Web has been in operational use since 2003 and has proven reliability of the sensor Web technologies for robust event detection and autonomous response using space and ground assets. This development effort highlights a number of areas for further work to move forward in infusing sensor Web technologies into NRO operational usage. Specific emphasis is on timeseries situational awareness, wide area and local surveillance, and change detection and focus of attention.

**U.S. Government Purpose Release**

### **CEOS Data Cube Platform, Version 2 (CEOS2)**

**LAR-18928-1**

The Committee on Earth Observation Satellites (CEOS) has long recognized a need for data processing infrastructure to support Earth science objectives in developing countries. Forest preservation initiatives, carbon measurement initiatives, water management and agricultural monitoring are just a few examples of causes that can benefit greatly from remote sensing data. Currently, however, many developing nations lack the in-country expertise and computational infrastructure to utilize remote sensing data. The CEOS Data Cube Platform provides a flexible model to address these needs. The platform provides a data ingestion framework that includes support for automated ingestion of a wide variety of remote sensing data products. The data products are ingested into an N-dimensional data array that abstracts away management of distinct acquisitions. The platform has a tiered API for data processing and a data/application platform layer for higher-level access.

**Open Source**

### **Characterization of Cloud Water Content Distributions**

**NPO-47248-1**

The fundamental problem of cloud parameterization is to characterize the distributions of cloud variables at sub-grid scales and to relate the sub-grid variations to the resolved flow. This software solves the problem by estimating the probability density function of cloud water content at the sub-grid scale using CloudSat measurements. The software uses a statistical method called maximum likelihood estimation to gauge the probability density function of the cloud water content.

**U.S. Government Purpose Release**

### **Coastal Salinity and Temperature (CSaIT) Web Application**

**SSC-00492**

This Coastal Salinity and Temperature Monitoring (CSaIT) Web application's objective is to provide daily access to salinity and temperature data on a continuous and unrestricted basis to authorized users. Numerical model data from multiple sources are collected and integrated with NASA remotely sensed satellite data to provide up-to-date and historical information on water temperature, salinity, and oyster lease locations for coastal environments along the Gulf of Mexico.

**General Public Release**



**Common Metadata Repository****GSC-17610-1**

The Common Metadata Repository (CMR) is a spatial and temporal metadata registry that enables the science community to more easily discover, use, and exchange NASA's data and services. The CMR's main objective is to enable broader use of NASA's Earth-observing systems' (EOSDIS) data. It allows users to more efficiently and reliably search and access data and services and increases the potential for interoperability with new tools and services. The CMR stores metadata from a variety of science disciplines and domains, including climate variability and change, carbon cycle and ecosystems, Earth surface and interior, atmospheric composition, weather, and water and energy cycle. To ensure the quality of the metadata, the CMR system contains a tool called the Metadata Management Tool (MMT) which enables metadata providers to develop standards-compliant, high-quality metadata.

**Open Source****Crisis Mapping Toolkit (CMT), Version 1****ARC-17472-1**

The CMT is a collection of tools for processing geospatial data (images, satellite data, etc.) into cartographic products that improve the understanding of large-scale crises such as natural disasters. The cartographic products produced by CMT include flood inundation maps, maps of damaged or destroyed structures, forest fire maps, and population density estimates. CMT is designed to rapidly process large-scale data using Google Earth Engine and other geospatial data systems.

**Open Source****Desktop Exploration of Remote Terrain (DERT)****ARC-17647-1**

Desktop Exploration of Remote Terrain (DERT) is a software tool for exploring large Digital Terrain Models (DTMs) in 3D. It aids in understanding topography and spatial relationships of terrain features, as well as performing simple analysis tasks relevant to the planetary science community.

**Open Source****Earth Global Reference Atmospheric Model 2010 (Earth GRAM 2010)****MFS-32780-1**

Earth Gram 2010 is an open-source Fortran computer code that can run on a variety of platforms including PCs and UNIX stations. The model provides values for atmospheric parameters such as density, temperature, winds, and constituents for any month and at any altitude and location within the Earth's atmosphere. Versions from 1999 and 2007 are also available.

**U.S. Release Only****Earth Global Reference Atmospheric Model 2016 (Earth GRAM 2016)****MFS-32780-2**

Earth GRAM 2016 is a computer code that can run on a variety of platforms including PCs and Linux stations. The model provides values for atmospheric parameters such as density, temperature, winds, and constituents for any month and at any altitude and location within the Earth's atmosphere. Earth GRAM 2010 is available in Fortran.

**General Public Release****"Earth Now" iPhone App****NPO-48558-1**

NASA's Earth Now is a mobile device application that visualizes recent global climate data from Earth science satellites, including surface air temperature, carbon dioxide, carbon monoxide, ozone, and water vapor, as well as gravity and sea level variations. The project was developed by the Earth Science Communications Team at NASA's Jet Propulsion Laboratory with support from NASA Headquarters.

**U.S. Government Purpose Release**

## **Earth Science Datacasting, Version 2.0**

**NPO-47725-1**

This software gives users control to download only the Earth science data files that are required for a particular application. The tool is essentially a simple, yet powerful informed pull and visualization mechanism. It is modeled on the server-client architecture used in podcasting and leverages existing NASA capabilities. On the server side, the latest data granule is placed in an online store and an XML feed is created for the granule. The XML feed is based on the RSS 2.0 and GeoRSS 1.0 standard, with additional namespaces for describing Earth science data (dataset- and granule-level descriptions).

**U.S. Government Purpose Release**

## **Earthdata Search Web Application**

**GSC-17399-1**

Earthdata Search is a Web application enabling users to quickly and intuitively discover, search, visualize, and access Earth Science data in a highly visual manner. It interfaces with and demonstrates current state-of-the-art services provided by NASA EOSDIS such as the Common Metadata Repository (CMR) for sub-second search results, the Global Imagery Browse Services (GIBS) for fast-tiled imagery visualizations of data, and OPeNDAP for data access, transformation, and subsetting.

**Open Source**

## **EarthKit**

**NPO-49145-1**

EarthKit provides a framework for collaboration among researchers in Earth science. It offers a set of software tools for sharing any user's research environment via the Web and managing workflows that run in the cloud. By leveraging cloud computing services in this novel way, EarthKit can instantly replicate a research computing environment (software, data, operating system, and hardware).

**Open Source**

## **Electric Propulsion Interactions Code (EPIC)**

**MFS-32165-1**

EPIC is an interactive computer toolset that enables the construction of a 3D spacecraft model and the assessment of a variety of interactions between the model's subsystems and the plume from an electric thruster. EPIC unites different computer tools to address the many complexities associated with spacecraft/plume interaction processes.

**U.S. Release Only**

## **ElectroStatic Return of Contaminants Tool (Updated)**

**MFS-32011-1**

The ElectroStatic Return of Contaminants (ESR) tool is a first-generation computational code created for the purpose of computing the return characteristics of spacecraft-generated contaminants. The code computes the Debye sheath (if necessary), the returned contaminant mass rate, returned mass flux, returned mass ratio, return velocity, and surface sputter (where applicable). To help the user, default values have been supplied for all program inputs.

**U.S. Release Only**

## **Emission of Solar Protons (ESP) Model**

**MFS-31315-1**

This model predicts total solar proton fluence levels for interplanetary space in the energy range of 1 to 300 MeV, which is the range required for both solar cell and electronics applications.

**U.S. Release Only**



**EOS MLS Level 1B Data Processing Software, Version 3****NPO-47219-1**

The primary goal of this level-one processing software is to: (1) qualify each data quantity using instrument configuration and checksum data, as well as data transmission quality flags and apply statistical tests for data quality; (2) calibrate the instrument engineering data (e.g., voltages, currents, temperatures, and encoder angles); (3) interpolate filter channel space reference measurements onto the times of each limb measurement and difference the interpolates from the measurements; (4) interpolate filter channel calibration target measurements onto the times of each limb measurement and compute radiometric gain; (5) determine the total signal power analyzed by each Digital Autocorrelator Spectrometer (DACS) during each data integration; and (6) convert each DACS data integration from an autocorrelation measurement in the time domain into a spectral measurement in the frequency domain. Finally produce a log file summarizing instrument performance and outputs.

**U.S. Government Purpose Release****EOS MLS Level 2 Data Processing Software, Version 3****NPO-47221-1**

The software to implement this algorithm has been written in Fortran 95, chosen because of its great suitability for handling the complex matrix and vector entities involved. Combining both the retrieval and simulation tasks in a single piece of software makes it far easier to ensure that identical forward model algorithms and parameters are used in both tasks and dramatically reduces the complexity of the code maintenance effort. The unique feature of this software is its capability to measure the atmospheric temperatures and composition at the Earth's limb.

**U.S. Government Purpose Release****Eyes on the Earth 3D****NPO-47782-1**

Using a 3D graphical interface, this software provides a generic means for people to interactively view the real-time location, speed, and recent data gatherings of several of NASA's Earth-observing satellites. It also displays several Earth science data sets that have been collected on a daily basis.

**U.S. Government Purpose Release****General EQFlux****GSC-14791-1**

The Windows EQFlux computer program converts solar-cell damage resulting from hard-particle radiation into the equivalent fluence on MeV electrons. Please visit the following URL for more information:

<http://opensource.gsfc.nasa.gov/projects/eqflux/index.php>

**Open Source****GeoCam, Version 2****ARC-16088-1A**

GeoCam is a geospatial system for disaster response that consists of (1) low-cost consumer hardware (i.e., a digital camera or cell phone, position/orientation sensors, and an optional embedded controller) and (2) a Web-based workflow that enables images and other geo-referenced data to be shared and viewed in a variety of ways. GeoCam includes software that computes image location and provides for geo-rectification, KML-formatted geospatial data generation, image management, and geo-referenced data sharing.

**Open Source****GEOS-5 Global Change Master Modeling Software****GSC-15354-1**

GEOS-5 is a next-generation circulation model. Developed using the Earth System Modeling Framework (ESMF) for its internal architecture, the technology represents a new paradigm for systems development. Please visit the following URL for more information: <http://opensource.gsfc.nasa.gov/projects/GEOS-5/>

**Open Source****GEOS2WRF and MERRA2WRF Processing Tools****GSC-16065-1**

GEOS2WRF and MERRA2WRF are data preprocessing tools for the Weather Research and Forecasting (WRF) limited-area weather model.

**U.S. Government Purpose Release**

### **Global Precipitation Measurement (GPM) Operational Simulator (GO-SIM) Instrument Simulations**

**GSC-16264-1**

These software-only science instrument simulations satisfy the GPM bus controller and allow flight software to operate as it would under normal conditions.

**U.S. Government Purpose Release**

### **Global Precipitation Measurement (GPM) Operational Simulator (GO-SIM) Core**

**GSC-16262-1**

GO-SIM core provides a software-only simulator capability for executing GPM systems. The technology loads and runs different versions of spacecraft flight software, integrates with the Wind River workbench, and executes faster than real time.

**U.S. Government Purpose Release**

### **Global Precipitation Space and Ground Radar Comparison Software**

**GSC-15469-1**

Designed to support a prototype validation network for the Global Precipitation Measurement (GPM) space-flight mission, this space and ground radar comparison software collects data from the Precipitation Radar instrument flying on the Tropical Rainfall Measuring Mission (TRMM) spacecraft. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/GPM/>

**Open Source**

### **GLOBE Program's Citizen Science Cloud App for iOS**

**GSC-17391-1**

GLOBE members currently enter their scientific data using a data entry tool on GLOBE's site. This app allows GLOBE and non-GLOBE members and GLOBE to enter cloud observations into their mobile devices and send their observations to the GLOBE database. Users may enter the data while the mobile device is not connected to the Internet, data will be sent to GLOBE on user command when the device is back online.

**General Public Release**

### **GLOBE Program's Data Entry App for Android**

**GSC-17390-1**

The Global Learning and Observations to Benefit the Environment (GLOBE) program is a worldwide hands-on, primary and secondary school-based science and education program. The GLOBE Program's Data Entry App for Android enables members to enter data to via their Android devices and while in the field (where they may not have Internet connection). Their data will be stored locally on their Android devices and sent to the GLOBE database once their devices get connected to Internet. This project also facilitates data entry by leveraging mobile capabilities including GPS, photography, and date/time.

**General Public Release**

### **GLOBE Program's Data Entry App for iOS**

**GSC-17389-1**

The Global Learning and Observations to Benefit the Environment (GLOBE) program is a worldwide hands-on, primary and secondary school-based science and education program. The GLOBE Program's Data Entry App for iOS enables members to enter data via their iOS devices and while in the field (where they may not have Internet connection). Their data will be stored locally on their iOS devices and sent to the GLOBE database once their devices get connected to Internet. This project also facilitates data entry by leveraging mobile capabilities including GPS, photography, and date/time.

**General Public Release**

### **GPS Detection Tsunami Scale and Genesis**

**NPO-45940-1**

This method works by locating an earthquake's by using seismometer data. GPS displacement data from stations near the epicenter are then gathered to derive seafloor motions. Based upon these data, as well as local topography data and new theoretical developments, a new "tsunami scale" measurement from one to 10 is generated, much like the Richter Scale used for earthquakes. The scale is then used to discriminate earthquakes capable of generating destructive tsunamis from those unlikely to do so.

**U.S. Government Purpose Release**



**Hazards and Population Mapper (HazPop) Mobile Application for iOS Platform** **GSC-17605-1**

HazPop is a free app developed by the NASA Socioeconomic Data and Applications Center (SEDAC). It enables users to easily display recent natural hazard data in relationship to population, major infrastructure, and satellite imagery. Hazards data include the location of active fires over the past 48 hours; earthquake alerts over the past 7 days; and yesterday's air pollution data measured from space. The app shows the location of major dams and nuclear power plants and provides more detailed information and imagery for these facilities where available. This app is available for download at: <https://itunes.apple.com/us/app/hazards-population-mapper/id1092168898?mt=8>

**General Public Release**

**HDFView Plugin** **GSC-14948-1**

This Java-language software plug-in to HDFView provides an interface for two versions of hierarchical data formats (HDF 4 and HDF 5). Please visit the following URL for more information: <http://opensource.gsfc.nasa.gov/projects/HDF/index.php>

**Open Source**

**ICESat-2 Standard Data Products Subsetter** **GSC-17780-1**

This software was designed to subset ICESat-2 Standard Data Products. It reads in a single HDF5 ICESat-2 data granule, uses rules in a control file to reduce the set of parameters according to the rules in the control file, and writes out the resulting file.

**Open Source**

**Implementation of a Terrain Radiometric Correction for UAVSAR** **NPO-47891-1**

The correction deals with the steered antenna and significantly improves the potential of UAVSAR data to map forest biomass.

**U.S. Government Purpose Release**

**InSAR Scientific Computing Environment** **NPO-47557-1**

This software uses the next generation of geodetic imaging processing technology for InSAR sensors, which is needed to provide flexibility and extensibility in reducing measurements from radar satellites and aircraft to new geophysical products.

**U.S. Government Purpose Release**

**Interactive Spacecraft Charging Handbook with Integrated, Updated Spacecraft Charging Models (ISCCH), Version 3.1** **MFS-31675-1**

The ISCCH is an interactive, Web-based multimedia product that offers updated and integrated spacecraft charging models. The software guides the non-expert using the power of sophisticated analysis tools.

**U.S. Release Only**

**Ionospheric Simulation System for Satellite Observations and Global Assimilative Model Experiments (ISOGAME)** **NPO-47626-1**

This software system can assess observing systems consisting of low-Earth-orbiting GNSS receiver constellations and ground-based GNSS receiver networks (of any distribution designed to meet user requirements such as achieving global coverage with uniformly distributed observations). Under this system, the GAIM physics model or an empirical ionospheric model (e.g., the International Reference Ionosphere) will simulate a nominal or geomagnetically disturbed ionosphere for a specific experiment.

**U.S. Government Purpose Release**



### **Ionospheric Simulation System for Satellite Observations and Global Assimilative Modeling Experiments (ISOGAME)**

**NPO-47779-1**

It is a scientifically important and technologically challenging task to assess quantitatively the impact of a new observation system on the capability to image and model the ionosphere. This question is often raised whenever a new satellite system is proposed, a new type of data is emerging, or a new modeling technique is developed. ISOGAME fills the need to conduct observation system simulation experiments.

**U.S. Government Purpose Release**

### **Ionospheric Specifications for SAR Interferometry (ISSI)**

**NPO-48351-1**

Signals transmitted and received by a polarimetric SAR are subject to the Faraday rotation effect (named after the scientist who discovered the phenomenon in 1845) as they traverse the magnetized ionosphere. The ISSI algorithms combine the horizontally and vertically polarized (with respect to the radar system) SAR signals to estimate the radar system calibration parameters and derive Faraday rotation. The ISSI software package has been designed and developed to integrate the algorithms, process PolSAR data, and image/visualize Faraday rotation.

**U.S. Government Purpose Release**

### **James Webb Space Telescope (JWST) Wavefront Sensing Software**

**GSC-15399-1**

This software package implements an image-based phase-retrieval algorithm. Using a variable number of irradiance measurements collected in defocused planes as input, the software is capable of determining optical wavefront information. In addition to the JWST, the technology is applicable to other segmented telescope systems.

**U.S. Government Purpose Release**

### **Kepler Community Data Analysis Tools**

**ARC-16805-1**

The Kepler archive contains time-series data calibrated and reduced from detector pixels. The pipelined reduction includes the removal of time-series trends systematic to a spacecraft and its environment.

**Open Source**

### **Land Information System (LIS) Software, Version 6.1**

**GSC-16290-1**

LIS can be used (1) as a problem-solving environment for hydrologic research to enable accurate global water- and energy-cycle predictions, or (2) as a decision support system to generate useful information for disaster, water resource, and agricultural management; numerical weather prediction; and air quality and military mobility assessment. Extensible interfaces allow the incorporation of new domains, land surface parameters, meteorological inputs, data assimilation, and optimization algorithms. Please visit the following URL for more information: <http://lis.gsfc.nasa.gov/>

**U.S. Government Purpose Release**

### **Landslide Hazard Assessment for Situational Awareness (LHASA)**

**GSC-17452-1**

This framework integrates a regional landslide susceptibility map and satellite-based rainfall estimates into a binary decision tree model, considering both daily and antecedent rainfall. Using a regionally distributed, percentile-based threshold approach, the model outputs a pixel-by-pixel nowcast in near real time at a resolution of 30 arcseconds to identify areas of moderate and high landslide hazard.

**Open Source**

### **Lightning Forecasting Algorithm (LFA)**

**MFS-33225-1**

The Lightning Forecasting Algorithm (LFA) is an algorithm that may be implemented within any cloud-allowing or cloud-resolving numerical forecast model that converts gridded forecasts of updraft speeds and graupel hydrometeor mixing ratios in the mixed phase layer into gridded estimates of total lightning flash rate density.

**General Public Release**



**Low-Altitude Trapped Radiation Model, Version 1****MFS-31309-1**

Accurate models of the Earth's trapped energetic proton environment are required for both piloted and robotic space missions. As astronomical and remote sensing detectors become more sensitive, proton flux can induce unwanted backgrounds in the instrumentation. The Low-Altitude Trapped Radiation Model, based on nearly 20 years of data from the TIRO/NOAA weather satellites, predicts the integral omnidirectional proton flux in three energy ranges. The model contains a true solar cycle variation and accounts for the secular variation in the Earth's magnetic field.

**U.S. Release Only****Lunar e-Library****MFS-32430-1**

The Lunar e-Library database provides an accessible, searchable set of technical references on the lunar environment, lunar studies, and past lunar missions. This DVD knowledge base contains 1100 (PDF) items with an emphasis on documents produced during the Apollo/Saturn era. Full text is available for 870 documents, and abstracts with source information are included for 230 documents that are copyrighted or are considered limited distribution materials.

**U.S. Release Only****Magnetogram Forecast (Mag4)****MFS-32802-1**

Forecasting from a magnetogram of a sunspot active region, this algorithm predicts solar eruptions anticipated within the next 24 to 48 hours. The technology essentially transforms available solar scientific data into forecasting tools for severe space weather conditions.

**U.S. Release Only****Mars Global Reference Atmospheric Model 2010 (Mars GRAM 2010)****MFS-33158-1**

Mars GRAM is an engineering-level atmospheric model widely used for diverse mission applications, including systems design, performance analysis, and operations planning for aerobraking, entry descent and landing, and aerocapture.

**General Public Release****Marshall MRMS Mosaic Python Toolkit (MMM-Py)****MFS-33236-1**

MMM-Py reads, analyzes, and displays three-dimensional national mosaicked reflectivity data produced by NOAA's National Severe Storms Laboratory (NSSL). MMM-Py can read MRMS mosaics from either their unique binary format or their converted NetCDF format; it can also read and properly interpret the current mosaic design (4 regional tiles), as well as mosaics produced prior to late July 2013 (8 tiles). The technology can easily stitch multiple tiles together to provide a larger regional or national picture of precipitating weather systems. Composites, horizontal/vertical cross-sections, and combinations thereof are easily displayed using as little as one line of code.

**Open Source****MATLAB-Based Solar System Ephemeris Toolbox****KSC-12544**

This set of MATLAB functions has been used to generate state data (position and velocity) for the Sun, the Earth's moon, and all of the other planets in the solar system. Provided by the Jet Propulsion Laboratory's Solar System Dynamics Group, the technology uses Chebychev polynomial fits of numerical integration results for solar system motion. Essentially, the toolbox functions as the MATLAB equivalent of JPL Fortran routines used to construct binary ephemeris files, verify correct installation, and generate state data.

**General Public Release**

### **Multiple-Doppler Radar Analysis Toolkit (MultiDop)**

**MFS-33436-1**

MultiDop merges three-dimensional variational analysis (3DVAR) software code developed by the University of Oklahoma with the Department of Energy's Python Atmospheric Radiation Measurement Radar Toolkit (Py-ART) software framework. This enables end users to ingest, correct, and grid their weather radar data using Py-ART, and then pass the radar volumes to MultiDop to synthesize, analyze, and display the 3D winds. By using the software developed in this effort, an entire science analysis project can be done using a shareable Jupyter notebook.

**Open Source**

### **Multi-Scale Three-Dimensional Variational Data Assimilation (MS-3DVAR) System for Coastal Ocean Prediction**

**NPO-47768-1**

A multi-scale three-dimensional variational data assimilation scheme (MS-3DVAR) has been formulated, and the associated software has been developed for high-resolution coastal ocean models. It assimilates simultaneously and effectively sparse vertical profiles and high-resolution surface measurements and constrains forward-model biases. The cost function is decomposed into two separate units for the large- and small-scale components, respectively.

**U.S. Government Purpose Release**

### **NASA Forecast Model Web (NFMW) Map Service**

**GSC-15276-1**

NFMW reads weather forecast models outputs; subsets the data to the region of interest; interpolates the data to the specified size; generates a visualization of the data using colors, contour lines, or arrows; and sends the visualization to the client. More information can be found at: <http://opensource.gsfc.nasa.gov/projects/NFMW/>

**Open Source**

### **NASA Unified Weather Research and Forecasting (WRF)**

**GSC-16234-1**

At NASA, WRF is being used to study: the precipitation processes associated with several high-impact weather events; aerosol impact on the area climate and water cycles over monsoon regions; the influence of land surface heterogeneity and soil moisture gradients on land-atmosphere interactions; explicit simulations of hurricanes; and interactive chemistry-aerosol processes.

**U.S. Government Purpose Release**

### **NASA Visualization Explorer (NASA Viz) for Android**

**GSC-17628-1**

NASA Visualization Explorer (NASA Viz) is an intuitive interactive Android application and an extension of the NASA Viz iPad and iPhone versions. The application delivers science stories with multimedia content linking high-quality explorable images, descriptive text, visualizations, videos and interviews with a fresh look and feel. App features include: credit information for each story, the ability to share stories with social media and to create lists of stories that can be shared with other users, and the ability to explore stories by keywords and search.

**General Public Release**

### **NASA/Air Force Spacecraft Charging Analyzer Program (NASCAP-2K), Version 4.2**

**MFS-32056-1**

NASCAP-2K is the next-generation spacecraft charging analysis code. The technology is a comprehensive update to the original NASCAP spacecraft charging codes written twenty years ago. A collaboration of NASA and the U.S. Air Force Research Lab (AFRL), the software builds upon the Air Force's DynaPAC charging algorithms and will replace 3D spacecraft charging codes for all environments.

**U.S. Release Only**

### **Neo-Geography Toolkit (NGT), Version 2**

**ARC-16341-1A**

NGT is a collection of automated processing tools that can transform raw geospatial raster data from remote sensing instruments into useful cartographic products, including visible image base maps and topographic models.

**Open Source**

**Neptune Global Reference Atmospheric Model (Neptune-GRAM), Version 1.0****MFS-32296-1**

From surface to orbital altitudes, this Fortran-based program provides engineering estimates of density, temperature, pressure, and winds for the Neptune atmosphere.

**General Public Release****Obs4MIPS****GSC-16848-1**

This technology is a front end to the Climate Model Output Rewriter (CMOR2) software package. The technology converts a variety of standard data formats (e.g., netcdf3, netcdf4, Grads control files, and MATLAB data files) to allow publication on the Earth System Grid Federation (ESGF) data node.

**Open Source****Oil Detection Algorithm (ODA)****SSC-00510**

This Oil Detection Algorithm (ODA) application identifies petroleum signatures at the surface of the ocean in 250-m Moderate Resolution Imaging Spectroradiometer (MODIS) data outside of the sun glint pool. Inputs to ODA are MODIS 250-m normalized water leaving radiance (nLWs) at four wavelengths: 531nm, 547 nm, 645 nm, and 678 nm. nLWs are Level 2 products resulting from the processing of the MODIS Level 1B data with the NASA SeaDAS 7.2 software. Since the algorithm uses MODIS-250m products, images processed with the ODA contain the striations inherent to this spatial resolution. To address this problem, a noise removal algorithm, developed by the Naval Research Laboratory, is applied after the processing of the MODIS data and the application of the ODA. The outputs of the ODA include: one graphics file depicting the distribution of the oil signature at the surface of the ocean, as well as one ASCII file containing the geographical coordinates of the pixels identified as containing oil. The operating system is Linux and requires an external HDF library as a header file.

**General Public Release****Orbital Debris Engineering Model (ORDEM), Version 3****MSC-25457-1**

ORDEM offers flux as a function of debris size and year. The technology can be operated in spacecraft mode or telescope mode. An upgraded user interface uses project-oriented organization and provides graphical representations of numerous output data products.

**General Public Release****Particle Trajectory with Shepard's Interpolation for Raindrops****KSC-13800**

A particle trajectory model, Particle Trajectory with Qshep interpolation (PTQ), was previously developed to describe the path of rocket plume ejected particles on the lunar surface, predicting the distance particles travel and their impact velocities. A modification of PTQ was made to support the study of the disdrometer-derived Z-R relation. The new version, Particle Trajectory with Shepards interpolation for Raindrops (PTS-R), incorporates an empirical relation between particle diameter D and the drag shape factor Sf to account for the fact that raindrops, unlike lunar soil particles, change shape in response to aerodynamic forces. A relationship was empirically determined relating Sf to particle diameter D for raindrops. The software also supports the original plume driven dust/soil particle application.

**General Public Release****Planetary Data Systems (PDS) Imaging Node Atlas II****NPO-47820-1**

This tool allows the user to search through the multiple mission databases and identify images based on parameters entered by the user. It includes both basic and advanced search capabilities, providing a product search tool to interrogate the collection of planetary images. The end-user can query information about each image.

**U.S. Government Purpose Release**

### **Predicting Magnetospheric Relativistic > 1 MeV Electrons**

**NPO-49852-1**

From the data analyses, we were able to determine that the relativistic electrons have a delay in their acceleration. The higher the kinetic energy, the longer the delay time. Thus, it is possible to give spacecraft engineers days of warning so they can save their spacecraft.

**U.S. Government Purpose Release**

### **Processing COSMIC/FORMOSTAT-3 Data for Slant Total Electron Content Measurements**

**NPO-47971-1**

Using the principle of maximum entropy and the analytic structure of the code- and phase-based ionospheric combinations, a new weighting scheme for providing a weighted average of the difference of the code- and phase-based combinations has been developed. These new weights are derived from the minimal information content of the multipath, under the assumption that the distribution itself is unknown.

**U.S. Government Purpose Release**

### **Python Advanced Microwave Precipitation Radiometer Data Toolkit (PyAMPR)**

**MFS-33219-1**

This toolkit will read geolocated brightness temperature data (in ASCII format) from any flight of the AMPR airborne instrument. A python script will pull out timing, brightness temperatures, and other information from each channel/geolocation and store them as attributes using the appropriate type of array. The approach consists of ingesting the entire file as a text string and then parsing and converting as necessary. The file is read and the data are populated when the class is instantiated with the full path and name of an AMPR file. Numerous visualization methods are provided, including track plots, strip charts, and Google Earth KMZs. In addition, polarization deconvolution is available.

**Open Source**

### **Python Interface to Cyclone Global Navigation Satellite System (CYGNSS) Wind Dataset**

**MFS-33273-1**

The CYGNSS is a NASA Earth science mission that launched in December 2016. This software, which is written in the Python language, was developed to facilitate the ingest, analysis, and display of CYGNSS data.

**Open Source**

### **Python Interface to Dual-Pol Radar Algorithms (DualPol)**

**MFS-33274-1**

This is an object-oriented Python module that facilitates precipitation retrievals (e.g., hydrometeor type, precipitation rate, precipitation mass, particle size distribution information) from polarimetric radar data. It leverages existing open source radar software packages to perform all-in-one retrievals that are then easily visualized or saved using existing software.

**Open Source**

### **Python Polarimetric Radar Beam Blockage Calculation (PyBlock)**

**MFS-33284-1**

This Python package will calculate beam blockage in polarimetric weather radar data using the specific differential phase (KDP) and fully self-consistent (FSC) methods of Timothy J. Lang et al. (2009; J. Atmos. Oceanic Technol.). This information can be used to correct the radar data when the radar beams intersect objects like trees, buildings, and mountains.

**Open Source**

### **Python Turbulence Detection Algorithm (PyTDA)**

**MFS-33237-1**

PyTDA, an MSFC-based implementation of the National Center for Atmospheric Research (NCAR) Turbulence Detection Algorithm (NTDA), can be used for convective-scale analysis, situational awareness, and forensic meteorology. The software provides Python functions that will estimate turbulence from Doppler radar data. It is written in the Python programming language.

**Open Source**

### **Radiation Environment Array Charge Transport (REACT)**

**MFS-32001-1**

The REACT detector array charge collection model is useful in the design of optical sensor missions.

**U.S. Release Only**



**Rapid Forest Triage by Sub-Canopy Micro Air Vehicles****NPO-49673-1**

Based on an existing micro-air vehicle system that executes an autonomous navigation framework to maneuver in GPS-denied environments (close to the ground and in highly cluttered environments), a data processing framework was developed to analyze imagery from an on-board forward-looking stereo vision system to calculate tree trunk distribution maps. This includes estimating the forest floor profile, detecting tree trunks in the images and calculating diameter of tree trunks at a certain height above the ground. The new technology includes all individual components at a low TRL level. Processing is currently done off-line from collected images that are manually labeled to compare tree diameter and position estimations with ground truth. The framework was tested on data from an example forest of live oak.

**U.S. Government Purpose Release****Regional Hydrologic Extremes Assessment System (RHEAS) Software Framework****NPO-49821-1**

This software automates the deployment of nowcasting and forecasting hydrologic simulations and ingests satellite observations (through data assimilation), and it also allows the coupling of other environmental models and facilitates delivery of data products to users via a GIS-enabled database.

**Open Source****Simple Thermal Environment Model (STEM) User's Guide****MFS-31728-1**

Helpful in the thermal analysis of near-Earth spacecraft, the STEM User's Guide is a Fortran-based program that provides engineering estimates of top-of-atmosphere albedo and outgoing longwave radiation.

**U.S. Release Only****Space Physics Data Facility (SPDF) Web Services****GSC-14730-1**

These Web services provide a distributed programming interface to a portion of the Space Physics Data Facility (SPDF) software. The technology conforms to all applicable Web service specifications of the World Wide Web Consortium. Please visit the following URL for additional information: <http://spdf.gsfc.nasa.gov/>

**Open Source****Space Weather Android App****GSC-16321-1**

Developed for the Community Coordinated Modeling Center, this Android application displays space weather information. Users can swipe between space weather data products to see the latest available data; pan and zoom to see a detailed view of any particular product; rearrange and add space weather data products to the application layout; and browse a data catalog by category. Get the app at: <https://play.google.com/store/apps/details?id=gov.nasa.gsfc.iswa.NASASpaceWeatherApp>

**General Public Release****Spacecraft Materials Selector (SMS) Expert System****MFS-31328-1**

The SMS knowledge base is a preliminary design tool that provides estimates of environmental exposures and/or materials performance. Inputs may launch date, altitude, inclination, mission duration, and certain characteristics of satellite motion.

**U.S. Release Only**

## **Terrestrial Observation and Prediction System (TOPS)**

### **Biogeochemical cycle (BGC) Model**

**ARC-16197-1A**

The Terrestrial Observation and Prediction System (TOPS) is a modeling software that integrates data from satellites, weather stations, climate models with ecosystem models to produce nowcasts and forecasts of ecological conditions. The key tools used in producing the nowcasts and forecasts are simulation models including biogeochemical and ecosystem models that estimate the states (vegetation leaf area, biomass, soil moisture, snow, etc.) and functions (evapotranspiration, photosynthesis, etc.) of various kinds of plant canopies (forests, crops, grass, shrubs). These ecological nowcasts and forecasts are akin to current and forecast weather conditions. Upon further refinement and testing, the ecological nowcasts and forecasts are useful for making a variety of management decisions such as irrigation scheduling, timing of field operations, preparing for floods/droughts and vector-borne diseases, and crop phenology and production.

**U.S. and Foreign Release**

### **TES Product File Readers**

**NPO-47000-1**

This effort supports the scientific utilization of TES data products for the NASA AURA mission. A file name is provided, and the contents are returned as simple IDL variables.

**U.S. Government Purpose Release**

### **The Charge Collector (TCC), Version 2.1**

**MFS-32019-1**

TCC is a compilation of spacecraft charging tools including design guidelines and a variety of information from government/industry/academic databases and reports.

**U.S. Release Only**

### **Thermal Protection System Sizing (TPSSZR) Using Sinda/Fluint**

**ARC-15016-1**

TPSSZR is an automated thermal protection system (TPS) distribution and sizing analysis code for analyzing space vehicles at the conceptual design level. The technology automatically generates TPS stackups and aerothermal environment files, maintains consistent material properties descriptions, and has the capability to simultaneously evaluate multiple nominal and abort flight trajectories.

**U.S. Government Purpose Release**

### **Titan Global Reference Atmospheric Model (Titan-GRAM), Version 1.0**

**MFS-32297-1**

Titan GRAM is a Fortran-based program that provides engineering estimates of density, temperature, pressure, and winds for the Titan atmosphere. More information on the Space Environments & Effects (SEE) Program can be found at: <http://see.msfc.nasa.gov/>

**General Public Release**

### **Trapped Proton Model (TPM)**

**MFS-31329-1**

TPM determines the differential omnidirectional proton flux from 1 to 100 MeV. At high altitudes, the model is based on CRRES/PRO developed by AFRL; at low altitudes, the model is based on data from the TIROS/NOAA (POES) low-altitude polar-orbiting satellites. The model contains a true solar cycle variation and also contains sub-models for quiet and active magnetospheric states.

**U.S. Release Only**

### **Trapped Radiation Models: Uncertainties for Spacecraft Design**

**MFS-31319-1**

The focus of this software development effort was to help spacecraft and payload designers to account for uncertainties in predictive models of the Earth's trapped radiation environment. A tool was needed for more accurately determining radiation requirements and risks, which are essential elements for producing less expensive, more reliable spacecraft.

**U.S. Release Only**



**Using a Moderate Ionospheric Storm Detector to Improve WAAS Availability****NPO-49669-1**

The current WAAS ionospheric threat model provides terms used to inflate the GIVEs that are independent of the state of the ionosphere. In this technology, the ionospheric threat model is separated into two branches: one to be used when the ionosphere is quiet, and one to be used when it is disturbed. Threats that cause the moderate storm detector to trip are eliminated from the quiet-time branch of the threat model. Using this quiet-time branch under nominal ionospheric conditions significantly reduces the magnitude of the users computed protection limits, thereby dramatically improving WAAS availability.

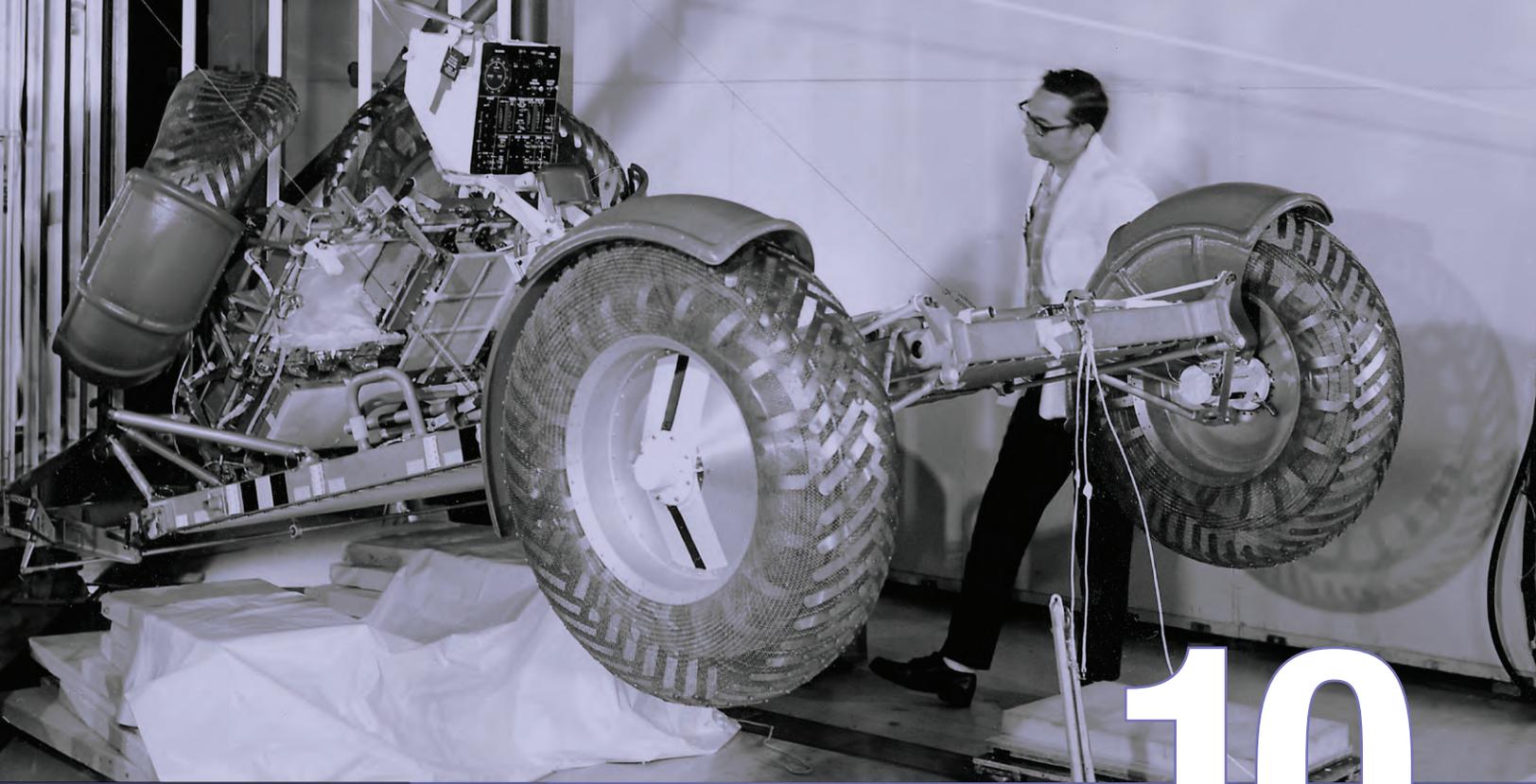
**U.S. Government Purpose Release****Venus Global Reference Atmospheric Model (Venus GRAM) 2005, Version 1.0****MFS-32314-1**

Venus GRAM 2005 is a Fortran-based program that provides engineering estimates of density, temperature, pressure, and winds for the Venus atmosphere.

**General Public Release****World Wind Virtual Globe Software Development Kit (SDK)  
For Java, Android, Web and iOS****ARC-15166-1A**

NASA World Wind is an intuitive software application supporting the interactive exploration of a variety of data presented within a geospatial context. The technology offers a 3D graphics user experience with seamless, integrated access to a variety of online data sources via open-standards protocols.

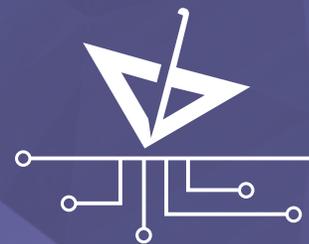
**Open Source**

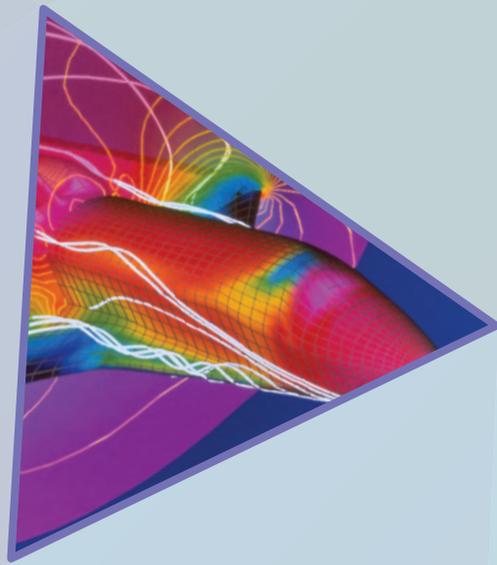


# 10

## Design and Integration Tools

Vehicle/Payload Modeling and Analysis,  
Component and Integrated System Simulation





## Featured Software

### **Automated Triangle Geometry Processing for Surface Modeling and Cartesian Grid Generation (Cart3D)**

**ARC-14275-1**

Cart3D is a high-fidelity inviscid analysis package for conceptual and preliminary aerodynamic design. It allows users to perform automated computational fluid dynamics (CFD) analysis on complex geometry. The package includes utilities for geometry import, surface modeling and intersection, mesh generation, and flow simulation. Cart3D is highly automated so that geometry acquisition and mesh generation can usually be performed within a matter of minutes on most modern UNIX workstations or PCs.

**U.S. Government Purpose Release**

### **Fully Implicit Ablation and Thermal Analysis Program, Version 3 (FIAT v3), Unrestricted Version**

**ARC-15779-1A**

FIAT v3 simulates one-dimensional thermal energy transport in a multilayer stack of isotropic materials and structures that can ablate from the front surface and decompose in depth. The implicit solution algorithm and general solution technique make the program very stable and robust for application to both robotic and crewed vehicles entering a planetary atmosphere from space. For input, the code reads material property information from a database file.

**U.S. and Foreign Release**

### **Knife, Version 1.0**

**LAR-17481-1**

The Knife library calculates the boolean subtraction of arbitrary watertight triangular polyhedral in order to make near-field sonic boom predictions.

**U.S. Release Only**



**42: A Comprehensive General-Purpose Simulation of Attitude and Trajectory Dynamics and Control of Multiple Spacecraft Composed of Multiple Rigid or Flexible Bodies** **GSC-16720-1**

This is a simulator of spacecraft attitude, orbit dynamics, and environmental models. Spacecraft models composed of multiple bodies are supported. The environment models include ephemerides for all planets and major moons in the solar system. The simulator is open source and portable across computing platforms, making it customizable and extensible. It is written to support the entire GNC design cycle, from rapid prototyping and design analysis to high-fidelity flight code verification.

**Open Source**

**Adaptation of GTAG Software for Validating Touch-and-Go Asteroid Sample Return Design Methodology** **NPO-47193-1**

The adaptation of G-TAG to an asteroid sample return mission requires developing G-TAG models for the asteroid sample return spacecraft and models describing the forces and torques applied at contact.

**U.S. Government Purpose Release**

**Advanced Life Support Sizing Analysis Tool (ALSSAT), Version 12.0** **MSC-25510-1**

ALSSAT is a computer model for sizing and analyzing designs of environmental control and life support systems (ECLSS) for spacecraft and surface habitats involved in the exploration of Mars and the Moon. It performs conceptual designs of advanced life support (ALS) subsystems that recycle air and water and process wastes in order to reduce the need for resource resupply. ALSSAT is a means of investigating combinations of such subsystems' technologies and thereby assists in determining the most cost-effective technology combination available. Using the Microsoft Excel spreadsheet software with Visual Basic programming language, ALSSAT has been developed to perform multiple case trade studies based on the calculated ECLSS mass, volume, power, and Equivalent System Mass, as well as parametric studies by varying the input parameters. ALSSAT's modular format is specifically designed for the ease of future maintenance and upgrades.

**U.S. Release Only**

**Advanced Life Support Sizing Analysis Tool (ALSSAT), Version 12.0** **MSC-25510-1**

ALSSAT has been developed for use in the sizing and analysis of Environmental Control and Life Support Systems (ECLSS) for spacecraft and habitats. The purpose of this tool is to perform life support system trade studies and analysis. ALSSAT aids in the creation of conceptual designs for advanced systems using physiochemical and biological processes in either open-loop systems or closed-loop systems that recycle air and water, as well as process human waste products. The regenerative life support processes can be used as a means to decrease the amount of consumable re-supply required for a range of missions including in-space transit vehicles or habitats, and surface habitats on the moon or Mars

**U.S. Release Only**

**Architecture Adaptive Computing Environment (ACE)** **GSC-14911-1**

The Architecture Adaptive Computing Environment (ACE) is a parallel computing language, compiler, and runtime library. The purpose of ACE is to allow a programmer to more easily write parallel programs for a wide variety of parallel computer architectures.

**Open Source**

**Architecture for an Intermediate Frequency Digital Down conversion and Data Distribution Network for Deep Space Network Downlink Receivers** **NPO-49686-1**

For this architecture, IF data from multiple antennas is digitized using analog-to-digital converters at a rate of 1280 Msamples/second or greater. The digitized data is broken up into sub-bands using a Modified Discrete Fourier Transform Filterbank. The MDFT is a critically sampled filterbank that allows for near-perfect reconstruction. The critically sampled property provides for optimal use of limited data bandwidth resources.

**U.S. Government Purpose Release**

**Area Coverage Path Planning Using Divided Grid-Graphs****NPO-49422-1**

The primary observation is that the telescope boresight can slew slowly while the mirror system maintains pointing on a specific field of view. This allows researchers to continually gather data (much like push-broom instruments) without needing to slew or settle, increasing the overall efficiency of the data collection.

**U.S. Government Purpose Release****Arnold Mirror Modeler Software****MFS-33271-1**

This software creates complex finite element models of large-format, lightweight mirrors for complete input decks. Before, building these models could take engineers weeks or even months to complete a single iteration. Now the modeler tool can do the same task in minutes. The software creates many levels of model complexity, from single mirrors (circular or hexagonal shapes) to arrays of mirror segments. Models can have local reinforcement surrounding attachment points, and mesh can be refined (doubled) as many times as necessary.

**U.S. Government Purpose Release****Assert-Based Unit Test Tools****GSC-16689-1**

These tools provide a framework and a collection of utilities designed to facilitate unit testing. They implement an assertion-based philosophy that requires the developer to explicitly write verification statements that assert whether a condition is true or false. In order to use the tools, the developer populates the framework with the ut-assert library to create an executable.

**Open Source****Automated Triangle Geometry Processing for Surface Modeling and Cartesian Grid Generation (Cart3D)****ARC-14275-1**

Cart3D is a high-fidelity inviscid analysis package for conceptual and preliminary aerodynamic design. It allows users to perform automated computational fluid dynamics (CFD) analysis on complex geometry. The package includes utilities for geometry import, surface modeling and intersection, mesh generation, and flow simulation. Cart3D is highly automated so that geometry acquisition and mesh generation can usually be performed within a matter of minutes on most modern UNIX workstations or PCs.

**U.S. Government Purpose Release****Automatic Tiepointer for In-Situ Pointing Correction****NPO-47083-1**

The program generates tiepoints for use with the Mars pointing correction software in a completely automated manner, with no operator intervention. It takes input images and finds overlaps according to the nominal pointing. It then finds the most “interesting” areas using a scene activity metric. Those points with most scene activity are most likely to be useful for tiepointing a mosaic. It then uses correlation techniques to find matching points in the overlapped image. Finally, it performs a series of steps to reduce the number of tiepoints to a manageable level.

**U.S. Government Purpose Release****Autonomous Coordination of Science Observations Using Multiple Spacecraft Assets****NPO-47398-1**

This autonomous science system for multiple spacecraft assets was integrated with the Interplanetary Delay-Tolerant Network to provide communication between spacecraft assets. The full integrated system was then demonstrated at the JPL Mars yard where it was shown to autonomously coordinate observations between multiple spacecraft, including a field test rover, multiple fixed landed assets, and multiple field test orbiters.

**U.S. Government Purpose Release****Bearing Analysis Tool (BAT)****MFS-31864-1**

The Bearing Analysis Tool (BAT) allows detailed design of rolling element bearings rocket engine turbopumps and other applications. It includes a graphical user interface that greatly reduces the effort required to define analytical models for simulation and design.

**U.S. Release Only**

### **Beyond Low-Earth Orbit (LEO) Architecture Sizing Tool (BLAST)**

**MSC-25505-1**

A user-friendly, configurable spacecraft sizing tool, BLAST provides a shareable, re-creatable and rigorous end-to-end multi-element architecture framework that has been used to generate mass data for in-space, beyond low-Earth orbit (LEO) transportation vehicles and architectures. Offering a novel approach to modeling, BLAST couples extensive MER research with the ability to assess mission changes instantaneously by analyzing sensitivity sweeps of several parameters at once.

**U.S. Government Purpose Release**

### **Capable and High-Fidelity 3D Electromagnetic (E&M) Propagation Modeling Tools**

**NPO-49985-1**

These tools are all written in MATLAB code to exploit built-in parallel matrix operation. All the necessary electric and magnetic fields are updated once without a time-consuming loop.

**U.S. Government Purpose Release**

### **Cassini Tour Atlas Automated Generation**

**NPO-47282-1**

During the Cassini spacecraft's cruise phase and nominal mission the Cassini Science Planning Team developed and maintained an online database of geometric and timing information called the Cassini Tour Atlas.

**U.S. Government Purpose Release**

### **CCSDS Advanced Orbiting Systems Virtual Channel Access Service for QoS**

**NPO-47464-1**

This software may be used to support various communications requirements imposed by different missions' interplanetary communication protocols that need to be designed, validated, and evaluated carefully. A communications network simulation tool is essential for the performance evaluation of space communications protocols.

**U.S. Government Purpose Release**

### **Chimera Grid Tools, Version 2.2**

**ARC-16025-1B**

The Chimera Grid Tools software package is used for performing pre- and post-processing of computational fluid dynamics analysis on complex configurations using overset grids. It contains a collection of software tools for performing geometry processing, surface and volume grid generation, grid manipulation and diagnostics, flow solver input preparation, multi-body dynamics input preparation and animation, flow solution visualization, debris trajectory analysis input preparation, strand grid and AMR Cartesian grid visualization, flow solution post-processing analysis including forces and moments computation, and convergence history visualization.

**U.S. Release Only**

### **CMPGEN: A Modeling Tool Used to Compute Off-Design Performance of Fans, Boosters, and Compressors**

**LEW-19686-1**

CMPGEN is a modeling tool used to compute off-design performance of axial fans, boosters, and compressors. Users can obtain rapid and consistent off-design performance characteristics from simple design point inputs. Component performance maps are suitable for use in the Numerical Propulsion System Simulation (NPSS) gas turbine engine cycle analysis code output.

**U.S. Release Only**

### **Cobra Code Browser and Analyzer: An Extendable, Interactive Tool for the Analysis of C Code**

**NPO-50050-1**

This tool provides software developers, peer reviewers, testers, and quality assurance personnel with an interactive method that facilitates searching for patterns, confirms compliance or non-compliance with coding guidelines and coding standards, and identifies suspicious code fragments. Cobra uses a lexical analyzer for C to scan in source code.

**Open Source**

**Collection of Nonlinear Aircraft Simulations in MATLAB****LAR-17463-1**

This package includes nonlinear six degree-of-freedom simulations for a variety of aircraft created using MATLAB. Data for aircraft geometry, aerodynamic characteristics, mass/inertia properties, and engine characteristics have been obtained from open-literature publications documenting wind tunnel experiments and flight tests. Each nonlinear simulation has been implemented within a common framework and includes an interface with another commercially available program to read pilot inputs and produce a 3D display of the simulated airplane motion. Aircraft simulations include the General Dynamics F-16 Fighting Falcon, Convair F-106B Delta Dart, Grumman F-14 Tomcat, McDonnell Douglas F-4 Phantom, NASA Langley Free-Flying Aircraft for Sub-scale Experimental Research (FASER), NASA HL 20 Lifting Body, NASA/DARPA X-31 Enhanced Fighter Maneuverability Demonstrator, and the Vought A-7 Corsair II.

**U.S. Release Only****Computational Fluid Dynamics (CFD) Utility Software Library****ARC-14467-1A**

A collection of utility programs and reusable subroutine libraries supports computational fluid dynamics, particularly on multiblock structured grids. The technology is applicable to all flight regimes (subsonic, transonic, supersonic, and hypersonic).

**Open Source****Computational Fluids Laboratory 3-Dimensional (CFL3D)****LAR-16003-1**

CFL3D is a structured-grid, cell-centered, upwind-biased, Reynolds-averaged Navier-Stokes (RANS) code. It can be run in parallel on multiple grid zones with point-matched, patched, overset, or embedded connectivities. Both multigrid and mesh sequencing are available in time-accurate or steady-state modes.

**Open Source****Constrained Direct Iterative Surface Curvature (CDISC) Aerodynamic Design Software****LAR-18693-1**

CDISC is a system of software codes that, when coupled with computational fluid dynamics flow solvers, provides a method for aerodynamic design. The core design algorithm uses prescribed flow/geometry sensitivity derivatives to make geometry changes based on the difference between target and analysis pressures on the surface of the configuration being designed. The target pressures can be directly specified or may be generated using the flow constraint options in CDISC that modify the current analysis pressures to meet common engineering quantities such as lift and pitching moment. Geometry constraints, such as wing thickness or curvature, are also included to meet requirements from other disciplines such as structures and manufacturing.

**U.S. Release Only****Data Parallel Line Relaxation Code (DPLR), Version 4****ARC-16021-1A**

The DPLR software package is a suite of CFD tools for the computation of supersonic and hypersonic flows in chemical and thermal nonequilibrium. Included in the package are 2D/axisymmetric and 3D structured-grid finite volume Navier-Stokes codes, a pre-processor, and a post-processor. The code supports implicit boundary conditions, generalized multi-block topologies, grid alignment to flow features, and generalized chemical kinetics and thermodynamic property databases.

**U.S. Government Purpose Release****Database Design for Storing Software Entity Metadata, User Identification, and License Terms and Also Determining Access Rights****NPO-48860-1**

The database design is represented in a Unified Modeling Language (UML) diagram, along with a data dictionary spreadsheet. A prototype implementation exists in MySQL with MySQL-stored procedures for adding entries and determining allowed access.

**U.S. Government Purpose Release**

**Degra, Version 3****NPO-45252-1**

Degra is a generalized simulation of the performance and degradation of a radioisotope thermoelectric Generator (RTG) over its lifetime. It is provided with a graphical user interface (GUI) that is used to edit the input parameters that describe the initial state of the RTG and the time-varying loads and environment to which it will be exposed. Degra is relevant to NASA's current and future work. It is currently being used by the Mars Science Laboratory project for prediction of MMRTG performance on Mars. It will be used in future SMD missions in which RTG power generation is applied.

**U.S. Government Purpose Release****Digital Interface Board to Control Phase and Amplitude of 4 Channels****NPO-42778-1**

The digital interface board will control the phase and amplitude of the signals for each element in the array. A host computer running Agilent VEE sends commands via serial UART connection to a Xilinx VirtexII FPGA. The commands are decoded and either outputs are set or telemetry data are sent back to the host computer describing the status and the current phase and amplitude settings.

**U.S. Government Purpose Release****EDLFLOW-F: A Next-Generation High-Order High-Fidelity All-Speed Time-Accurate Flow Solver for Simulating Fluid Flows****ARC-16349-1**

EDLFLOW-F solves the unsteady three-dimensional equations for compressible flow using a fourth-order Runge-Kutta integration scheme and a sixth- and/or tenth-order compact differencing scheme for spatial derivatives. Deforming geometry simulations can be carried out using this solver. The technology can also be used in a low-order mode as a Reynolds-Averaged Navier-Stokes (RANS) solver. Any flow regime (from incompressible flow to hypersonic flow about arbitrary geometries) can be simulated using EDLFLOW-F.

**U.S. Government Purpose Release****Efficient Parallel Engineering Computing on Linux Workstations****NPO-46892-1**

This software provides an off-the-shelf approach to high-performance engineering computing with numerous applications in NASA aeronautical and space mission analysis and simulations. A C software module has been developed that creates lightweight processes (LWP) dynamically to achieve parallel computing performance in a variety of engineering simulation and analysis applications.

**U.S. Government Purpose Release****Estimation of Coriolis Force and Torque Acting on Ares 1****NPO-47326-1**

The objective of this effort was to estimate Coriolis force and torque applied to the vehicle during its ascent. Maveric flight simulation software was used to produce the required angular velocity data for the Coriolis force and torque computations. For the simulation of gas movement in the SRB, the team developed software using a dynamical model of internal ballistics of the five-segmented SRB.

**U.S. Government Purpose Release****ExPRESS Logistics Carrier Suitcase Simulator Software****GSC-15813-1**

The ExPRESS Logistics Carrier Suitcase Simulator Software simulates the ExPRESS Logistics Carrier Flight Software and the ExPRESS Logistics Carrier hardware interfaces for experiments. Analog and digital channels are supported by a custom SAB PCI card that allows the user to configure each of the analog and digital channels to the experiment.

**U.S. Government Purpose Release****Extended Testability Analysis (ETA) Tool, Version 8.0****LEW-19241-1**

This technology is a NASA Glenn-developed software application that supports fault management (FM) by performing testability analyses on the fault propagation model of a given system.

**U.S. Release Only**

**FAILSAFE****NPO-46981-1**

FAILSAFE is software for health management in mission-critical, real-time embedded systems. The project unites features of the industry standard ARINC 653 Avionics Application Software Standard Interface. The ARINC 653 standard establishes requirements for the services provided by partitioned real-time operating systems.

**U.S. Government Purpose Release****Failure Modes and Effects Analysis Tool (FMEA)****MSC-25379-1**

This prototype failure analysis software tool models a system's components, their connective relationships, and functions in order to assist in Failure Modes and Effect Analysis (FMEA) early in the design lifecycle. The technology semi-automatically generates a model with functions and failure modes to support FMEA.

**General Public Release****FCOD Rapid Prototyping Lab Generic Display Software (FCOD Generic Displays)****MSC-25185-1**

This software permits the user to interact with and understand the user interface for a generic "glass" spacecraft cockpit. Based on standards developed by NASA for the Orion spacecraft, it simulates various phases of flight and various malfunction situations to help users understand operating a spacecraft exclusively through computer screens instead of a large number of physical switches, gauges, and other controls.

**U.S. Government Purpose Release****Flight Dynamics Simulation of a Generic Transport Model****LAR-17625-1**

This software is a flight dynamics simulation of a transport aircraft. It implements general rigid body equations of motion for the vehicle dynamics and draws aerodynamic forces from a standard coefficient expansion implemented as table lookups. Dynamics of actuator servos and bandwidth of sensors are also included. The simulation is coded in Simulink, a model-based environment using a commercial simulation package from MathWorks, Inc. The software is not standalone; it must be run from inside this commercial environment, making use of numerical libraries for basic operations, as well as the overall time-stepping and numerical integration routines.

**Open Source****Flight Planning in the Cloud****NPO-47472-1**

This software can be used by the Light Project funded by NASA, and it can also be used by other airborne science instruments. Some of the main features of the interface include drawing flight lines on a map, nudging them, adding them to the current flight plan, and reordering them. The user can also search and select takeoff, landing, and intermediate airports. As the flight plan is constructed, all of its components are constantly being saved to the database and the estimated flight times are updated.

**U.S. Government Purpose Release****Formal Validation of Model-Based Fault Management Design Solutions****NPO-49337-1**

Generic SysML fault protection behavior model patterns were established and SMAP fault protection logical design was implemented into the model (included a subset of SMAP devices, error monitors and responses). Multiple fault injection tests were run to ensure correct behavior of the model and to produce auto-generated event reports. Once the model accurately represented the logical design, it was transformed to Java and executed in JPF with assertions (domain specific constraints). Upon completion of an exhaustive check in JPF, the logical design of the system is validated against domain specific constraints. The model checking performance and results can be found in the attached document (Formal Validation of Model-Based Fault Management Design Solutions).

**U.S. Government Purpose Release**

### **Freespace Simulation Environment**

**GSC-15480-1**

The Freespace Simulation Environment is a collection of software applications for the design and analysis of complex system dynamics. It uses a shared memory workspace and inherent multi-processor architecture to parallelize and process data from simulations.

**U.S. Government Purpose Release**

### **Fully Implicit Ablation and Thermal Analysis Program, Version 3 (FIAT v3): Unrestricted Version**

**ARC-15779-1A**

FIAT v3 simulates one-dimensional thermal energy transport in a multilayer stack of isotropic materials and structures that can ablate from the front surface and decompose in depth. The implicit solution algorithm and general solution technique make the program very stable and robust for application to both robotic and crewed vehicles entering a planetary atmosphere from space. For input, the code reads material property information from a database file.

**U.S. and Foreign Release**

### **functional Availability Simulation Tool (fASTER) Enhanced Release**

**MSC-24823-1**

fASTER is a Monte Carlo simulation tool that assists the International Space Station (ISS) Program with determining logistics support resources by simulating a multitude of different operational scenarios of the ISS configuration (during and following assembly). This allows for the impacts of complex program resource restrictions and constraints (e.g., crew maintenance time, carrier upmass capability, and sparing postulate) to be assessed and reported.

**U.S. Government Purpose Release**

### **General Mission Analysis Tool (GMAT), Version 2011A**

**GSC-16228-1**

GMAT is a software system for trajectory optimization, mission analysis, trajectory estimation, and prediction. Analysts use GMAT to design spacecraft trajectories, optimize maneuvers, perform orbit determination, visualize and communicate mission parameters, and understand a mission trade space. GMAT contains models of real-world objects such as spacecraft and thrusters, as well as analysis “objects” such as plots and reports. These objects are used in the mission sequence wherein the user employs commands supported by the system to model missions and perform estimation. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/GMAT/index.php>

**Open Source**

### **General Mission Analysis Tool (GMAT), Version R2016a**

**GSC-17177-1**

The General Mission Analysis Tool (GMAT) is the world’s only enterprise, multi-mission, open-source software system for space mission design, optimization, and navigation. It supports missions in flight regimes ranging from low-Earth orbit to lunar, libration point, and deep space. GMAT, developed by a team of NASA, private industry, and public and private contributors, contains models of real-world objects such as spacecraft and thrusters, as well as analysis “objects” such as propagators, plots, and reports. New capabilities contained in this release include Code 500 ephemeris propagator; STK ephemeris file output; and write command to save GMAT configurations during execution.

**Open Source**

### **General Mission Analysis Tool (GMAT), Version R2018a**

**GSC-18094-1**

GMAT is the world’s only enterprise, multi-mission, open-source software system for space mission design, optimization, and navigation. The system supports missions in flight regimes ranging from low-Earth orbit to lunar, libration point, and deep space missions. GMAT has developed by a team of NASA, private industry, public, and private contributors and is used for real-world mission support and engineering studies as a tool for education and public engagement.

**Open Source**

**General Mission Analysis Tool, Version R2016a****GSC-17778-1**

The GMAT development team is pleased to announce the release of GMAT version R2016a. GMAT is the world's only enterprise, multi-mission, open-source software system for space mission design, optimization, and navigation. The system supports missions in flight regimes ranging from low-Earth orbit to lunar, libration point, and deep space missions. GMAT is developed by a team of NASA, private industry, public, and private contributors and is used for real-world mission support, engineering studies, and as a tool for education and public engagement.

**Open Source****General Tool for Evaluating High-Contrast Coronagraphic Telescope Performance Error Budgets****NPO-47220-1**

This software tool uses a Code V prescription of the optical train and uses MATLAB programs to call ray-trace code that generates linear beam-walk and aberration sensitivity matrices for motions of the optical elements and line-of-sight pointing (with and without controlled fine-steering mirrors).

**U.S. Government Purpose Release****General-Use Nodal Network Solver (GUNNS), Version 17****MSC-26290-1**

This set of C++ generic models can be used to simulate and solve complex networks of fluid, thermal, and electrical systems.

**General Public Release****Generic Reusable Aerospace Software Platform (GRASP)****GSC-15695-1**

The purpose of GRASP is to provide a generic operating-system-independent framework for creating multi-process real-time applications. In the modular GRASP architecture, all operating system and hardware interfaces are isolated within GRASP libraries. The application developer uses GRASP interface libraries and device drivers to interact with external hardware. Should a new hardware item require a driver, that development would be part of GRASP and would be added to the GRASP interface libraries and become available for future projects. GRASP application software is developed by using the GRASP template, which offers access to the services GRASP provides. The templated generic code handles process initialization, thread creation, inter-process messaging, process health monitoring, data logging, data distribution, etc., with hooks that provide for subsystem tailoring. Using GRASP allows application developers to concentrate on mission specifics, reducing development time, cost, and risk.

**U.S. Government Purpose Release****Global Modeling Initiative (GMI) Software****GSC-15363-1**

The Global Modeling Initiative (GMI) is a state-of-the-art, modular 3D chemistry and transport model (CTM) that can be used for assessment of the impact of various natural and anthropogenic perturbations on atmospheric composition and chemistry, including but not exclusively the effect of aircraft.

**U.S. Government Purpose Release****Goddard Dynamic Simulator (GDS)****GSC-15340-1**

The Goddard Dynamic Simulator (GDS) is used to test both software and hardware flight systems. GDS software integrates the dynamics equations of motion for a spacecraft; models environmental forces acting on the spacecraft; and models spacecraft components such as reaction wheels, thrusters, star trackers, other actuators and sensors.

**U.S. Government Purpose Release**

### **Goddard Satellite Data Simulation Unit**

**GSC-15874-1**

The Goddard Satellite Data Simulation Unit (SDSU) is a comprehensive unified system of multi-sensor satellite instrumental simulators. Skill of weather forecasting models can be evaluated in terms of satellite-observed multi-sensor radiance levels. Alternatively, the remote sensing community can more readily utilize atmospheric model simulations to develop and test their retrieval algorithms for application of Earth science.

**Open Source**

### **GTM\_Polysim: Nonlinear GTM Aircraft Polynomial Simulation in MATLAB, Version 2.0**

**LAR-17595-1**

The GTM\_POLYSIM is a nonlinear simulation of the Generic Transport Model (GTM) aircraft at a 5.5-percent scale. The simulation software is a collection of scripts and programs written and executed in the MATLAB computing environment.

**U.S. Release Only**

### **HLA2MPC, Version 3.0: A Software Bridge Between the IEEE 1516 High-Level Architecture to the NASA MPC Model Process Control (MPC) 3.0 Telemetry Language**

**KSC-14109**

HLA2MPC provides the link between HLA (High Level Architecture, IEEE 1516) Simulation Federation data and any MPC3- compliant simulation or visualization tool. One such tool is DON, the Distributed Observer Network, now in version 3.1.

**Open Source**

### **HURON: A Python-Based Multi-Agent Temporal Activity Planner/Scheduler**

**NPO-47573-1**

Different mission architectures, ranging from support of human-based exploration to fully autonomous rovers, dramatically affect the cost, safety, and science return of lunar and planetary missions. Mission durations may range from days to months and affect the mission architecture that will be developed and deployed. Architecture tradeoff analysis plays a key role in assessing which mission scenarios offer the maximal science productivity and crew safety while minimizing development and operational costs.

**U.S. Government Purpose Release**

### **IMCE Ontological Modeling Framework**

**NPO-49756-1**

The Jet Propulsion Laboratory's Integrated Model-Centric Engineering (IMCE) initiative developed ontologies for Model-Based Systems Engineering (MBSE) to support JPL's MBSE practices and methodologies. The IMCE ontologies have been carefully engineered to provide support for scalable query and reasoning according to the semantics of the Ontology Web Language (OWL) standard in such a way that these ontologies can be mapped as extensions of the Unified Modeling Language (UML) and Systems Modeling Language (SysML) standards.

**Open Source**

### **Implicit Finite-Difference Code for a Two-Equation Turbulence Model for Three-Dimensional Flows (KEM)**

**ARC-16271-1**

This semi-implicit finite-difference code solves the transport equations for the turbulence kinetic energy and its dissipation rate in generalized curvilinear coordinates in three dimensions. The finite difference equations are solved using the Beam-Warming approximate factorization algorithm.

**U.S. Government Purpose Release**

### **Incompressible Navier-Stokes CFD Solver (INS3D)**

**ARC-14020-1**

The INS3D code solves the incompressible Navier-Stokes equations in three-dimensional generalized coordinates for both steady-state and time-varying flow. The equations are formulated using artificial compressibility. The convective terms are differenced using an upwind biased flux-difference splitting. The equations are solved using an implicit line-relaxation scheme. The code is written for single- or multiple-zone calculations. It can utilize either pointwise continuous zonal interfaces or overset zonal interfaces if a PEGASUS interpolation database is supplied.

**U.S. Release Only**

**Integrated Composite Analyzer in JAVA (ICAN/JAVA)****LEW-17247-1**

ICAN/JAVA, the Integrated Composite Analyzer written in Java, was primarily designed to analyze the hygrothermomechanical response and properties of fiber- or particulate-reinforced, resin-matrix-layered composite materials, given the local membrane loads and bending moments. ICAN/JAVA was coded in the Java computer language combining features from earlier versions for both fibers and particulates, as well as adding impact modeling. The multi-factor interaction model allows factors to interact to allow for property changes due to operating conditions after fabrication. ICAN/JAVA has both a batch version and an interactive version that can also plot selected outputs.

**U.S. Release Only****Integrated Lunar Information Architecture for Decision Support (ILIADS), Version 3.0****GSC-16210-1**

ILIADS 3.0 provides the data management capabilities to access CxP-vetted lunar data sets from the LMMP-provided Data Portal and the LMMP-provided OnMoon lunar data product server. (LMMP stands for Lunar Mapping and Modeling Project.) It also provides specific quantitative analysis functions to meet the stated LMMP Level 3 functional and performance requirements specifications that were approved by the CxP.

**Open Source****Integrated Science Instrument Module (ISIM) Hardware Models****GSC-17039-1**

These Wind River Simics Device Modeling Language (DML) models for the ISIM Command and Data Handling (ICDH) electrical components include the housekeeping card (HK), the bus interface card (BIC), and focal plane array processor (FPAP). They allow the ISIM flight software to be executed within a COTS emulator product, Wind River Simics.

**U.S. Government Purpose Release****Interface Between STAR-CCM+ and 42 for Enhanced Fuel Slosh Analysis****GSC-17081-1**

STAR-CCM+, a commercially available computational fluid dynamics (CFD) code, is linked with this software tool to 42, a user-friendly NASA in-house flight simulation program, enabling the modeling of fuel slosh as a part of the 42 flight simulation.

**U.S. Government Purpose Release****International Space Station (ISS) Onboard Emergency Simulator Software****MSC-25520-1**

This technology enables onboard crewmembers to receive more effective training during regularly scheduled emergency drills onboard the ISS.

**U.S. Government Purpose Release****ISS Systems Integration Lab (ISIL) Operations Framework (RIM 10)****MSC-25380-1**

The Software Development and Integration Laboratory (SDIL) in Sonny Carter supports ISS flight software development, integration, and verification. The complexity of the ISS requires efficient and reliable test reconfiguration, flexible resource scheduling, and effective workflow and also time-effective configuration management. An electronic workflow system was conceived and dubbed Rig Information Management (RIM). The SDIL was then transitioned from standalone manual systems to the RIM system with data-base-centric, Web-based solutions enabling significant efficiencies and paperless operations. It also created productivity improvements in flight software development. This innovation was recognized with a JSC 2007 Exceptional Software Award.

**U.S. Release Only****James Webb Space Telescope Independent Verification and Validation Simulation and Test (JIST) Core****GSC-16739-1**

JIST executes James Webb Space Telescope (JWST) test procedures, exercises the flight software subsystems, injects hardware and software faults, and integrates additional tools to support test objectives. The components, models, and interfaces can be reused on other missions that utilize similar interfaces and components.

**U.S. Government Purpose Release**

**James Webb Space Telescope Independent Verification and Validation  
Simulation and Test (JIST) RT Logic T501 Emulator**

**GSC-16740-1**

The T501 emulator, developed in support of the JIST environment, receives software commands via TCP/IP packets and converts them for the James Webb Space Telescope (JWST) test bed's hardware.

**U.S. Government Purpose Release**

**Jitter\_Correct.m**

**NPO-47215-1**

This jitter correction software removes frame-to-frame image translations caused by line-of-sight motion. It is a MATLAB function that takes an image sequence with unknown jitter and computes the translations of each frame (column and row, in pixels) relative to a chosen reference frame.

**U.S. Government Purpose Release**

**JWST IV&V Simulation and Test (JIST) Solid-State Recorder (SSR) Simulator**

**GSC-16741-1**

This tool is a component of the JIST system and is responsible for simulating basic SSR functionality. It is a software-only simulator that provides the necessary interface to the JWST flight software and typically simulates SSR management functions. Specific functions include playback, record, and normal telemetry transmission.

**U.S. Government Purpose Release**

**Knife v1.0 Boolean Subtraction Library for Polyhedra**

**LAR-17481-1**

The Knife library calculates the Boolean subtraction of arbitrary watertight triangular polyhedral in order to make near-field sonic boom predictions.

**Open Source**

**KSOPT: An Indirect Method for Numerical Optimization  
Using the Kreisselmeier-Steinhauser Function, Version 3.1**

**LAR-18488-1**

This is a technique for converting a constrained optimization problem into an unconstrained problem. The software transforms one or more objective functions into reduced objective functions analogous to goal constraints used in the goal programming method. The reduced objective functions are appended to the set of constraints, and an envelope of the entire function set is computed using the Kreisselmeier-Steinhauser function.

**U.S. Release Only**

**LAURA.5**

**LAR-17673-1**

LAURA.5 is a structured, multi-block, computational aerothermodynamic simulation code. It provides a major refactoring of the original LAURA code in a modular structure utilizing Fortran 95. The technology shares gas physics modules, MPI modules, and some fundamental data set modules with the unstructured-grid code FUN3D.

**U.S. Release Only**

**LEWICE3D, Version 3.63**

**LEW-19433-1**

LEWICE3D is a software system capable of predicting the accumulation of ice on three-dimensional aircraft surfaces given the flight and meteorological conditions representative of an icing cloud. The software utilizes input information of the airflow surrounding the body of interest and then calculates trajectories of approaching water droplets, the mass and energy transfer processes at the surface of the body, and the resulting ice mass and the shape it will take on the body.

**U.S. Release Only**

**Light Gas Gun Performance Code (ONEDIM)**

**ARC-18153-1**

This program calculates the performance of a two-stage light gas gun from first-stage powder burn through projectile exit from gun muzzle.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Body-Centric Insertion Tool** LAR-18741-1

This tool is intended to support mission architecture designers to design simple orbits for vehicles entering into the sphere of influence of a planet from heliocentric space. It allows architects to put in information about the dV or C3 energy state and provide information about the desired parking orbit. From either C3 or dV, it calculates the remaining dV required to take the vehicle and place it in the desired orbit based on the planet and its sphere of influence.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Body-Centric Orbit Change Tool** LAR-18746-1

This tool provides dV requirements for orbit changes in inclination, periapsis, and apoapsis.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Destination Campaign Tools** LAR-18752-1

This tool provides a rough mass estimate of ground campaign equipment.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Fission Power Sizing Tool** LAR-18745-1

This system uses lifetime, chosen archetype, and EOL power demand to determine the mass and power characteristics of a fission power system.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Heliocentric Trajectory Tool** LAR-18744-1

This tool is produced is take advantage of pre-existing resources of known lambert trajectory solutions to various bodies, NEAs and more. This database is created and maintained by Ames Research Center and provides a two-significant-figure estimate of the injection deltaV to get to the desired orbit and the insertion dV to stop at the location. Additionally, it does calculate flyby maneuver effects.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: ISRU Demo Plant Sizing Tool** LAR-18734-1

The Agile ISRU Demo Plant Sizing Tool will provide a rough parametric estimate of ISRU plant mass and power requirements based on fitting data to a heritage curve. NEO, Phobos, lunar surface, and Martian surface are included at a notional level within this system that allows architecture designers to roughly scale ISRU plants before talking to specialists.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Long-Duration Habitat Sizing Tool** LAR-18737-1

This tool does parametric sizing of long term human habitats based on duration and crew size up to ten members.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Multiburn/Large-Vehicle Sizing Tool** LAR-18733-1

This tool will design a large vehicle and do inert mass fraction sizing to scale a vehicle for multiple impulsive maneuvers and different payloads.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: One-Way/Small-Vehicle Sizing Tool** LAR-18739-1

This tool sizes small or one-way/one-time-use vehicles for propulsive maneuvers both in and out of atmosphere. The system will provide rough Figure of Merit (FOM) estimates of mass, power, volume, and ephemeris/trajectory change capacity and provide a rough breakdown of the inert masses, propulsive masses, and payload masses. Additionally, the system provides context for the mass breakdown and is intended for small vehicles doing one or two maneuvers.

**U.S. Release Only**



**Low-Fidelity Space Systems Analysis Tools: Orbiter Sizing Tool** **LAR-18736-1**

This tool sizes rough orbiter buses that include avionics, science payloads (user choice), and a scientific mass fraction, and it produces a baseball card for presentation.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Planetary Ascent/Descent dV Tool** **LAR-18743-1**

This tool is designed to provide rough estimates for a landing on the surface of a planet with no atmosphere. Data from this tool are used to drive sizing calculations.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Rover Sizing Tool** **LAR-18735-1**

This tool is intended to be used for scientific rover missions based on a heritage catalogue of scientific components, as well as relationships between scientific tool mass and total rover body mass.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Short-Duration Habitat Sizing Tool** **LAR-18738-1**

This tool sizes short duration human habitats for short missions less than 20 days based on identified human operations requirements.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Solar Cell/Fuel Cell/Battery Sizing tool** **LAR-18740-1**

This tool sizes solar power systems utilizing batteries, fuel cells, and solar cells and calculates the mass, power, and potential volume requirements of the system. It will provide a rough estimate of the sizes of the cells and the tank volumes and masses for the fuel cells and for determining decay rates and BOL/EOL power-generation demands.

**U.S. Release Only**

**Low-Fidelity Space Systems Analysis Tools: Thermal Protection System Sizing Tool** **LAR-18742-1**

This system sizes Thermal Protection Systems based on simple flight path angle assessments and mass properties of the vehicle. It provides estimates of heat loads and relevant materials.

**U.S. Release Only**

**Low-Order Potential Flow Panel Code (PMARC), Version 14** **ARC-14407-1**

PMARC is a three-dimensional panel code to solve potential flow around wings and bodies. Relative motion between multiple bodies can be simulated.

**U.S. and Foreign Release**

**MatchGUI: A graphical MATLAB-Based Tool for Automatic Image Co-Registration** **NPO-47513-1**

This software enables automatic image registration, which is a first step towards automatic change detection. Change detection is a key method for study of dynamic processes on planetary bodies. The software requires minimal user input and performs a registration over scale and in-plane rotation automatically. This tool is a steppingstone for automatic change detection from aerial/orbital imagery.

**U.S. Government Purpose Release**

**MBJEOD: An Integrated Multibody and Orbital Dynamics Simulation Module** **MSC-25732-1**

MBJEOD is a multi-body dynamics (MBDyn) software interface layer that allows transfer of forces between multi-body articulating objects and the JEOD orbital dynamics package.

**U.S. Government Purpose Release**

**MIPP-D: Situ Resource Utilization (ISRU)****Propellant Production Discrete Event Simulation (DES)****KSC-14131**

MIPP-D is a Simio-based Discrete Event Simulation modeling Mars surface propellant production. The focus is on the actual chemical plant and processes, including incoming and outgoing materials associated with the production of rocket fuel on Mars. The fuel will be for the Mars Ascent Vehicle used to carry humans into space from the surface of Mars. The simulation utilizes NASA ground rules and assumptions, as well as data from prototype chemical plants, NASA experts, and literature. It is designed to grow in capability and complexity as needed or as additional information becomes available. The simulation does not attempt to model the complexities of surface elements acquiring feed stock or disposing of spent resources, although it does acknowledge those functions exist and uses informed assumptions where necessary.

**U.S. Government Purpose Release****MIRO Continuum Calibration for Asteroid Mode****NPO-47075-1**

This software is used to calibrate microwave Instruments. The software determines the relationship between the raw digital unit measured by MIRO and the equivalent brightness temperature by analyzing data from calibration frames. The found relationship is applied to non-calibration frames which are the measurements of an object of interest such as asteroids and other planetary objects that MIRO encounters during its operation. This software characterizes the gain fluctuations statistically and determines which method to estimate gain between calibration frames.

**U.S. Government Purpose Release****Model-Driven, Science Data Product Registration Service****NPO-47832-1**

The Planetary Data System (PDS) has undertaken an effort to overhaul the PDS data architecture (e.g., data model, data structures, data dictionary, etc.) and deploy a software system (online data services, distributed data catalog, etc.) that fully embraces the PDS federation as an integrated system while leveraging modern information technology. The CCSDS reference model in turn relies heavily on the electronic business using eXtensible Markup Language (eXML) standards for registry services and the registry information model, managed by the OASIS consortium.

**U.S. Government Purpose Release****Modeling Lunar Surface Systems Concepts of Operations****NPO-48214-1**

This is an adaptation of Microsoft Excel and ASPEN (Activity Scheduling/Planning Environment) for lunar surface system concepts of operations. The goal of the overall system is to enable searching through several concepts of operations, where a concept of operations consists of a proposed schedule of high-level activities and parameterization of resources (e.g., power, communications, oxygen, water, etc.). Three distinct phases of development occurred: (1) initial system development for lunar, (2) planning system development for lunar, and (3) planning system development for the live trial of NASA's thirteenth Desert Research and Technology Studies (Desert RATS).

**U.S. Government Purpose Release****Modular Instrumentation/Controller System (MICS)****MSC-25413-1**

This innovation describes a small computer system form factor that is modular in design in order to encourage reconfigurable designs. Current key modules in the concept include power, CPU, and communications. Other modules can be added as the target project requires. No agreement needed. Get open-source software at: [http://esetwiki.net/index.php?title=Modular\\_Integrated\\_Stackable\\_Layer](http://esetwiki.net/index.php?title=Modular_Integrated_Stackable_Layer)

**Open Source**

**Morbiter****NPO-47212-1**

The long-term evolution characteristics (and stability) of an orbit are best characterized using a mean element propagation of the perturbed two-body variational equations of motion. The averaging process eliminates short period terms leaving only secular and long period effects. In this software a non-traditional approach is taken that averages the variational equations using adaptive numerical techniques and then numerically integrating the resulting EOMs. Doing this avoids the Fourier series expansions and truncations required by the traditional analytic methods. The resulting numerical techniques can be easily adapted to propagations at most solar system bodies.

**U.S. Government Purpose Release****NAIF Toolkit Extended****NPO-47017-1**

The Navigation Ancillary Information Facility (NAIF) at the Jet Propulsion Laboratory has built a data system, named SPICE, to assist scientists in planning and interpreting scientific observations. SPICE provides geometric and some other ancillary information needed to recover the full value of science instrument data, including correlation of individual instrument data sets with data from other instruments on the same or other spacecraft.

**U.S. Government Purpose Release****NASA Lewis Steady-State Heat Pipe (LERCHP) Code****LEW-15625-1**

LERCHP predicts the performance of heat pipes in the steady state. It can be used as a design tool on a personal computer or, with a suitable calling routine, as a subroutine for a mainframe radiator code. For accurate heat pipe modeling, a variety of wick structures are available to the user, including a user wick input option. Several working fluids can be chosen as well (including potassium, sodium, and lithium) for which the monomer-dimer equilibrium is considered.

**U.S. Release Only****NASA Operational Simulator (NOS) Common****GSC-17146-1**

The NOS Common software is a collection of libraries and applications to support the development and maintenance of pure software spacecraft emulators and associated technologies. These applications are project agnostic and flexible enough to support any implementation.

**U.S. Government Purpose Release****NASA Operational Simulator (NOS) Motion (NMotion)****GSC-17145-1**

The Nmotion suite provides an automation framework for performing full integration and system testing on NOS-based systems.

**U.S. Government Purpose Release****NASA STRuctrual ANalysis (NASTRAN)****LAR-16804-GS**

NASTRAN is a finite element analysis program that was originally developed for NASA in the late 1960s under U.S. government funding for the aerospace industry. The software suite provides engineers a comprehensive simulation solution for insight into structural behavior. NASTRAN source code is integrated into a number of different software packages, which are distributed by a range of companies.

**Open Source****NASA.rb (formerly fUnit)****GSC-15137-1**

NASA.rb (formerly fUnit) is a collection of Fortran modules that provide a framework for automating the construction, execution, and reporting of unit tests for Fortran software applications. Support is provided for several aspects of unit testing that are peculiar to scientific technical computing including distributing jparallel applications and parameterized behavior.

**Open Source**

**NetworkKing: Space Communications and Navigation (SCaN) App****ARC-16778-1**

The NetworkKing Game is an educational, interactive 3D game in which the player develops a space communication network. As he builds his network infrastructure, client spacecraft are attracted to the network, generating income and allowing the player to build further. As the player expands his robust communication network, fortunate and unfortunate events occur. The game can be downloaded at: [http://www.nasa.gov/multimedia/3d\\_resources/scan.html](http://www.nasa.gov/multimedia/3d_resources/scan.html)

**General Public****Nonequilibrium Radiative Transport and Spectra Program (NEQAIR), Version 14****ARC-15262-1B**

NEQAIR v14.0 is a complex code that enables the calculation of: (1) nonequilibrium or equilibrium populations of excited energy levels for atomic and diatomic molecules; (2) optical radiation emitted and absorbed by atomic and diatomic rotational lines along a line of sight or across a shock tube; (3) transport of optical radiation through a non-uniform gas mixture to a solid surface; and (4) detailed spectra at points along a line of sight and at a surface and plots them.

**U.S. and Foreign Release****Normalized Cross Correlation: FPGA Implementation****NPO-48892-1**

Normalized cross correlation measures how closely a small template image compares to a larger search image at each point in the search image. The cross-correlation score is adjusted to reduce the influence of contrast and brightness across the search image resulting in a normalized cross correlation score in the range from -1.0 to 1.0 at each point, where 1.0 is returned for a perfect match.

**U.S. Government Purpose Release****Novel Method for Pre-Conditioning a Measured Surface Height Map for Model Validation****NPO-47593-1**

This software can be used in any NASA space optics system, such as TPF. It is currently being used for the Advanced Wavefront Control Testbed project at JPL. Because this contribution reduces model validation errors significantly in any model involving optical surfaces, cost savings can be significant.

**U.S. Government Purpose Release****NPSS Elements, Models, and Interfaces****LEW-17051-1A**

These engineering elements and sample models were a part of the overall NPSS package before the 2.8 release. The package contains the default set of engineering elements, sample models, and interfaces with other software packages.

**U.S. Government Purpose Release****NPSS Numerical Propulsion System Simulation****LEW-17051-1**

NASA Glenn Research Center is developing a common collaborative full engine simulation tool for the U.S. Government, aerospace industry, and academia called the Numerical Propulsion System Simulation (NPSS). NPSS provides an environment for the analysis and design of propulsion systems for thermodynamic systems. The NPSS focuses on the potential integration of multiple disciplines such as aerodynamics, structures, and heat transfer, along with the concept of numerical zooming between 0-Dimensional to 1-, 2-, and 3-dimensional component engine codes.

**U.S. Government Purpose Release**

### **Observing System Simulation Experiment (OSSE) for the HypsIRI Spectrometer Mission NPO-47048-1**

This software is for the optimal instrument design for Earth-observing missions that depend on the complicated interplay between atmospheric radiative transfer, surface characteristics, orbital geometry, retrieval algorithms, and science objectives. It accomplishes this by implementing an Observing System Simulation Environment (OSSE) and is used to demonstrate science return for proposed instruments by modeling the whole ground truth, sensing, and retrieval chain.

**U.S. Government Purpose Release**

### **OMINAS: Open-Source Modular Image Navigation and Analysis System NPO-50136-1**

The primary motivation for the development of this software was to separate the analysis part of a problem from the data-specific part. This allows the exact same software to be used for multiple missions as needed; the only requirement for new mission input is the creation of a translator specific to that data source. The software provides an API and for developing tools for astronomical data analysis.

**Open Source**

### **Open Scheduling and Planning Interface for Exploration (OpenSPIFe) ARC-15795-1B**

The Open Scheduling and Planning Interface for Exploration (OpenSPIFe) is an integrated planning and scheduling toolkit based on hundreds of hours of expert observation, use, and refinement of state-of-the-art planning and scheduling technology for several applications within NASA. It was designed from the ground up with the needs of the operational user in mind, and it presents unique solutions to a number of problems common in other commercial and homegrown systems.

**Open Source**

### **Orbit Lifetime Monte Carlo (OLMC) LAR-17498-1**

Given the dynamic environment in which spacecraft exist, a better methodology for performing orbital lifetime analyses over the current practice of point analyses was desired. The approach chosen was to utilize Monte Carlo-based predictions; this provides the ability to gauge the probability of meeting mission lifetime goals, as well as identifying driving factors. The Monte Carlo analysis, called Orbital Lifetime Monte Carlo (OLMC), is based on the NASA Langley Research Center long-term orbit propagator Orbital Lifetime. OLMC incorporates the ability to model variations in predictions of solar flux levels and timing of associated peaks, the variation in launch vehicle orbit insertion accuracy (altitude, velocity, and flight path angles), spacecraft ballistic coefficients, and launch delays.

**U.S. Release Only**

### **Parallel Wavefront Analysis for a 4D Interferometer NPO-47384-1**

This invention reduces the time to measure adaptive optics systems (e.g., the James Webb Space Telescope), reducing the cost of system verification and validation. A process that would have taken weeks to complete can be done in a few hours.

**U.S. Government Purpose Release**

### **PLOT3D Export Tool for Tecplot LAR-17678-1**

The PLOT3D Export Tecplot add-on is a runtime library linked into Tecplot at the time of startup of the Tecplot software. It enables Tecplot users with the ability to output PLOT3D style files from Tecplot as a grid, grid and solution, or grid and function file for use by another computer code. Existing functionality of Tecplot only offers input of PLOT3D data and output of image data or Tecplot proprietary formatted data. The PLOT3D Exporter add-on thus enables the use of Tecplot as a generation and manipulation of grid and solution data for output to flow solvers. In this capacity, Tecplot can be used to interpolate old solutions onto new grids imported into Tecplot or created within the Tecplot software. The output of PLOT3D data also enables use of Tecplot to convert solutions from other flow solvers into a standard PLOT3D data set.

**General Public Release**

**Porous Material Analysis Toolbox Based on OpenFoam (PATO)****ARC-16680-1A**

The Porous Material Analysis Toolbox (PATO) is a modular analysis platform for multiphase porous reactive materials. It can be run as a simple Fourier heat transfer code or include more advanced features as internal decomposition (pyrolysis, vaporization), gas-gas and gas-solid chemical interactions (combustion, cracking, coking), gas species transport (convection, diffusion), and solid morphology evolutions (internal density changes, surface ablation). PATO is implemented as a C++ top-level module of the open-source (GNU GPL) computational fluid dynamics software program OpenFOAM. This offering is not approved or endorsed by OpenCFD Limited, the producer of the OpenFOAM software and owner of the OPENFOAM and OpenCFD trademarks. PATO also uses the open-source (GNU LGPL) thermodynamics, transport, and chemistry library Mutation++ produced by the von Karman Institute for Fluid Dynamics.

**Open Source****Program Round-Off Certifier Via Static Analysis (PRECiSA) with Kodiak Integration****LAR-19227-1**

PRECiSA is a fully automatic static analyzer for floating-point valued functions. It computes an over-approximation of the round-off error of a given floating-point expression and provides a formal certificate that ensures the correctness of the estimated error. The current invention extends PRECiSA in three ways: (1) it enables the use of external tools such as the global optimization tool Kodiak to compute numerical bounds in an efficient way; (2) it adds input language support for loops and recursion, and (3) it implements a more efficient analysis of nested conditionals.

**Open Source****PSSEARCH: A System for Predictive Sea State Estimation for Automated Ride Control and Handling****NPO-47533-1**

This system enables a manned or unmanned watercraft to determine the 3D map and sea state conditions in its vicinity in real-time. Adaptive path-planning/re-planning software and a control surface management system will then use this information to choose the best settings and heading relative to the seas for the watercraft.

**U.S. Government Purpose Release****PyCycle: A Cycle-Modeling Tool for Design with Gradient Based-Optimization****LEW-19288-1**

PyCycle is a novel software library written in the Python programming language. It allows a user to perform standard engine cycle analysis while also providing analytic derivative (sensitivity) calculations to the end user.

**Open Source****QEMU Model for BAE Rad750 (Board Model)****GSC-17147-1**

This work provides a board model and implementation of the BAE Rad750en PPCI PowerPC to PCI bridge chipset for QEMU.

**U.S. Government Purpose Release****Reconfigurable Bandwidth-Efficient Transmit Waveform for High-Rate Telemetry****LEW-19307-1**

This software has been developed for space communications and is intended for implementation on software-defined radio (SDR) technology. The waveform is designed to optimize the data-throughput through NASA's Space Network, in particular, the Ku-band or Ka-band single-access service, which has 225 MHz of available bandwidth. The waveform is written in very high-speed integrated circuit Hardware Description Language (VHDL), appropriate for space-qualified Field Programmable Gate Arrays (FPGAs).

**U.S. Release Only**

### **Savors: A Scalable Aural-Visual Environment for Security Event Monitoring, Analysis, and Response**

**ARC-16186-1**

Savors is a tool for security event monitoring, analysis, and response. The technology scales to real-world environments and uses high-end computing resources on-demand to compile behavior profiles that point to anomalous behavior. Auralization allows both monitoring and analysis to be performed in parallel and draws attention to critical events in one tool when utilizing another. Remote data access and response capabilities across distributed resources are enabled using grid computing that provides a secure, single sign-on environment.

**Open Source**

### **SCaN Optical Link Assessment Tool, Version 3**

**LEW-19463-1**

This calculation procedure has been designed and implemented in software that enables the specification and design of a space-based optical communications system. The resulting optical link budget essentially accounts for the communication power flow through the entire optical communications channel from the transmitter to the receiver and yields design specifications for the optical system necessary to assure reliable data transmission with desired operational metrics such as data rate, link margin, etc.

**U.S. Release Only**

### **SCaN Optical Link Budget Tool**

**LEW-19225-1**

A calculational procedure in this software enables the specification and design of a space-based optical communications system. The resulting optical link budget essentially accounts for the communication power flow through the entire optical communications channel (from the transmitter to the receiver) and yields design specifications for the optical system necessary to assure reliable data transmission with desired operational metrics. The link budget takes into account all of the sources of deleterious noise that enters into the communications, and it has the capability of being interfaced with the orbital element calculations of the Satellite Tool Kit (STK) to allow the dynamic description and evolution of optical link operation from any space-borne satellite within the solar system to and from the Earth.

**U.S. Release Only**

### **Signal Processing Software for Remote Vital Signs Monitoring**

**NPO-47243-1**

This work has tremendous value to NASA aeronautical and space activities. The software enables the capability to remotely estimate the heart rate and respiration rate of individuals using high-frequency, narrow-band microwave (18Ghz-30Ghz).

**U.S. Government Purpose Release**

### **Software Architecture Framework for Extensibility Using Dynamic Assembly of Reflective Types (SAFE-DART)**

**LEW-19593-1**

SAFE-DART is a framework designed to increase the extensibility and flexibility of a software system written in C++ and utilizing the Qt C++ framework from The Qt Company. SAFE-DART adds flexibility to the software system by making it simple to change computer software components (CSC) by selecting from multiple implementations provided by the software system in a way that can be controlled by the user at run-time. SAFE-DART also allows the use of modules to provide additional CSC implementations without the need to alter the original software system, allowing additional functionality to be added to the system even at run-time.

**Open Source**

### **Software for Controlling a Magnetically Levitated Rotor**

**LEW-17293-2**

The ultimate goal in designing this code was to achieve full rotor levitation and control at a loop time of 50 s. Using a 1-GHz processor, the code controls a five-axis system in either a decentralized or a more elegant centralized (model control) mode at a loop time of 56 s.

**General Public Release**

**Software for Hybrid Airship Steady Flight Analysis and Preliminary Design****ARC-16503-1**

This software helps designers of hybrid airships to understand the effects of aerodynamic and thruster performance on steady-state flight mechanics. The software is capable of producing a large number of useful plots and requires only basic geometric, mass, and aerodynamic data to describe the vehicle. The resultant plots and plotting script are compatible with a widely used and freely available plotting package.

**U.S. Government Purpose Release****Software Modules for Proximity-1 Space Link Interleaved Time Synchronization (PITS) Protocol****NPO-47404-1**

This software implements the NTP algorithm for space communications and can be used as a basis for further higher TRL prototype or flight software development. It is an implementation to test the functionality of the NTP basic and interleaved symmetric algorithm that can be integrated with CCSDS Prox-1 to provide the time distribution and synchronization service.

**U.S. Government Purpose Release****Space Mission Architecture and Risk Analysis Tool (SMART)****NPO-49732-1**

SMART supports a high-level system trade study on a complex mission, such as a potential Mars Sample Return (MSR) mission, in an intuitive and quantitative manner. SMART offers a unique capability of handling correlated redundancies and accurately evaluating the probability of mission success, as well as its sensitivity to the reliability of mission components.

**Open Source****Space Station Multi-Rigid Body Simulation (SSMRBS)****MSC-25738-1**

The SSMRBS innovation uses a commercial off-the-shelf software package to generate the equations of motion (EOM) used in a simulation. The EOM generated and solved in the simulation is based on an Order-N algorithm.

**U.S. Government Purpose Release****Station Spacewalk Game App****ARC-16779-1**

This video game features simulations of Extravehicular Activities (EVAs) conducted by NASA astronauts on missions to the International Space Station.

**General Public****Station/Orbiter Multibody Berthing/Docking Analysis Tool (SOMBAT)****MSC-25528-1**

SOMBAT is a multibody dynamics and control system simulation tool. It provides an integrated software environment to perform kinematic and dynamics analysis of space structures and robotic manipulators including their control elements. The multibody system can consist of an arbitrary number of rigid and flexible bodies in an open-loop topology. The dynamics equations of a given system are generated in a computationally efficient and optimized form in SOMBAT using a symbolic code generator.

**U.S. Government Purpose Release****Support for Systematic Code Reviews with the SCRUB Tool****NPO-46817-1**

SCRUB is a code review tool that supports both large team-based software development efforts (e.g., for mission software) and individual programming tasks. The tool was developed at JPL to support a new streamlined code review process that combines human-generated review reports with program-generated analysis reports from a customizable range of state-of-the-art source code analyzers. All reports are accessed through a single uniform interface that facilitates browsing code and reports.

**U.S. Government Purpose Release**

### **SysML System Model for the Thirty-Meter Telescope (TMT)**

**NPO-50126-1**

SysML is a standard, visual, and general-purpose system modeling language developed by the Object Management Group (OMG). MagicDraw from NoMagic is used as a modeling tool.

**Open Source**

### **System/Observer/Controller Identification Toolbox (SOCIT), Macintosh Version**

**LAR-15241**

SOCIT is a collection of functions, written in MATLAB language and expressed in M-files, that implements a variety of modern system identification techniques. For an open-loop system, it features functions for identification of a system model and corresponding forward and backward observers directly from input and output data. For a closed-loop system, SOCIT identifies an open-loop model, an observer, and corresponding controller gain directly from input and output data.

**U.S. Release Only**

### **Systems Capability Organization Reporting Engine Board (SCOREboard)**

**LAR-18852-1**

SCOREboard was developed to integrate 12 sometime disparate data sets into a cohesive human exploration capability story that can be used to communicate NASA's exploration investments within the capability-driven framework. The SCOREboards are graphical visualizations of SMT capability data that enable the EMC architecture and notional missions.

**U.S. Government Purpose Release**

### **TEAMS Model Analyzer**

**NPO-46842-1**

This technology is aimed at helping NASA people conducting modeling activities in the areas of Function Fault Analysis and Ground-Based System Diagnostics for the Ares project. The reporting features of the tool allows the modelers to quickly gather statistics about a model and generate an input/output report pertaining to all of the components. The model checking framework allows for rules to be automatically validated against the model and reports a list of the resulting inconsistencies. The software reduces the manual processing a TEAMS modeler must perform in the preparation of reporting for modeling reviews.

**U.S. Government Purpose Release**

### **Testgen: A Combinatorial Test Suite Generation Tool**

**NPO-45921-1**

This system has applicability to the Constellation Program in NASA. It has been used to generate test suites for the analysis of ANTARES Re-Entry Guidance Algorithms. The main purpose of the software is to generate as few test cases as possible to cover the test space of a system as specified by a set of user requirements.

**U.S. Government Purpose Release**

### **TetrUSS Computational Fluid Dynamics Software (TetrUSS)**

**LAR-16882-1**

The most awarded software in the history of NASA, TetrUSS is a suite of computer programs used for fluid dynamics and aerodynamics analysis and design. The software is widely used in other government organizations, the aerospace industry, academia, and non-aerospace industries such as automotive, bio-medical, and civil engineering.

**U.S. Release Only**

### **Total Verification System and C++ Based Verification Test Bench**

**GSC-16013-1**

This technology verifies complex space flight digital designs in a more thorough manner than was previously possible while offering cost savings and reduced schedule time. The software combines a custom-designed GSE unit, the Total Verification System, along with a powerful test bench environment that uses C++. Together, these elements allow a high level of code reuse between all phases of the design and test cycle.

**U.S. Government Purpose Release**

**Transport Class Model (TCM) Aircraft Simulation Software****LAR-18322-1**

This six-degree-of-freedom, flat-earth dynamics, non-linear, and non-proprietary aircraft simulation is a representation of a generic mid-sized twin-jet transport aircraft.

**General Public Release****TREETOPS****MFS-33566-1**

TREETOPS is a time history simulation of the motion of a complex multi-body flexible structures with active control elements. The name TREETOPS refers to the class of structures that may be simulated by the program, i.e., those having a tree topology (where loop closures are handled with a cut graph technique). TREETOPS offers the user an advanced capability for analyzing the dynamics and control-related issues of such structures.

**U.S. Government Purpose Release****Trick 13 Simulation Environment****MSC-25665-1**

The Trick Simulation environment is a generic simulation toolkit used for constructing and running simulations. The Trick 13 Interface Code Generator (ICG), a utility that provides math model class and structure layout data, has been rewritten and is based off of the open-source clang/llvm project. The numerical integrators have been replaced with a common set of integrators, and several core components have been enhanced from previous Trick versions. Trick 13 can be downloaded at: <http://code.nasa.gov/#/>

**Open Source****Trick High-Level Architecture (HLA) Framework for Facilitating IEEE 1516 Simulation Integration****MSC-24544-1**

This framework removes the complexity of adhering to the Institute of Electrical and Electronics Engineers (IEEE) 1516-2000 High-Level Architecture (HLA) standards for simulation interoperability. The framework is data driven and includes a simple application programming interface (API), making it relatively easy to enhance an existing Trick simulation into a distributed simulation.

**General Public Release****Uncertainty Quantification Toolbox (UQTools)****LAR-17855-1**

UQTools is a MATLAB-based software package designed to efficiently analyze dynamic systems subject to parametric uncertainty. UQTools accepts uncertainty models based upon both probabilistic and non-probabilistic definitions, and it realizes several complementary methods for performing a variety of uncertainty quantification tasks.

**U.S. Release Only****USM3D****LAR-16670-GS**

USM3D is a tetrahedral unstructured flow solver that has become widely used in industry, government, and academia for solving aerodynamic problems. Since its first introduction in 1989, USM3D has steadily evolved from an inviscid Euler solver into a full viscous Navier-Stokes code. The technology has been a part of the NASA TetrUSS system.

**U.S. Release Only****Vehicle Sketch Pad (VSP)****LAR-17491-1**

The Vehicle Sketch Pad (VSP) is an aircraft geometry tool for rapid evaluation of advanced design concepts. Fast and accurate geometry modeling allows the designer to use more complex analysis methods earlier in the design process and reduces reliance on empiricism in conceptual design. VSP includes tools to model and export the internal structural layout.

**Open Source**

### **Versatile Impulsive Interplanetary Trajectory OptimizeR (VISITOR)**

**LAR-18538-1**

The design of trajectories for interplanetary missions represents one of the most complex and important problems to solve during conceptual space mission design. To facilitate conceptual interplanetary mission sizing activities, it is essential to obtain sufficiently accurate trajectories in a fast and repeatable manner. To this end, the VISITOR software tool was developed. This tool modularly augments a patched conic, multiple gravity-assist with one deep space maneuver (MGA-1DSM) trajectory model with a mass model, launch window analysis, and the capability to simulate realistic arrival and departure operations. The tool was validated against seven flown missions. VISITOR is well-suited for the conceptual design of interplanetary trajectories and facilitates future improvements due to its modular structure.

**General Public Release**

### **Virtual ADAPT**

**ARC-18001-1**

Virtual ADAPT is a MATLAB/Simulink simulation of the Advanced Diagnostics and Prognostics Testbed (ADAPT) located at NASA Ames Research Center. ADAPT is an electrical power system testbed that emulates the power distribution systems on spacecraft. It allows users to inject faults in order to study how faults affect the operation of the electrical power system and to evaluate automated diagnostics technologies. Virtual ADAPT provides a high-fidelity simulation of this capability. It includes dynamic models of all the components of ADAPT and enables all faults that can be injected into the actual testbed to be injected into the simulation, including some that would be difficult or unsafe to do in the actual hardware. In this way, simulated fault scenarios can be quickly generated under many possible conditions, generating simulated data that closely matches what the behavior of the actual testbed would be. This simulated data can then be used for diagnostics algorithm development and testing before testing on the actual hardware or deploying to a real application.

**Open Source**

### **Visual International Space Station Configuration Viewing Tool (VIC)**

**MSC-25339-1**

The Visual International Space Station Configuration Viewer (VIC) is a software tool to assist with visualizing and communicating the current and potential ISS configuration to a wide audience. The tool consists of a simplified 3-dimensional model of the ISS external configuration that allows the user to interact using a mouse or keyboard (e.g., drag, pan, rotate, zoom) and manually reconfigure the ISS with pre-defined elements, vehicles, and cargo to assist with visualizing ISS during trade study and ops con development and during presentations.

**U.S. Government Purpose Release**

### **Weight Analysis of Turbine Engine: An Object-Oriented Version (WATE++)**

**LEW-19687-1**

WATE++ is an object-oriented computer code for gas turbine engine weight estimation; it calculates the weight and dimension of each major gas turbine engine component. It is used to create engine architecture that could achieve an engine thermodynamic cycle produced by a thermodynamic cycle code. The thermodynamic cycle data, the material properties, and design rules for geometric, stress, and turbo-machinery stage-loading limits were used to determine an acceptable engine flowpath and weight.

**U.S. Release Only**

### **WinASSIST: Windows Abstract Semi-Markov Specification Interface to the SURE Tool**

**LAR-16060-1**

WinASSIST uses a rule-oriented language to automatically generate input files for the SURE/WinSURE program. The user describes the failure behavior and recovery behavior of a fault-tolerant computer system in an abstract language. WinASSIST then automatically generates a corresponding semi-Markov model. The abstract language allows efficient description of large, complex systems

**Open Source**



### **Windows Semi-Markov Range Evaluator (WinSURE)**

**LAR-16059-1**

This package is used by aerospace flight software developers to predict the reliability of flight-critical computer processes.

**Open Source**

### **X-Band Acquisition Aid Software**

**NPO-47004-1**

The X-Band Acquisition Aid (AAP) software is a low-cost acquisition aid for the Deep Space Network (DSN) antennas and is used while acquiring a spacecraft shortly after it has launched. The DSN consists of three complexes located at Goldstone, CA; Madrid, Spain; and Canberra, Australia. Each complex has from three to six antennas.

**U.S. Government Purpose Release**





# 11

## Crew and Life Support

Biological Sensors, Food, Medical, Biological  
Analysis, Crew Support, Basic Human Model  
and Cognition

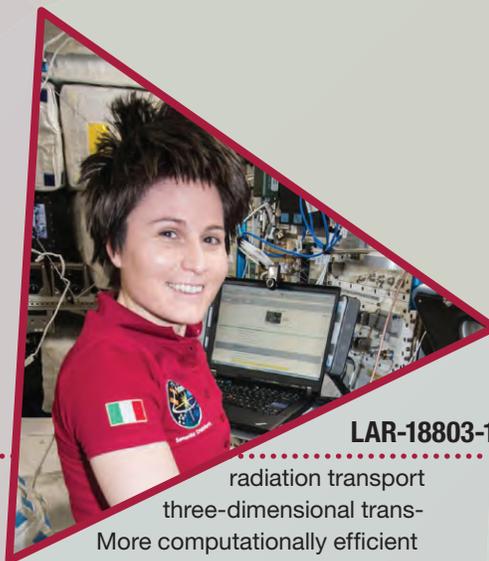


## Featured Software

### HZETRN 2015

This latest update to the HZETRN deterministic space code contains new algorithms and options for calculating transport in user-defined combinatorial or ray-trace geometry. bi-directional algorithms may be used to perform transport through multilayer slabs. Users may also opt to create an interpolation database for various thicknesses within one to three user-defined material layers using a straight-ahead transport algorithm. Calculations may be executed for galactic cosmic ray (GCR), solar particle event (SPE), low-Earth orbit (LEO), and user-defined environment boundary conditions.

**General Public Release**



**LAR-18803-1**

radiation transport  
three-dimensional transport  
More computationally efficient  
through multilayer slabs. Users may also

### Multi-Attribute Task Battery (MATB-II)

MATB-II is a computer-based task battery designed to facilitate research in human multiple task performance with consideration for the effects of automation. The tool includes five component tasks: system monitoring, tracking, communications monitoring, and resource management. A scheduling window provides preview of anticipated workload, and component tasks can be automated or manual. Coded in C++, MATB-II has been tested on the Windows XP® Service Pack 3, Windows® Vista, and Windows® 7 operating systems.

**General Public Release**

**LAR-17835-1**

### Multi-Attribute Task Battery (MATB-II) Event File Builder (EFBt)

This standalone application allows a researcher to create and edit event files for the NASA MATB II task battery through a graphical interface. A scheduling window provides preview of anticipated workload. Component tasks can be automated or manual. EFBt generates event files in XML code; files can be coded and edited in a standard XML editor.

**General Public Release**

**LAR-17840-1**

### NASA Task Load Index (TLX)

The NASA Task Load Index (TLX) provides multi-dimensional ratings of overall workload based on a weighted average of six subscales: mental demands, physical demands, temporal demands, performance, effort, and frustration.

**General Public Release**

**ARC-15150-1**

### Relativistic Ion Tracks (RITRACKS)

RITRACKS has been developed over the last several years at Johnson Space Center to simulate the effects of ionizing radiations at the microscopic scale and to understand the effects of space radiation at the biological level. The fundamental part of this code is the stochastic simulation of the radiation track structure of heavy ions, an important component of space radiations. The code can calculate many relevant quantities (e.g., radial dose and voxel dose) and may also be used to calculate the dose in spherical and cylindrical targets of various sizes. The software can be installed independently on PCs and tablets using the Windows operating system and does not require any coding from the user. It includes a graphic user interface (GUI) and a 3D OpenGL visualization interface. Calculations are executed simultaneously (in parallel) on multiple CPUs.

**General Public Release**

**MSC-25937-1**



### **Acute Radiation Risk and BRYNTRN Organ Dose (ARRBOD), Version 2.1**

**MSC-26211-1**

ARRBOD is a radiation risk projection model for typical space traveling scenarios that calculates gender-dependent organ doses and various acute radiation responses due to some historical large solar particle events (SPEs).

**General Public Release**

### **Atomistic Simulation of Complex DNA DSBs and the Interactions with the Ku70/80 Heterodimer**

**MSC-25180-1**

This software assisted in the development of molecular dynamics simulations on a series of DNA duplexes with various complex lesions. The tool helped to investigate the effects of such lesions on the structural integrity and stability of DNA after it had been insulted by infrared radiation.

**U.S. Government Purpose Release**

### **GCR Event-Based Risk Model Code (GERMcode)**

**MSC-24760-1**

GERMcode provides scientists with data interpretation of their experiments. For mono-energetic ion beams, basic physical and biological properties are calculated for a selected ion type, such as kinetic energy, mass, charge number, absorbed dose, or fluence. Evaluated quantities include linear energy transfer, range, absorption and fragmentation cross-sections, and the probability of nuclear interactions. In addition, a set of biophysical properties are evaluated (e.g., Poisson distribution for a specified cellular area, cell survival curves, and DNA damage yields per cell). GERMcode also calculates the radiation transport of the beam line for either a fixed number of user-specified depths or at multiple positions along the Bragg curve of the particle in a selected material.

**General Public Release**

### **Geometric Reasoning for Automated Planning**

**NPO-47436-1**

An important aspect of mission planning for NASA's operation of the International Space Station is the allocation and management of space for supplies and equipment. The Stowage, Configuration Analysis, and Operations Planning teams collaborate to perform the bulk of that planning. A geometric reasoning engine has been developed and can be shared by the teams to optimize item placement in the context of crew planning.

**U.S. Government Purpose Release**

### **Histogrammatic Method for Determining Relative Abundance (MCA) of Input Gas Pulse in the Presence of Obscuring Gas Background**

**NPO-47217-1**

The Vehicle Cabin Atmosphere Monitor (VCAM) is capable of monitoring the air within enclosed environments (e.g., the International Space Station, crew exploration vehicles, a lunar habitat, or a vehicle traveling to Mars). Its miniature preconcentrator, gas chromatograph, and mass spectrometer provide unbiased detection of a large number of organic species. VCAM's software can identify chemicals on a targeted list of hazardous compounds, and it can also gauge chemical concentrations.

**U.S. Government Purpose Release**

### **Human Factors Analysis Support Tool (H-FAST), Version 2.0**

**MSC-25653-1**

This software increases human factors awareness among design engineers, facilitates communication between human factors engineers and design engineers, and promotes the application of human factors best practices early in the design cycle. H-FAST also offers detailed guidance regarding human factors evaluations and provides the capability to store these evaluations

**U.S. Government Purpose Release**



**HZETRN 2015****LAR-18803-1**

This latest update of the HZETRN deterministic space radiation transport code contains new algorithms and options for calculating three-dimensional transport in user-defined combinatorial or ray-trace geometry. More computationally efficient bi-directional transport algorithms, similar to those found in HZETRN 2010, may also be used to perform transport through multilayer slabs, or users can opt to create an interpolation database for various thicknesses within one to three user-defined material layers using a straight-ahead transport algorithm, similar to the one in HZETRN 2005. Transport calculations may be executed for galactic cosmic ray (GCR), solar particle event (SPE), low-Earth orbit (LEO), and user-defined environment boundary conditions. Neutrons, protons, and light ions are transported for SPE and LEO boundary conditions. For GCR boundary conditions, heavy ions, pions, muons, electrons, positrons, and photons are also transported.

**General Public Release****Kidney Stone Detection Using a Combined Method of B-Mode and Doppler Ultrasound, UW C4C Reference No. 45493****MSC-25189-1**

This NASA algorithm first detects the outlier within a Doppler signal ensemble and then weights the magnitude of the outlier by the magnitude of the B-mode at the same point in space. Thresholding, color scaling, and spatial filtering are applied to output detection, and the information is overlaid onto the B-mode image in real time.

**U.S. Government Purpose Release****Man-Machine Integration Design and Analysis System (MIDAS), Version 5****ARC-16050-1A**

MIDAS is a 3D rapid-prototyping human-performance modeling environment that facilitates the design, visualization, and computational evaluation of complex man-machine system concepts in simulated operational environments. The tool links a virtual human to a computational cognitive structure that represents human capabilities and limitations. MIDAS operates on a Microsoft Windows-based PC platform. An easy-to-use graphical user interface makes the software an accessible tool for designers; no expertise in computer science, programming, or human performance modeling is required.

**U.S. and Foreign Release****Multi-Attribute Task Battery (MATB-II)****LAR-17835-1**

MATB-II is a computer-based task battery designed to facilitate research in human multiple task performance with consideration for the effects of automation. The tool includes five component tasks: system monitoring, tracking, communications monitoring, and resource management. A scheduling window provides preview of anticipated workload, and component tasks can be automated or manual.

**General Public Release****NASA Space Radiation Cancer Risk (NSCR) Model 2012****MSC-25352-1**

NSCR is an integration of various components of the cancer risk projection model used for assessing radiation-induced cancer risks for humans in space. It utilizes the latest analysis of human radio epidemiology for low-linear energy transfer (LET) radiation and cancer, as well as survival rates in the U.S. population and a population of never-smokers. Models of space environments and radiation transport are used to determine organ exposures behind spacecraft shielding. NSCR uses Monte-Carlo propagation of errors in various factors to determine the overall uncertainties in radiation cancer projections.

**U.S. Government Purpose Release****NASA Task Load Index (TLX) iOS****ARC-15150-1A**

The NASA Task Load Index (TLX) provides multi-dimensional ratings of overall workload based on a weighted average of six subscales: mental demands, physical demands, temporal demands, performance, effort, and frustration. Data collection may be performed through an iPhone or an iPad.

**General Public Release**

### **Network-Form Game Software Library (libnfg)**

**ARC-16764-1**

The libnfg software library describes how humans interact with their environment and with other humans. The tool provides a Monte Carlo analysis of user-specified “network-form games,” which are flexible modeling methodologies that combine Bayes nets and game theory to model complex systems.

**Open Source**

### **New Regime of Ultrasound Imaging of Strong Scatterers in Tissue Using Envelope-Based Beam Forming**

**MSC-25190-1**

Sacrificing resolution quality, this tool improves the contrast between a kidney stone and other tissue in an ultrasound image.

**U.S. Government Purpose Release**

### **New Ultrasound Imaging Regime for Improved Size Measuring of Hard Concretions Present in Soft Tissues Based on Observation of Ultrasound Shadow on a B-Mode Image**

**MSC-25187-1**

This NASA-developed technology improves kidney-size determination through ultrasound.

**U.S. Government Purpose Release**

### **Performing Major Constituents Analysis (MCA) on the VCAM Instrument Including Automated Mass Calibration**

**NPO-46956-1**

The Vehicle Cabin Atmosphere Monitor (VCAM) is capable of monitoring the air within enclosed environments (e.g., the International Space Station, crew exploration vehicles, a lunar habitat, or a vehicle traveling to Mars). Its miniature preconcentrator, gas chromatograph, and mass spectrometer provide unbiased detection of a large number of organic species. VCAM’s software can identify chemicals on a targeted list of hazardous compounds, and it can also gauge chemical concentrations.

**U.S. Government Purpose Release**

### **POSTPROC User-Interactive Software for the Analysis of Human Physiological Data**

**ARC-15287-1**

POSTPROC offers researchers and clinicians user-friendly software for processing and analyzing human physiological data. Measurements include electrocardiography, electromyography, respiration, beat-to-beat blood pressure, skin temperature, blood volume pulse, skin conductance levels, and cardiovascular dynamics derived from impedance. The customized application runs under DADiSP/2002, a commercially available engineering spreadsheet from DSP Development Corporation.

**U.S. Government Purpose Release**

### **Quantification of Trace Chemicals Using a Vehicle Cabin Atmosphere Monitor (VCAM)**

**NPO-46691-1**

VCAM is a miniature preconcentrator/gas chromatograph/mass spectrometer (PCGC/MS) system used to identify and quantify trace chemicals. It provides a needed trace-gas monitor for the International Space Station (ISS).

**U.S. Government Purpose Release**

### **Real-Time Kidney Stone Tracking Algorithm**

**MSC-25192-1**

A software component of the Rolling Stones prototype, this algorithm uses focused ultrasound to clear stones from a kidney. The tool processes a series of B-mode images to track a region of interest, offers visual feedback of position location to the user, and targets a stone for automated adaptive pushing. The algorithm uses a colored display scheme to report a confidence estimation of stone location.

**U.S. Government Purpose Release**



**Ring Image Analyzer****NPO-47579-1**

This software resonator is used for the stabilization of a laser. In doing so, it becomes a reference frequency source for a miniature space clock. Such clocks can play a crucial role in space navigation and communication, as well as in fundamental astrophysics research. The Ring Analyzer program attempts to recognize elliptical fringes (e.g., Newton Rings) on a photograph and determine their centroid position, the short-to-long axis ratio, and the angle of rotation of the long axis relative to the horizontal direction on the photograph.

**U.S. Government Purpose Release****RITRACKS: A Software for Simulation of Stochastic Radiation Track Structure, Micro- and Nano-Dosimetry, Radiation Chemistry, and DNA Damage by Heavy Ions****MSC-25937-1**

RITRACKS has been developed over the last several years at Johnson Space Center to simulate the effects of ionizing radiations at the microscopic scale and to understand the effects of space radiation at the biological level. The fundamental part of this code is the stochastic simulation of radiation track structure of heavy ions, an important component of space radiations. The code can calculate many relevant quantities such as radial dose, as well as voxel dose, and it may also be used to calculate the dose in spherical and cylindrical targets of various sizes. Recently, DNA structure and damage simulations at the molecular scale have been incorporated into RITRACKS.

**General Public Release****Space Science Investigations: Plant Growth****MSC-26184-1**

This interactive app for mobile platforms teaches about growing plants in space. Downloads are available on iTunes or the Google Play Store (no agreement with NASA needed).

**General Public Release****Spaceflight Dietary Intake****MSC-25693-1**

This technology allows a crew to record dietary intake quickly and accurately.

**U.S. Government Purpose Release****Spinal Ultrasound Just-in-Time Training Tool****MSC-25501-1**

Augmenting/reducing required Earth-based training and enhancing ultrasound-image reproducibility, this NASA-developed tool provides crewmembers with a review of anatomical landmarks and experimental protocols.

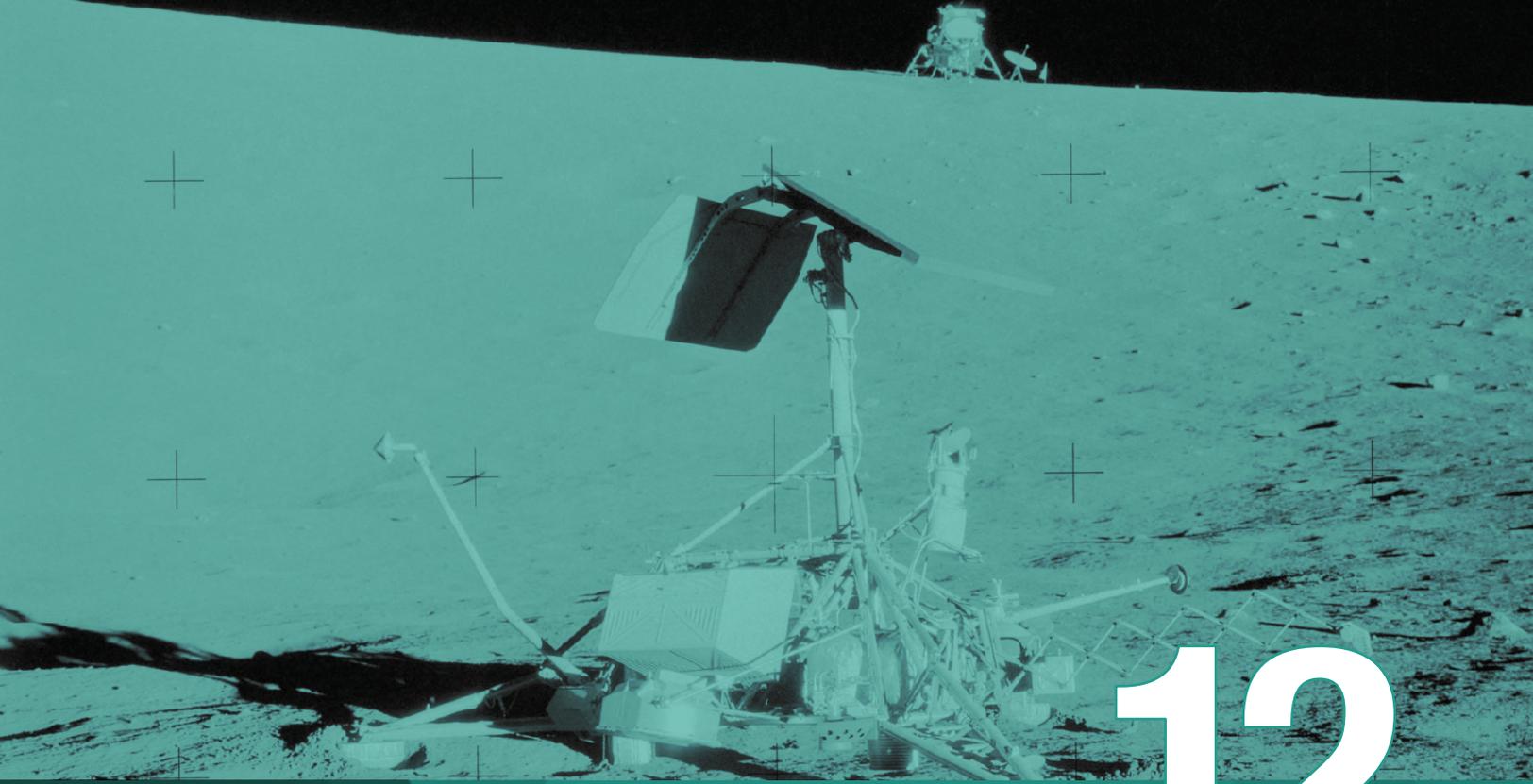
**U.S. Government Purpose Release****Spine Elongation Prevention and Exercise Device for Microgravity Environment****MSC-25654-1**

This technology is being designed to prevent the spinal column lengthening and spinal column bone loss that can occur in a microgravity environment.

**U.S. Government Purpose Release****Ultrasound Technique to Separate Hard Objects from Tissue by the Long-Lasting Reverberation in Hard Objects****MSC-25188-1**

The ultrasound imaging of hard objects creates a reverberant signal, whereas imaging tissue does not. This technology development effort has sought to exploit that difference to improve kidney stone detection.

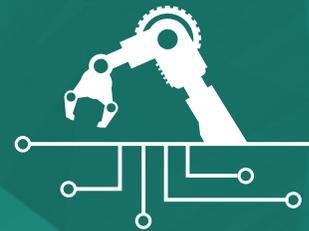
**U.S. Government Purpose Release**

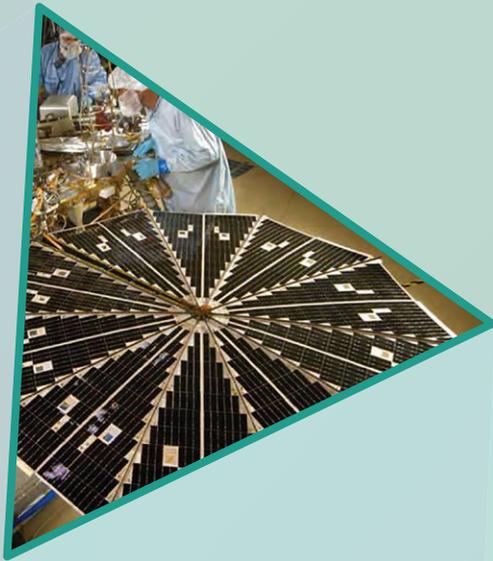


# 12

## Autonomous Systems

Robotics, Automated Systems, Systems Health Monitoring





## Featured Software

### **Autonomous Real-Time Requirements Tracing (ART)**

**MFS-33209-1**

ART offers the ability to directly trace the real-time execution of software to specific requirements, a unique capability that can only be performed with a Timeliner-TLX system, as no other computer languages directly report this data during execution. The tracing feature does not impose input/output requirements (e.g., print/write statements) on the targeted software because the tracing is performed by an outside program executing separately. The Timeliner-TLX language is currently used for auto-procedures on the International Space Station (ISS) and the Autonomous Mission Operations (AMO) project, and future manned deep-space missions will require the use of extensive auto-procedures to assist in remote intelligent operations.

**U.S. Government Purpose Release**



### **Adaptation of the AMDIS Method to Flight Status on the VCAM Instrument for ISS Installation in an Autonomous Manner**

**NPO-46563**

This software functions onboard the ISS to help safeguard human health by detecting noxious compounds in the air, both in identity and concentration. The standalone VCAM instrument was designed to provide an automated method of monitoring air quality within the ISS via a miniaturized mass spectrometer and gas chromatograph system.

**U.S. Government Purpose Release**

### **AprilNav: Indoor Real-time Landmark Navigation System**

**MFS-33648-1**

AprilNav uses printable 2D fiduciary markers, an HD camera, and software running on a single-board computer to create a scalable and accurate system for vehicular autonomous navigation and localization.

**Open Source**

### **Astrobee Robot Software (ARS)**

**ARC-17994-1**

Astrobee is a free-flying robot that is designed to operate as a payload inside the International Space Station (ISS). The Astrobee Robot Software (ARS) consists of the embedded (onboard) software and simulator.

ARS operates on Astrobee's three internal computers and uses the open-source Robot Operating System (ROS) framework to link multiple software modules. ARS performs localization and navigation of Astrobee, supports autonomous docking and perching, manages various sensors and actuators, and supports user interaction (via screen-based displays, light signaling, and sound).

**Open Source**

### **Automated Evaluation Software (AES) Web Application**

**GSC-16544-1**

AES allows source evaluation boards to enter, modify, and rate vendor proposals against a request for proposal (RFP). Created using modern Java enterprise technologies, the tool provides Microsoft output and dynamic report generation. The user interface is compatible with both Internet Explorer and Firefox. A Tomcat application server makes the application robust, fast, and reliable.

**U.S. Government Purpose Release**

### **Automation Framework Designed for Flight Dynamics Products Generation (XFDS)**

**GSC-15618-1**

This software framework automates the generation of flight dynamics products by providing a unified and consistent graphical interface to various tools. The technology coordinates the execution of applications such as Satellite ToolKit, FreeFlyer, and MATLAB; allows for the embedding of Perl code; provides a mechanism for passing messages between a collection of XFDS processes; and allows GMSEC messages to be sent and received. Automation configuration is stored in text files and can be edited directly or by using graphical editors implemented for each tool.

**U.S. Government Purpose Release**

### **Autonomous Phase- Retrieval Calibration (APRC)**

**NPO-47270-1**

APRC is technologically significant to the space (astronomy) community since it provides a significant leap in the optical performance of a large observatory by using only software to optimize existing controllable hardware in ways that were never possible before.

**U.S. Government Purpose Release**

### **Autonomous Quadrotor Safety System**

**NPO-49233-1**

This safety system consists of two features. The first part is a system monitor that runs on the quadrotor UAV flight computer to analyze system health. If a critical state is detected the module triggers a safety alert to initiate emergency behaviors like hover in place or emergency landing. The second part is a monitoring module on a base station computer that receives live data from a quadrotor UAV about its internal states (battery level, flight status, planned behavior, etc.) via a wireless link.

**U.S. Government Purpose Release**



**Autonomous Real-Time Requirements Tracing (ART)****MFS-33209-1**

This NASA software offers the ability to directly trace the real-time execution of software to specific requirements, a unique capability that can only be performed with a Timeliner-TLX system, as no other computer languages directly report this data during execution. The tracing feature does not impose input/output requirements (e.g., print/write statements) on the targeted software because the tracing is performed by an outside program executing separately. The Timeliner-TLX language is currently used for auto-procedures on the International Space Station (ISS) and the Autonomous Mission Operations (AMO) project, and future manned deep-space missions will require the use of extensive auto-procedures to assist in remote intelligent operations.

**U.S. Government Purpose Release****Detect and Avoid Alerting Logic for Unmanned Systems (DAIDALUS) with Dynamic Well-Clear Separation Volumes****LAR-19282-1**

DAIDALUS is a software library that implements a detect-and-avoid concept for unmanned aircraft systems. Functionality provided by DAIDALUS includes: detection logic, maneuver guidance logic (e.g., loss of well-clear recovery), and alerting logic.

**Open Source****Extendable Uniform Remote Operations Planning Architecture (EUROPA), Version 2.1****ARC-15936-1**

EUROPA is a general-purpose, reusable, artificial intelligence software system. The tool generates plans for performing complex activities in parallel. Functionality includes the capability of verifying that a plan satisfies all constraints.

**Open Source****G-PROX: Autonomous Spacecraft Guidance in the Vicinity of Primitive Celestial Bodies Using Sequential Convex Programming****NPO-49325-1**

The G-PROX guidance algorithm generates fuel-optimal trajectories in the vicinity of asteroids and small bodies. The non-convexity in the control constraints is handled with the lossless convexification technique, which consists of a convex relaxation on the control constraints. G-PROX solves a convergent sequence of convex optimization problems generated via sequential linearization of both the dynamics and control bounds synergistically combined with lossless convexification. Sufficient conditions are derived and guarantee that the sequence of convex optimization problems converges to a locally optimal solution of the original nonlinear non-convex problem.

**U.S. Government Purpose Release****Generic Software Architecture for Prognostics (GSAP)****ARC-17748-1**

GSAP is a generic, extendable, flexible, modular framework for applying prognostics technologies. The software manages top-level control, communications, logging, configuration, integration, and other general activities. A simple, standard interface is provided for integrating prognostics algorithms and models, minimizing the work required to deploy prognostics technologies.

**Open Source****Gold Standard Test Set (GSTS)****GSC-15873-1**

The GSTS ground support equipment verifies that a command, control, communications, and intelligence (C3I) system complies with the interoperability standards for radio links and Ethernet interfaces. The technology, which does not check content, has been used to verify the interoperability protocols (language only) between Constellation systems.

**U.S. Government Purpose Release**

### **Hazards Analysis Management Tool (HAMT)**

**GSC-16846-1**

HAMT uses a single software tool to increase the efficiency and effectiveness of hazard analyses. Composed of a Microsoft Access front-end (that contains the user interface) paired with a Microsoft Access back-end (that stores analysis data), the software can be used to enter, edit, and report information throughout the hazard analysis lifecycle.

**U.S. Government Purpose Release**

### **Independent Configurable Architecture for Reliable Operations of Unmanned Systems with Distributed On-board Services (ICAROUS-2)**

**LAR-19281-1**

ICAROUS-2 enables the robust integration of mission-specific software modules and highly-assured core software modules for building autonomous unmanned aircraft applications. The core software modules are implemented as distributed onboard services that communicate using a publisher/subscriber communication layer. The ICAROUS-2 independent architecture provides support for integration with standard and open-source communication and computation layers, including Core Flight Systems (CFSs), Data Distribution Service (DDS), MAVLink, and Plan Execution Interchange Language (PLEXIL).

**Open Source**

### **Jet Propulsion Laboratory (JPL) Stereo Vision Software Suite (JPLV)**

**NPO-18593-1T**

JPLV provides a set of libraries and utilities for basic robotic vision, including stereo ranging and camera calibration. Primarily intended for vision system users rather than vision system developers, the suite hides most implementation details behind a high-level application user interface. No specialized computer-vision knowledge is required.

**U.S. Government Purpose Release**

### **Lidar-Based Hazard-Relative Navigation (HRN) Algorithm for Safe Lunar Landing**

**NPO-47115-1**

The purpose of HRN is to provide measurements to the navigation filter so that it can limit errors on the position estimate after hazards have been detected. Hazards are detected by processing a hazard digital elevation map (HDEM). The HRN process takes lidar images as the spacecraft descends to the surface and matches these to the HDEM to compute relative position measurements.

**U.S. Government Purpose Release**

### **Linked Autonomous Interplanetary Satellite Orbit Navigation (LIAISON) Between a Satellite in a Lunar Halo Orbit and a Geosynchronous Earth Orbiter**

**NPO-48736-1**

LIAISON involves the collection of satellite-to-satellite tracking data between a satellite near the Moon (e.g., a halo orbit about either the lunar L1 or L2 points) and a satellite in GEO orbit. Measurements can be one-way (if both satellites have accurate clocks) or two-way. Tracking data are processed using standard orbit determination methods.

**U.S. Government Purpose Release**

### **Livingstone 2 (System for Automated Diagnosis and Discrete Control of Complex Systems) and Skunkworks (Suite of Supporting Development and Runtime Tools)**

**ARC-14725-1**

Livingstone 2 is a reusable artificial intelligence (AI) software system designed to assist spacecraft, life support systems, chemical plants, or other complex systems in operating robustly with minimal human supervision, even in the face of hardware failures or unexpected events. The technology diagnoses the current state of a spacecraft or other system and recommends commands or repair actions that will allow the system to continue operations. A re-engineered version of the Livingstone diagnosis system that was flight-tested onboard the Deep Space One spacecraft in 1999, Livingstone 2 contains significant enhancements to robustness, performance, and usability. Skunkworks is a suite of software tools that supports the rapid deployment of model-based representations of complex systems for Livingstone2 via a visual model builder/tester and two graphical user interface tools that provide status information during testing.

**Open Source**



### **Mars Science Laboratory Flight Software and Algorithms for Autonomously Drilling Rocks**

**NPO-48965-1**

This technology consists of algorithms and software for: signal filtering; force sensor signal processing; force control; spindle, feed, chuck, and voice coil actuation and resistance calibration; rock surface seek; rock hardness test; hole start; rate of penetration estimation; drilling algorithms; voice coil level control; retraction; and bit exchange.

**U.S. Government Purpose Release**

### **Mission Analysis Low-Thrust Optimizer (MALTO)**

**NPO-43625-1**

MALTO is a software tool for preliminary design and optimization of low-thrust interplanetary trajectories. The tool is easy to use, has robust convergence, and can handle many intermediate encounters.

**U.S. Government Purpose Release**

### **Model-Based Diagnosis Engine for Stochastic Hybrid Systems (HyDE)**

**ARC-15570-1A**

HyDE is a model-based diagnostic engine capable of detecting and isolating discrete (possibly multiple) faults in physical systems. The current version of HyDE has been implemented in C++. Please visit the following URL for more information: <http://ti.arc.nasa.gov/tech/dash/diagnostics-and-prognostics/hyde-diagnostics/>

**U.S. Government Purpose Release**

### **Multi-Source Autonomous Response for Targeting and Monitoring Volcanic Activity**

**NPO-48148-1**

The software uses multiple source languages and is a general framework for combining inputs and incrementally submitting observation requests/reconfigurations.

**U.S. Government Purpose Release**

### **Mystic Low-Thrust Trajectory Design and Visualization Software**

**NPO-43666-1**

Mystic provides very high-fidelity optimization of low-thrust spacecraft trajectories for mission design. The software can be used for general body-centered trajectories, interplanetary trajectories, and trajectories that combine body-centered and interplanetary trajectory legs. Mystic will also provide navigational/operational support for low-thrust spacecraft.

**U.S. Government Purpose Release**

### **Nemesis Autonomous Test System**

**NPO-47596-1**

The Nemesis framework has been provided to NASA's Dawn Mission to use in continuing testing of fault protection. Autonomous systems are more difficult to validate than traditional systems because they require more numerous and complex behaviors in order to operate self-sufficiently.

**U.S. Government Purpose Release**

### **Planetary Observer Planning Software (POPS)**

**NPO-45418-1**

The POPS application suite performs mission design analysis of a spacecraft orbiting a terrestrial planet. POPS is not intended for the study of hyperbolic or interplanetary orbits, although some limited hyperbolic capabilities exist.

**U.S. Government Purpose Release**

### **Planning and Execution for an Autonomous Aerobot**

**NPO-46895-1**

This software offers onboard planning and execution technologies to provide robust and opportunistic mission operations for an aerobot. The planning/execution component of AerOASIS is able to generate mission operations plans that achieve science and engineering objectives while respecting mission and resource constraints adapting the plan to respond to new science opportunities.

**U.S. Government Purpose Release**



### **PolyCARP: Algorithms and Software for Computations with Polygons**

**LAR-18798-1**

PolyCARP is a package of algorithms, including both their formal models and software implementations, for computing containment, collision, resolution, and recovery information for polygons. The intended applications of PolyCARP are related, but not limited, to safety-critical systems in air traffic management. Algorithms center on weather avoidance, ensuring that an aircraft stays inside a predetermined safety region, and obstacle avoidance by an aircraft.

**Open Source**

### **Probabilistic Guidance for Swarms of Autonomous Agents**

**NPO-47851-1**

PGA is a new method for performing swarm guidance. It is probabilistic in nature, guiding the shape of the swarm to conform to a prescribed probability distribution. The main idea is to have each agent follow an independent realization of a Markov chain. The desired distribution emerges as the ensemble of agents in the swarm maneuver about, asymptotically achieving a desired statistical steady-state condition and eliciting a clear emergent behavior from the swarm. The implementation of the probabilistic guidance law is completely decentralized and leads to an important swarm behavior that exhibits autonomous self-repair and maintenance capabilities.

**U.S. Government Purpose Release**

### **Prognostics Algorithm Library**

**ARC-17735-1**

The Prognostics Algorithm Library is a suite of algorithms implemented in the MATLAB programming language for model-based prognostics (remaining life computation). It includes algorithms for state estimation and prediction including uncertainty propagation. The algorithms take inputs component models developed in MATLAB and perform estimation and prediction functions. The library allows the rapid development of prognostics solutions for given models of components and systems. Different algorithms can be easily swapped to do comparative studies and evaluations of different algorithms to select the best for the application at hand.

**Open Source**

### **Prognostics Model Library**

**ARC-17736-1**

The Prognostics Model Library is a modeling framework focused on defining and building models for prognostics (computation of remaining useful life) of engineering systems. It provides a set of models for select components developed within this framework. The library currently includes models for valves, pumps, and batteries.

**Open Source**

### **Risk-Aware Mars Rover Operation Tool with Autonomous Terrain Classifier and Path Planner**

**NPO-49679-1**

The Risk-Aware Mars Rover Operation Tool is built upon two existing technologies. One is a machine learning-based terrain classification that is capable of identifying potential hazards (e.g., pointy rocks and soft terrains) from images. The other is risk-aware path planning, which suggests safe paths in consideration of terrain types, slopes, and positive and negative obstacles.

**U.S. Government Purpose Release**

### **RoboSimian: Software Algorithms for a Mobile Manipulation Quadruped Robot**

**NPO-49694-1**

This software consists of multiple processes and modules running simultaneously across two computers inside RoboSimian, as well as one remote operator machine. The two RoboSimian computers communicate over a gigabit Ethernet link. Each RoboSimian computer, the high-brain and low-brain machines, runs 12.04 Ubuntu LTS on an Intel Quad-Core i7. The low-brain machine runs a low-latency (soft real-time) kernel and the EtherLab R open-source real-time kernel module, which runs low level processes such as limb and control processes. The high-brain machine is responsible for higher level processes not concerned with real-time execution but rather higher throughput.

**U.S. Government Purpose Release**



**Robot Application Programming Interface Delegate (RAPID), Version 2****ARC-16368-1A**

RAPID is a software reference implementation framework for remote operations. The technology promotes interoperability between robot software modules and includes a standard programming interface and data distribution middleware. RAPID facilitates integration of experimental robot software modules created by a distributed development team; improves the compatibility and reusability of robotic functions; and offers speed prototype robot development in a wide range of configurations and environments.

**Open Source****Simple, Scalable, Script-Based Science Processor for Missions (S4PM)****GSC-14841-1**

S4PM is a set of Perl scripts that implement a data-driven processing system that executes science algorithms automatically as new data arrive. S4PM includes a graphical user interface for monitoring algorithms and the overall system for failures. The Perl scripts can currently process data from the Moderate Resolution Imaging Spectroradiometer and the Atmospheric Infrared Sounder, but the technology can be extended to process data from other missions if desired. Please visit the following URL for more information:

<http://opensource.gsfc.nasa.gov/projects/s4pm/>

**Open Source****Small Body Navigation and Topography (SBN&T)****NPO-41647-1**

SBN&T provides an integrated program for the spacecraft navigation and determination of small-body dynamics, shape, and high-resolution topography. Multiple-image stereography and photogrammetry are used to construct high-resolution topographic and albedo maps centered on control points. These landmark maps are re-illuminated and correlated with images to act as body-fixed navigation tie-points.

**U.S. Government Purpose Release****Smartphone Video Guidance Sensor (SVGS)****MFS-33014-1**

The Smartphone Video Guidance Sensor (SVGS) allows for calculation of the distance and orientation of an object relative to the SVGS. A known retroreflective target pattern is mounted on the target object. The retroreflectors are then illuminated by the camera flash on the smartphone and imaged by the smartphone camera. The resulting image is processed using photogrammetry algorithms running on the smartphone to extract the relative X, Y, and Z distance and relative orientation, expressed as a roll, pitch, yaw angle sequence.

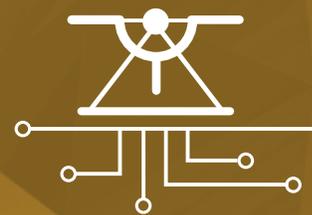
**U.S. Government Purpose Release**



# 13

## Vehicle Management Space • Air • Ground

Flight Software, Spacecraft Processes, Command and Data Handling, Instrument Management





## Featured Software

### **Advanced Spacecraft Integration & System Test Software (ASIST) Version 20.0**

**GSC-16783-1**

Since the early 1990s, a government/contractor team has been developing a spacecraft ground system capable of being used for all phases of a spacecraft's life: box-level development and testing, satellite integration and test, and post-launch mission operations. This system uses a single, industry-standard protocol to ease integration with other products and employs COTS, GOTS, and public domain software to form one cohesive unit. It is composed of several parts. ASIST is the user-interface, providing the user with the ability to view and analyze telemetry, send commands, and automate tests. The Front End Data System reads telemetry from spacecraft, distributing requested data packets to subscribing clients; additionally, it controls the forward (command) link to the spacecraft, formatting command packets and verifying that commands are transferred correctly. The Digital History Data Store (DHDS) archives the raw telemetry received from spacecraft and distributes historical telemetry data to clients.

**U.S. Government Purpose Release**

### **Formation Flying System for Unmanned Aerial Vehicles (UAVs) and Satellites**

**MFS-33193-1**

Using a distributed mesh network communication architecture, this system facilitates formation flying by providing a framework for the exchange of information among multiple vehicles. By exchanging pertinent data, the vehicles can perform as a single formation deployment shape without direct control from the ground. The technology's generic design affords applicability to an array of vehicle types, including UAVs and satellites.

**U.S. Release Only**



### **Onboard Short-Term Plan Viewer (OSTPV), Version 4.0**

**MSC-24832-1**

Innovators at Johnson Space Center have developed a Web-based application to support the International Space Station (ISS) Program's real-time operations. OSTPV contains the integrated ISS mission schedule in use at NASA's Mission Control Center (MCC) and onboard the ISS, and it displays all ISS activities (onboard and on the ground) in an integrated timeline.

**U.S. Government Purpose Release**

### **Range Safety Algorithm Software Module for an Autonomous Flight Safety System**

**GSC-15594-1**

This software library was developed to mitigate the public safety risks of hazards associated with the flight of expendable launch vehicles and other unmanned flight vehicles. The software encapsulates the various constructs and algorithms required to accomplish Time Space Position Information (TSPI) data management from multiple tracking sources. At its core, the technology evaluates various user-configurable rule sets that govern the qualification of TSPI data sources; provides a pre-launch autonomous hold-launch function; performs flight-monitoring/flight-termination functions; and provides end-of-mission safing.

**General Public Release**

### **ROAMS Rover Analysis and Modeling Software**

**NPO-30722-1**

ROAMS is a planetary rover simulation software package. The technology consists of mechanical models of a rover, instrument arms, actuators and sensors, power resources, terrain interactions, and onboard software.

**U.S. Government Purpose Release**

### **SpaceWire 2014**

**GSC-17201-1**

SpaceWire is a spacecraft communication network based in part on the IEEE 1355 standard of communications. The 2014 version is an update to fix "bugs," improve performance, and change the back-end user interface.

**U.S. Release Only**



**AEGIS: Autonomous Exploration for Gathering Increased Science** **NPO-46876-1**

AEGIS provides automated targeting for remote sensing instruments on the Mars Exploration Rover (MER) mission, which currently has two rovers exploring the surface of Mars. AEGIS enables the rover flight software to analyze imagery onboard in order to autonomously select and sequence targeted remote-sensing observations in an opportunistic fashion.

**U.S. Government Purpose Release**

**AEGSE Virtuoso Charting: Browser-Based Application for Telemetry Monitoring of Robotic Assets** **NPO-46348-1**

This software offers animated real-time charting of telemetry data streams from the rover. Automatically scaled charts are completely interactive and allow users to choose the variables that they want to monitor. The charts have been designed for extremely high performance, and they can process data from streams with many variables at frequencies as high as 100 Hz.

**U.S. Government Purpose Release**

**Algorithm Enhancements to Powered Descent Guidance (PSG) Software: Constrain Speed and Avoid Downward Thrust** **NPO-47702-1**

The PDG algorithm and software for computing Mars pinpoint- or precision-landing guidance was enhanced with options to constrain the maximum allowable speed and the allowable attitude profiles. The constraints were added to ensure that velocity profiles could be limited from the speed that would produce excessive drag or approach the speed of sound. The attitude constraints were added as an option to ensure that attitude profiles would avoid downward thrust (i.e., avoid thrusting the spacecraft downward toward the surface).

**U.S. Government Purpose Release**

**Alternative Flight Software Trigger Paradigm: Applying Multivariate Logistic Regression to Sense Trigger Conditions Using Inaccurate or Scarce Information** **MSC-25684-1**

Helping Guidance, Navigation, and Control (GN&C) engineers to develop robust flight software tools, this innovation allows an autonomous vehicle to trigger certain actions.

**U.S. Government Purpose Release**

**Automated Planning and Scheduling Environment (ASPEN)** **NPO-41986-1**

ASPEN automates space mission planning and other tasks that involve the reasoning of time, states, resources, and actions.

**U.S. Government Purpose Release**

**Autonomous Landing Hazard-Avoidance Technology (ALHAT) Scanning Lidar-Based Simulation for Mars Landing** **NPO-21220-1**

The ALHAT simulation tool provides an efficient software model and a set of algorithms in C++ code for performing scanning lidar-based hazard detection and avoidance.

**U.S. Government Purpose Release**

**CFS Command and Data Dictionary Tool (CCDDT)** **MSC-26167-1**

This software is a configurable ground-based software tool for managing spacecraft command and telemetry data. It accepts multiple input formats and produces output files suitable for use by flight and display software tools. No agreement with NASA is needed. Please visit the following URL to download the software: <https://github.com/nasa/CCDD>

**Open Source**

**CFS-101 Training** **MSC-26323-1**

This is a training tool for learning to develop software with the NASA-developed Core Flight Software (CFS) framework. No agreement is necessary through this catalog. Software is available at the open-source site.

**Open Source**



**Change-Based Satellite Monitoring Using Broad Coverage and Targetable Sensing** **NPO-48147-1**

This generic software framework is used to analyze data from broad coverage sweeps or general larger areas of interest. Change detection methods are used to extract a subset of directed swath areas that intersect with areas of change. These areas are prioritized and allocated to targetable assets.

**U.S. Government Purpose Release**

**Constellation Visualization Tool (CVT)** **GSC-17917-1**

CVT is a touchscreen interactive software tool designed to model automated analyses of the Earth Observing System (EOS) Morning and Afternoon Constellations. Displays educate and inform users and the public about the missions NASA supports. Combining data presentation with user experience, user-selected stories are brought to life.

**U.S. and Foreign Release**

**Core Flight Executive (cFE)** **GSC-16232-1**

The Core Flight Executive (cFE) provides software bus, time, event, executive, table, and file services, and it defines the application programming interface (API) for each set function. Applications subscribe to cFE services at runtime, making system modifications easy. Facilitating rapid prototyping, new applications can be compiled, linked, loaded, and started without requiring the entire system to be rebuilt.

**Open Source**

**Core Flight System (cFS) CFDP, Version 2** **GSC-16125-1**

The CFDP application provides the capability to transmit and receive files to/from the ground. Tables are used to allow flexibility in specifying directory priorities and configurations.

**Open Source**

**Core Flight System (cFS) Checksum Application, Version 2** **GSC-15996-1**

Checksum (CS) is one of the reusable applications that make up the core Flight System (CFS). The technology performs memory integrity management by verifying the contents of critical flight memory regions. Unexpected changes in memory (i.e., due to an SEU) are reported to ground operators.

**Open Source**

**Core Flight System (cFS) Data Storage (DS) Application, Version 2** **GSC-16126-1**

The DS application provides the ability to store data (i.e., messages) into files. Tables are used to provide the flexibility for specifying messages.

**Open Source**

**Core Flight System (cFS) File Manager (FM) Application, Version 2** **GSC-16007-1**

FM provides the user commands to perform the following operations: copy file, move file, rename file, delete file(s), close file, concatenate file, decompress file, delete directory contents, create directory, remove directory, obtain file information, obtain open file listing, and obtain directory listings.

**Open Source**

**Core Flight System (cFS) Health and Safety Application, Version 2** **GSC-16151-1**

The plug-and-play cFS Health and Safety application is compatible with the Core Flight Executive (cFE) and uses the Operating System Abstraction Layer (OSAL), both of which were developed by Goddard Space Flight Center in order to provide a reusable, platform-independent, mission-independent, layered architecture for hosting applications. The technology can be used for any government or commercial spacecraft. Please visit the following URL for additional information: <http://sourceforge.net/projects/coreflightexec/files/cFE-6.1.1/>

**Open Source**



**Core Flight System (cFS) Housekeeping (HK) Application, Version 2** **GSC-16127-1**

The cFS Housekeeping application provides the ability to organize data from various packets into new packets in order to best utilize the telemetry bandwidth available for a mission.

**Open Source**

**Core Flight System (cFS) Limit Checker (LC) Application, Version 2** **GSC-16010-1**

The Limit Checker (LC) application is responsible for monitoring telemetry values.

**Open Source**

**Core Flight System (cFS) Memory Dwell Application, Version 2** **GSC-16012-1**

The Memory Dwell application telemeters the contents of table-defined addresses at a table-defined dwell rate. Addresses can be processed using symbols if the target processor/operating system includes symbols.

**Open Source**

**Core Flight System (cFS) Memory Manager Application, Version 2** **GSC-16011-1**

The Memory Manager application processes commands, generally from the ground, in order to dump the contents of a memory location, dump the contents of a range of memory locations, load a memory location with specified data, load a range of memory with specified data, or fill an area of memory with the specified fill pattern. Operations can be performed on non-volatile, volatile, and memory mapped I/O.

**Open Source**

**Core Flight System (cFS) Scheduler Application, Version 2** **GSC-16123-1**

The Scheduler application uses a one-second major timeframe that is divided into a designer-determined collection of equally divided minor timeframes. The technology is configurable and table-driven to provide greater flexibility.

**Open Source**

**Core Flight System (cFS) Software Bus Network (SBN) Application, Version 1.0** **GSC-16917-1**

The SBN serves as a plug-in to the cFE framework to transfer messages across process/processor interfaces. The technology has three primary functions: to establish and maintain a connection to each peer over available process/processor interfaces; to distribute and maintain a subscription message database for each peer; and to distribute messages to peers that have subscribed to message identifiers.

**Open Source**

**Core Flight System (cFS) Stored Command (SC) Application, Version 2** **GSC-16009-1**

The cFS SC application provides the ability to execute onboard absolute-time and relative-time command sequences. The technology offers a generic implementation that can be configured by a user to fit the needs of a specific mission.

**Open Source**

**G-TAG: A Multibody Simulation Software Testbed for Small-Body Exploration and Sampling** **NPO-47196-1**

This software tool is used for the multi-body simulation of a spacecraft with a robotic arm and a sampling mechanism that performs a touch-and-go (TAG) maneuver for sampling from the surface of a small celestial body. G-TAG utilizes G-DYN, a multi-body simulation engine, and interfaces to controllers, estimators, and environmental forces that affect the spacecraft. G-TAG can easily be adapted for the analysis of stress cases to assist the design of a TAG system, as well as for comprehensive Monte-Carlo simulations to analyze a particular TAG system.

**U.S. Government Purpose Release**



**G-View: A Spacecraft GN&C Visualization Tool for Small-Body Exploration and Sampling** **NPO-47197-1**

This software, developed in MATLAB, provides users with the ability to visualize the behavior of their simulations, regardless of which programming language (or machine) is used to generate simulation results. The only requirement is that multibody simulation data must be generated and placed in the proper format before applying G-View.

**U.S. Government Purpose Release**

**GFechutes Lo-Fi** **MSC-25004-1**

The GFE Lo-Fi Chutes Model provides basic modeling capability of a sequential series of parachute activities. Actions include deploying the parachute, changing the reefing on the parachute, and cutting away the parachute. Multiple chutes can be deployed at any given time, but all chutes in that case are assumed to behave as individually isolated chutes. There is no modeling of any interactions between deployed chutes. Drag characteristics of a deployed chute are based on a coefficient of drag, the face-area of the chute, and the local dynamic pressure only. The orientation of the chute is approximately modeled for purposes of obtaining torques on the vehicle, but the dynamic state of the chute as a separate entity is not integrated.

**U.S. Government Purpose Release**

**GMSEC Architecture Application Programming Interface (API), Version 3.7** **GSC-17417-1**

This software release contains major enhancements to previous releases of the GMSEC API, offering greater reliability and enhanced usability. The version includes a new feature that allows users to determine quickly and easily if their current operations environment has been correctly configured to use GMSEC.

**U.S. Government Purpose Release**

**GMSEC Remote Application Service Provider (GRASP), Version 2.0** **GSC-16822-1**

This entirely new software utility facilitates the secure transmission of GMSEC messages from a secure environment to a less secure environment and makes these messages available to Web applications operating in the less secure environment via a generic language-independent mechanism.

**U.S. Government Purpose Release**

**GMSEC Room Alert Adapter, Version 1.1** **GSC-16526-1**

The Goddard Mission Services Evolution Center (GMSEC) Room Alert Adapter (RAA) 1.1 is the most recent and updated version to the interface between GMSEC-compliant components and commercial off-the-shelf (COTS) environment-monitoring devices (AVTECH Room Alert). In addition to providing environmental sensor data to GMSEC-compliant components via a middleware-based architecture on a periodic basis, now GMSEC components can request sensor values on demand and receive the values in reply messages. The messages can be used by other components to notify operations personnel and automatically begin mitigation or recovery actions in the event of a degraded environment for the computers that support the Mission Operation Center (MOC).

**U.S. Government Purpose Release**

**GN&C Covariance Analysis Tool (G-CAT) for Descent and Landing** **NPO-47854-1**

G-CAT has been developed to support landing/descent/ascent/rendezvous applications in lunar, planetary, and small body missions. G-CAT characterizes on-board knowledge propagation errors associated with Inertial Measurement Unit (IMU) errors (gyro and accelerometer), gravity errors and dispersions (spherical harmonics, masscons), and radar errors (multiple altimeter beams, multiple Doppler velocimeter beams). G-CAT is a standalone MATLAB-based tool intended to run on any engineer's desktop computer.

**U.S. Government Purpose Release**



**Goddard Mission Services Evolution Center (GMSEC) Countdown Clock (CC), Version 2.0** **GSC-17186-1**

This is an adaptation of the original 2D Countdown Clock that internally treats countdown records uniformly. It offers displays in two modes: alternating record (like the original) and multi-record. The software allows dynamic configuration of a number of features including font size. It is capable of reading WOTIS files, but can also read TRMM TDX-PLAN files and can readily add compatible file formats through the use of Java interface implementations.

**U.S. Government Purpose Release**

**In-situ Pointing Correction and Rover Micro-Localization** **NPO-46696-1**

Due to mechanical backlash, calibration errors, and other sources, errors in camera pointing knowledge create geometric seams in image mosaics. For rover missions, motion of the rover in between frames can create additional seams. This software corrects such seams as much as possible (some parallax seams are uncorrectable). It also provides one the ability to understand in-situ mission image metadata so that pointing overlap can be determined in advance and the corrections applied automatically.

**U.S. Government Purpose Release**

**Iris: DSN-Compatible, CubeSat-Compatible Transponder** **NPO-49284-1**

Iris is an X-Band deep-space transponder consisting of an exciter board (26 dBm output at X-Band), a receiver board (-120 dBm sensitivity), a power supply board, two antenna boards featuring four patch antennas (a transmit and receive in each of two directions), and a Marina-2 board for digital signal processing on a Virtex V FPGA. The design for INSPIRE features PC104 board interfacing and stacking in the Pumpkin CubeSat style.

**U.S. Government Purpose Release**

**ISAAC: Highly-Reusable, Highly-Capable, Integrated Instrument Control and Computing Platform** **NPO-46031-1**

This 3-year effort started at Technology Readiness Level (TRL) 3 with a commercial-off-the-shelf (COTS) FPGA-based breadboard Xilinx ML410 for developing key ISAAC components. It was then be followed by retrofitting the existing FPGA-based ESMD MicroInspector avionics board with respect to the instrument control and computing requirements. The effort culminated with the system-level radiation test of complete ISAAC technology to mature it to TRL 6. The success of this effort resulted in a flight-ready product for infusion into SMAP/HYDROS.

**U.S. Government Purpose Release**

**Jet and Tropopause Products for Analysis and Characterization (JETPAC)** **NPO-47709-1**

These programs use data from gridded meteorological analyses (including GEOS-5/MERRA and NCEP/GFS, but designed to easily adapt to others) to identify the locations and characteristics (windspeed, temperature, wind components, potential vorticity, equivalent latitude, potential temperature, relative vorticity, and other fields) at the jet maximum and the edges of the jet regions.

**U.S. Government Purpose Release**

**Loosely Coupled GPS-Aided INS for Range Safety** **GSC-15549-1**

The Autonomous Flight Safety System replaces the human element of range safety operations and reduces reliance on expensive down-range assets. The system provides a highly reliable platform consisting of multiple navigation sensors and flight computers.

**U.S. Release Only**

**Magnetosphere Multi-Scale (MMS) Spacecraft Flight Software** **GSC-16471-1**

This spacecraft flight software was developed to support unique multi-satellite MMS mission requirements. The technology interfaces to a sensor/actuator complement that includes a star sensor and digital sun sensor, accelerometer, and thruster hardware to implement the functionality for determining and controlling spacecraft attitude and orbit.

**U.S. Government Purpose Release**



### **Mesh Network Communication System**

**MFS-33391-1**

This system provides a framework for the exchange of information between multiple network nodes to facilitate cooperation using a distributed mesh network communication architecture. A node is any entity, such as a vehicle, ground control station, etc., that is connected to the mesh network. Data exchanged could include telemetry from vehicle-based nodes, commands from ground control nodes, and science data. By exchanging pertinent data, multiple nodes can act together to perform a task without requiring direct control from a central control node. The system was generically designed so that it would be applicable to any node type and many different vehicle types including UAVs and satellites. The mesh network architecture allows the system to adapt to individual node failures because by design the system has no master controlling the operation of the entire network.

**Open Source**

### **Mission Data System Java Edition, Version 7**

**NPO-47804-1**

The Mission Data System framework defines closed-loop control system abstractions from state analysis, including interfaces for state variables, goals, estimators, and controllers that can be adapted to implement a goal-oriented control system. The framework further provides an execution environment that includes a goal scheduler, execution engine, and fault monitor that support the expression of goal network activity plans. Using these frameworks, adapters can build a goal-oriented control system in which activity coordination is verified before execution begins. Plan failures including violations of safety constraints expressed in the plan can be handled through automatic replanning.

**U.S. Government Purpose Release**

### **Mixed Real/Virtual Operator Interface for ATHLETE (MSim-ATHLETE)**

**NPO-46869-1**

MSim-ATHLETE is a new operator interface system for inspection and manipulation motions of the Jet Propulsion Laboratory's 36-joint ATHLETE (All-Terrain Hex-Legged Extra-Terrestrial Explorer) based on the idea of allowing the operator to extend the robot's actual kinematics with virtual links and joints.

**U.S. Government Purpose Release**

### **MSLICE: Science Activity Planner for MSL**

**NPO-45908-1**

MSLICE has been tasked to fulfill a challenging set of requirements. To meet these requirements, MSLICE delivers a rich feature set which includes: (1) a simple, intuitive, and powerful search capability; (2) visualization of the rover's traverse in a HiRISE image; and (3) visualization of data products and the ability to view mosaics.

**U.S. Government Purpose Release**

### **Multi-Mission Three-Axis Stabilized Spacecraft (MTASS) Attitude Determination and Sensor Calibration System**

**GSC-15811-1**

Unlike single-purpose ground support systems, which attempt to reduce costs by reusing software specifically developed for previous missions, this development effort is an intermediate step in the progression to a single fully generalized mission support system that could be used for numerous missions.

**U.S. Government Purpose Release**

### **Multiple-Force Vector and Field Detection and Measurement Through a Flexible Medium**

**MSC-25704-1**

This innovation can be used as a tactile human-machine input device or as a tool to improve the grasping quality of robot manipulators. Incipient slip, sample stiffness, and tangential force vector parameters are extracted and used in high-level control algorithms to drive a robotic arm.

**U.S. Government Purpose Release**



**NanoSat Launch Adapter System (NLAS)****ARC-16732-1**

NLAS maximizes the efficiency of satellite launch opportunities. The technology acts as a “spacer” between the rocket and the primary spacecraft. NLAS consists of three main subsystems: the adapter, the dispenser, and the deployment sequencer. Each subsystem can be configured to meet the specific needs of a given launch.

**U.S. Government Purpose Release****Ndarts****NPO-47703-1**

Ndarts is designed as a general-purpose dynamics library that can be used for the modeling of robotic platforms, space vehicles, and molecular dynamics. All NASA space vehicles use such capabilities.

**Open Source****Onboard Short-Term Plan Viewer (OSTPV), Version 4.0****MSC-24832-1**

Innovators at NASA Johnson Space Center have developed a Web-based application to support the International Space Station (ISS) program’s real-time operations. The Onboard Short-Term Plan Viewer (OSTPV) contains the integrated ISS mission schedule in use at NASA Mission Control Center (MCC) and onboard the ISS. OSTPV displays all ISS activities (onboard and on the ground) in an integrated timeline.

**U.S. Government Purpose Release****Open MDAO: The Next-Generation Multidisciplinary Design Analysis and Optimization (MDAO) Open-Source Framework****LEW-18550-1**

OpenMDAO provides the core software infrastructure to integrate multidisciplinary variable fidelity tools and enable design, analysis, and optimization of complex systems. OpenMDAO functionalities include component linking, data passing, driver interface, and lazy evaluation.

**Open Source****Operating System Abstraction Layer (OSAL)****GSC-14921-1**

The OSAL library isolates embedded application software from a Real-Time Operating System (RTOS). The technology provides a well-defined, generic interface to RTOS services; a generic interface to hardware services; and an implementation for several current RTO systems. By using the library, an embedded application can remain portable among multiple operating systems on multiple platforms. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/osal/>

**Open Source****Operator Interface and Control Software for the Reconfigurable Surface System Tri-ATHLETE****NPO-47777-1**

This full 3D interactive kinematic simulator enables the configuration and reconfiguration of modular robotic systems. Modular robotics pave the way for new classes of exploration missions for NASA, and this research is a step toward making them more operable.

**U.S. Government Purpose Release****Orion Guidance, Navigation & Control Flight Software****MSC-25615-1**

The Orion Crew Exploration Vehicle’s onboard Guidance, Navigation & Control (GN&C) flight software has been developed to a class-A, human-spaceflight-ready standard. The technology uses a MATLAB/Simulink tool suite to embrace a model-based development approach.

**U.S. Government Purpose Release**

### **Powered Descent Guidance with General Thrust-Pointing Constraints**

**NPO-47853-1**

The PDG algorithm for generating Mars pinpoint- or precision-landing guidance profiles has been enhanced to incorporate thrust pointing constraints, a significant theoretical contribution. Pointing constraints would typically be needed for onboard sensor and navigation systems that have specific field-of-view requirements to generate valid ground proximity and terrain-relative state measurements.

**U.S. Government Purpose Release**

### **Quick Thrust Profile Design Analysis for Verifying Spacecraft Operational Capabilities (qSTAT)**

**NPO-48434-1**

qSTAT executes the flight software's attitude steering algorithm to determine the attitude command that follows the thrust direction profile in the TVF while keeping the arrays on the Sun (per the power steering logic). From the attitude command, qSTAT computes the attitude rate and angular accelerations required to follow the thrust profile, checking these against allowable limits. The software then passes the commanded attitude and angular rate through a simplified closed-loop transfer function that models the low-bandwidth closed-loop dynamics of the spacecraft while under TVC control, producing an attitude estimate.

**U.S. Government Purpose Release**

### **Range Safety Algorithm Software Module for an Autonomous Flight Safety System**

**GSC-15594-1**

This software library was developed to mitigate the public safety risks of hazards associated with the flight of expendable launch vehicles and other unmanned flight vehicles. The software encapsulates the various constructs and algorithms required to accomplish Time Space Position Information (TSPI) data management from multiple tracking sources. At its core, the technology evaluates various user-configurable rule sets that govern the qualification of TSPI data sources; provides a pre-launch autonomous hold-launch function; performs flight-monitoring/flight-termination functions; and provides end-of-mission safing.

**General Public Release**

### **Rapid: Collaborative Commanding and Monitoring of Lunar Assets**

**NPO-46332-1**

This technology provides a framework to address the specific challenges for time-delayed operations and geographically distributed collaborative monitoring and control. It affords the capability to build an effective architecture for integrating a heterogeneous collection of robotic assets into a common work. It allows operators from any NASA center to control any NASA lunar asset, regardless of location.

**U.S. Government Purpose Release**

### **Reducing Drift in Stereo Visual Odometry**

**NPO-48855-1**

This software propagates noise to a triangulated point using statistical means.

**U.S. Government Purpose Release**

### **ROAMS: Rover Analysis and Modeling Software**

**NPO-30722-1**

ROAMS is a planetary rover simulation software package. The technology consists of mechanical models of a rover, instrument arms, actuators and sensors, power resources, terrain interactions, and onboard software.

**U.S. Government Purpose Release**

### **Rock Identification Toolkit (RockIT)**

**NPO-41133-1**

RockIT is an interactive tool used by mission scientists to identify and characterize rocks and rock distributions.

**U.S. Government Purpose Release**



**Safe Maritime Autonomous Path Planning in a High Sea State****NPO-49304-1**

In this effort, response amplitude operators (RAOs) were used to find a set of speeds and headings that result in excessive pitch and roll oscillations. A RAO is essentially a Bode plot that describes the frequency response of each of the six ship motions (i.e., roll, pitch, yaw, heave, sway, and surge) to a sea state (i.e., wave spectrum). RAO is obtained from a linearized model of ship motions of a specific vessel hull shape at a specific speed and wave heading. Commercial software is available to compute RAOs based on computational fluid dynamics.

**U.S. Government Purpose Release****SAR Flight-Planning System****NPO-45877-1**

This software is written in Fortran and Perl. A set of input files define the desired image swath or flight plan, the radar constraints, flight parameters, and any ground targets that will be imaged. The image swath or flight plan may be defined by either the image swath length, heading, and center coordinate; the flight path endpoints; or the image swath endpoints. The radar constraints define such things as the maximum and minimum PRF, data window length, data window position, pulse repetition interval, data rate, and duty cycle.

**U.S. Government Purpose Release****Simulation of Cryogenic Tank with Temperature Stratification****ARC-17900-1**

This is a MATLAB-based simulation of temperature stratification effects for cryogenic fluids in a tank. It is a reduced dynamical model describing temperature stratification effects driven by natural convection in a liquid hydrogen cryogenic tank. It accounts for storage, loading, and unloading of the cryogenic fluid.

**Open Source****Sliding Gait (SGait) for ATHLETE Mobility****NPO-47887-1**

The SGait algorithm uses the kinematic capability of ATHLETE's limbs to reposition wheels independently of the robot's payload deck while keeping them in contact with the ground. The wheel is rolled along the ground in coordination with limb repositioning. This can be done for individual wheels or groups of wheels, allowing the approximation of any 6-limbed walking gait. Between or during wheel repositioning motions, the payload deck is shifted to maintain a desired stable position above the wheels.

**U.S. Government Purpose Release****Software Applications for the Control and Management of the Amine Swingbed Experiment****MSC-25526-1**

This disclosure covers the following software components: the Swingbed Loader Computer Software Configuration Item (CSCI), the Swingbed Control Module (CSCI), and the Swingbed Ground Controller. As a whole, the Amine Swingbed Experiment is investigating the removal of carbon dioxide from the International Space Station breathing environment via a system of vacuum-regenerated amine pressure swing absorption reaction beds. Please visit the following URL for additional information: [http://www.nasa.gov/mission\\_pages/station/research/experiments/Amine\\_Swingbed.html](http://www.nasa.gov/mission_pages/station/research/experiments/Amine_Swingbed.html)

**U.S. Government Purpose Release****SpaceWire 2014****GSC-17201-1**

SpaceWire is a spacecraft communication network based in part on the IEEE 1355 standard of communications. SpaceWire 2014, is an update to fix "bugs," improve performance, and change the back-end user interface for different embedded applications to the original SpaceWire Link and Switch.

**General Public Release****SpaceWire Reliable Data Delivery Protocol (RDDP) Software****GSC-15402-1**

The RDDP software provides virtual channelization, reliable data delivery, and fire-and-forget functions on a single SpaceWire link. The technology runs in a microcontroller used in Power PC single-board flight computers.

**U.S. Government Purpose Release**

### **Sulcata: Terminal Descent Sensor Simulation**

**NPO-46161-1**

Sulcata is a high-fidelity simulation of the MSL TDS (radar). It is used for performance evaluation, anomaly resolution, and design validation.

**U.S. Government Purpose Release**

### **Swift Burst Alert Telescope (BAT) Engineering Flight Software**

**GSC-15242-1**

The BAT engineering software controls and coordinates all aspects of the instrument's operation in nominal and anomalous conditions. It distributes commands to, and collects data from, all instrument subsystems, including the power system, the 16 detector blocks, the digital signal processor, and the science data processing software. The technology also communicates with the Swift spacecraft to receive commands from the ground and send all instrument telemetry data. In addition, the software monitors the health of various instrument subsystems and takes corrective actions when necessary.

**U.S. Government Purpose Release**

### **Virtual Machine Language, Version 2.1**

**NPO-47696-1**

VML has been the command and sequence system for more than a dozen of the Jet Propulsion Laboratory's past and current missions. VML 2.1 provides the network of decision-making and action-taking power needed to turn the knowledge of expert subsystems such as GN&C into specific mission-enabling events in space.

**U.S. Government Purpose Release**

### **XMbodyinfo**

**NPO-46482-1**

This software is very useful for streamlining the spacecraft tour design process. On Cassini many hours were saved in the evaluation of the extended mission tour.

**U.S. Government Purpose Release**







# 14

## Data and Image Processing

Algorithms, Data Analysis, Data Processing





## Featured Software

### **BALFIT: A Multivariate Regression Analysis Tool**

**ARC-15804-1A**

BALFIT is designed for the automated regression analysis of wind tunnel strain-gage balance calibration data. Related strain-gage balance data analysis tasks are also supported. In addition, BALFIT performs an automated regression analysis of more general multivariate data sets at a basic level.

**U.S. Release Only**

### **Distributed Observer Network (Don), Version 3.1**

**KSC-13775**

Distributed Observer Network 3 (DON3) is an innovative combination of NASA simulation technologies, NASA information technologies, and commercial video game technology that provide a unique system that leverages the strengths of all three. A key component of the innovation is a standardized data interface for simulation-related information that is coupled with custom software integrated into the game environment.

**U.S. and Foreign Release**

### **Quick Plot General-Purpose Plotting Tool**

**DRC-012-022**

Quick Plot is a general-purpose tool used to plot Armstrong Flight Research Center time-history data files and data files in the MATLAB format. The graphical user interface allows commands to be scripted and read from an input script file; input signals can be modified using algebraic expressions.

**U.S. and Foreign Release**

### **WinPlot Graphical Display System**

**MFS-31664-1**

WinPlot is a powerful desktop graphical analysis tool that allows the user to generate displays of unrestricted amounts of data. It was developed to fulfill the need for fast and easily managed graphical displays of NASA test articles and facilities. WinPlot features include seamless displays of realtime and post-test data with time and event-time synchronization of data from multiple sources.

**General Public Release**



### **3D Mapping Software for High-Resolution Display of Hail and Rain Data from NWS Radar**

**KSC-12952**

This software can be used to generate a 3D hail/rain map around a large structure (e.g., a launchpad or a power plant).

**U.S. Release Only**

### **A Free Space Optical Receiver for Data Detection and Radio Science Measurements** **NPO-49393-1**

This method is an optical module to the existing optical communication receiver architecture. For links with intensity-modulated laser transmission or phase-modulated CW laser communications, the technology provides both data detection and the signals required to extract radio science data, including amplitude, phase, and frequency resulting from planetary atmospheric changes.

**U.S. Government Purpose Release**

### **A Nonlinear Estimation Approach to Real-Time Georegistration from Aerial Images** **NPO-47255-1**

This nonlinear estimation algorithm is based on a linearized Kalman filter structure that carries 19 states in its current implementation. The new georegistration approach was validated by computer simulation based on an aircraft flying at a speed of 70 m/s in a 3 km radius circle at an altitude of 15,000 feet using a camera pointed at the ground toward the center of the circle. Results from using the nonlinear estimation algorithm in combination with GPS and camera images taken once per second indicate that after 20 minutes of operation, real-time georegistration errors are reduced to values of less than 2 meters, 1 sigma, on the ground.

**U.S. Government Purpose Release**

### **A Web-Based Interface for Command and Control of Network Sensors** **NPO-47110-1**

This software provides for the visualization and control of a network of sensors through a Web browser interface. In addition to volcano monitoring, it is generic enough to be deployed on different types of sensor networks with minimal changes and time investments.

**U.S. Government Purpose Release**

### **A Web-Based Search Service to Support Imaging Spectrometer Instrument Operations** **NPO-49004-1**

Just as Web search involves more than matching phrases, spectral search is more challenging than simply matching the shape of the spectrum. The background substrate and illumination changes can cause the same signature to appear very different across scenes. This search service uses an adaptive matched-filter approach that compensates for the context and background characteristics of each scene.

**Open Source**

### **Accelerated Adaptive MGS Phase Retrieval** **NPO-47101-1**

The Modified Gerchberg-Saxton (MGS) algorithm is an image-based wavefront sensing method that can turn any science instrument focal plane into a wavefront sensor. MGS has been utilized on many projects, and it has been demonstrated on many optical systems, from laboratory testbeds to space telescopes.

**U.S. Government Purpose Release**

### **Aerosol and Surface Parameter Retrievals for Multiangle Multiband Spectrometer** **NPO-47510-1**

This software uses novel technologies for highly accurate spectro-polarimetric imaging and physically based dehazing from space.

**U.S. Government Purpose Release**



### **An Algorithm for Estimating the Wavefront to be Measured by a Phase-Retrieval Camera**

**NPO-47785-1**

Phase retrieval (PR) and Shack-Hartmann Sensor (SHS) are the two preferred methods of image-based wavefront sensing widely used in various optical testbeds, adaptive optical systems, as well as ground- and space-based telescopes. They are used to recover the phase information of an optical system from defocused point source images and focused point source or extended scene images. For example, the Terrestrial Planet Finder Coronagraphs (TPF-Cs) High-Contrast Imaging Testbed (HCIT) uses a phase-retrieval camera to estimate and subsequently correct the phase error at the exit pupil of this optical system.

**U.S. Government Purpose Release**

### **Analysis Software for Cosmic Microwave Background Research**

**GSC-17667-1**

This is a suite of analysis tools for cosmic microwave background research. It currently consists of an implementation of the pure C++ cosmic microwave background power spectrum estimator, as well as an implementation of the mode-mixing matrix calculation.

**Open Source**

### **ARAJ Low-Density Parity Check (LDPC) Codes**

**NPO-43949-1**

This software provides a construction method for protograph-based Low-Density Parity Check (LDPC) codes that simultaneously achieve low iterative decoding thresholds and linear minimum distance. The technology can be used for various code rates. Proposed codes may have either fixed input block or fixed output block sizing. Both cases provide rate compatibility. In fact, one encoder and one decoder can support different code rates.

**U.S. Government Purpose Release**

### **Architectural Implementation of NASA Space Telecommunications Radio System (STRS) Specification**

**NPO-47328-1**

The STRS standard provides a common, consistent framework to develop, qualify, operate, and maintain complex reconfigurable and reprogrammable radio systems. It also provides a detailed description and set of requirements to implement the architecture.

**U.S. Government Purpose Release**

### **Auto Draw from Excel Input Files**

**NPO-46926-1**

This software allows visualization of complex data in an easily understandable format. Graphical output is updated automatically.

**U.S. Government Purpose Release**

### **AutoBayes: Automatic Design of Customized Analysis Algorithms and Programs**

**ARC-16276-1**

AutoBayes uses extended Bayesian networks, a powerful symbolic system, and algorithm schemas to automatically generate efficient and customized programs for data analysis. It generates a standardized design document containing a graphical representation of the Bayesian network and of the details regarding the code's generation.

**Open Source**

### **Autogen Hypertext Map Generator**

**NPO-45424-1**

This tool is now being used in the flight operations environment to document the MRO and multi-mission autogen/apgen model files. The Autogen Hypertext Map Generator parses the autogen script and the autogen model files and produces a hypertext of the files to aid in the navigation of the model. These hypertext maps are also being used in multi-mission autogen/apgen training sessions.

**U.S. Government Purpose Release**



### **Automated Performance Characterization of DSN System Frequency Stability Using Spacecraft Tracking Data**

**NPO-47532-1**

This software expands characterizing frequency stability performance of the ground system in the NASA Deep Space Network (DSN). It significantly increases the amount of data available for analysis (roughly by two orders of magnitude), making it possible to conduct trend analysis with reasonable confidence. Since the system is monitored daily, any significant variation in performance can be detected in a timely manner.

**U.S. Government Purpose Release**

### **Automated Snow Index Tool (ASIT)**

**LAR-19128-1**

This software will load in image collections from Google Earth Engine from different sensors (Landsat 5, 7, and 8, and Sentinel 2a, 2b). The code will identify pixels using two snow indices (Normalized Difference Snow Index (NDSI) and the Saito S3 Snow Index). The area of snow can then be calculated for a region or for an individual watershed.

**Open Source**

### **Automatic Lunar Rock Detection and Mapping**

**NPO-48104-1**

Computer vision techniques have been applied to implement algorithms that detect rocks from images. At NAC nominal resolution it is possible to fully resolve boulders 2.5m or larger and detect boulders as small as 1.2m. With knowledge of sun angles, the shadows detected from the images are used to generate rock models describing the location, width, and height of boulders. A mapping tool kit computes statistical plots and maps of rock density and abundance.

**U.S. Government Purpose Release**

### **Automatic Rock Detection and Mapping from HiRISE Imagery**

**NPO-45752-1**

This software is currently being used by the Phoenix mission for landing-site selection. So far 39 HiRISE images (> 28 GB) covering one sigma landing ellipse of the three primary landing sites have been processed and their rock distribution maps have been produced. Over 10 million hazard rocks have been detected and mapped. This technology is also applicable to the Mars Science Laboratory (MSL) mission, as well as any future surface missions.

**U.S. Government Purpose Release**

### **Automatic Sequence Generation (AutoGen), Version 5.0**

**NPO-45984-1**

Autogen is used for operations of MRO, MER, Mars Odyssey, and Phoenix, and was also used on MGS. Through the utilization of Autogen for the base sequence generation of these missions, significant operations cost savings have been realized through reductions in labor, time, and risk.

**U.S. Government Purpose Release**

### **Autonomous Data Reduction for NASA Earth Science Data**

**NPO-45583-1**

NASA atmospheric and Earth science missions generate vast amounts of data every day. Clustering algorithms are used in various applications including pattern recognition, classification, data compression, regression, and related optimization problems. The design implements a computational solution for an autonomous data-reduction/clustering process to produce a representative distribution and joint relationships of the data without assuming a specific type of distribution and relationship nor resorting to domain-specific knowledge about the data.

**U.S. Government Purpose Release**

### **AutoPost**

**MFS-32925-1**

AutoPost can process any configuration of test data as needed. The tool can combine a series of data parameters into a single parameter.

**U.S. Release Only**



**BALFIT: A Multivariate Regression Analysis Tool****ARC-15804-1A**

BALFIT is designed for the automated regression analysis of wind tunnel strain-gage balance calibration data. Related strain-gage balance data analysis tasks are also supported. In addition, BALFIT performs an automated regression analysis of more general multivariate data sets at a basic level.

**U.S. Release Only****BGen: A UML Behavior Network Generator Tool****NPO-46787-1**

This program simplifies the development of C-code for behavior-based control systems. The autocoding approach used in this work is derived from that previously applied to such NASA missions as the Mars Science Laboratory.

**U.S. Government Purpose Release****Building a 2.5D Digital Elevation Model from 2D imagery****NPO-47571-1**

Pose data are often noisy and also insufficient to build a high-quality DEM. This software passes source imagery through a feature-tracking algorithm and a multiplane-homography algorithm to refine geometric transforms between images.

**U.S. Government Purpose Release****Calibrate Image****NPO-47191-1**

This software, coded in MATLAB, a widely used analysis software package, takes as input any image of an object or phenomenon of scientific interest (along with two reference images generated by the same digital imaging hardware), applies corrections for the three most prominent sources of image degradation, and outputs a corrected image of the object or phenomenon.

**U.S. Government Purpose Release****Cassini Mission App****NPO-47866-1**

This software has been developed using the Apple iOS SDK and utilizes components inherent to that SDK to deliver images and other content on the iOS platform. It retrieves content from the public Cassini Web site using HTTP, XML, and JSON. The software is a direct link to the general public from Cassini-related images and other information. It is intended to help spark interest in space exploration for current and future generations.

**U.S. Government Purpose Release****CertWare Safety Case Workbench Software****LAR-18067-1**

This technology contributes several core modules to support safety case models and offers a service-based application programming interface that enables new model-processing capabilities to be plugged into the workbench.

**Open Source****Change\_Detection.m****NPO-47671-1**

Recently, evidence of water-induced changes to the Martian surface were observed by a frame-to-frame change-detection technique. This software performs the same task at a much quicker rate allowing for more data to be analyzed. It also identifies changes in satellite imaging over time for NASA Earth-orbiting satellites as well planetary exploration missions.

**U.S. Government Purpose Release**

## Chapter 10 Tools

DRC-014-009

Sometimes even though post-flight processing data files originating from various onboard digital recorders follow the Range Commanders Council Inter-Range Instrumentation Group (IRIG) 106 Chapter 10 Digital Recording Standard, they use differing interpretations of it. This software toolkit reads data files regardless of the vendor implementation of the source recorder, display data, identify and correct errors, and produce a data file that can be successfully processed post-flight.

**General Public Release**

## Chesapeake Bay Chlorophyll Hotspot Identifier (CBCHI)

LAR-18794-1

CBCHI takes in raw Landsat 8 surface reflectance products and produces two maps to be opened in ArcMap to identify chlorophyll hotspots. It also creates a true color image.

**Open Source**

## Cliffbot Maestro

NPO-46433-1

Maestro is a rover operations application that uses the data products from Orchestrator to give an operator the context in which to command Cliffbot. The user interface provides two sets of tools for operations: stereo image browsing and command generation. The browsing features let the operator see stereo images acquired from the Cliffbot cameras in 2D and 3D views to analyze the appearance and shape of the terrain in the vicinity of the rover.

**U.S. Government Purpose Release**

## Coastal Mid-Atlantic METRIC Model

LAR-18665-1

This software calculates evapotranspiration rates of agricultural fields by executing the METRIC model in an ArcGIS Python script. It requires input data from Landsat 8 OLI/TIRS and local weather stations. The software was developed to reduce irrigation costs for farmers and provide a means to monitor droughts.

**Open Source**

## Code for Finding the Argmin and Argmax of a Data Variable in Stata Statistical Software

MSC-25718-1

This technology is used to find the argmin and argmax of a data variable within a Stata data set. The argmin and argmax in this case are the observation numbers at which the data variable achieves its minimum and maximum values (rather than the values themselves). Besides calculating and returning the argmin and argmax (i.e., observation number), the code returns the minimum and maximum values for reference, and, upon request, returns the values of other data variables at the same observation numbers.

**U.S. Government Purpose Release**

## Code for Finding the Running Maximum, Minimum, and Range of a Data Variable in Stata Statistical Software

MSC-25722-1

This technology is used to create a data variable that contains the running maximum, minimum, and range (maximum minus minimum) of another variable in a Stata data set. The code can also conceptually divide a data set according to values of other variables and calculate the running maximum, minimum, or range separately within each division.

**U.S. Government Purpose Release**

## Comet Gas and Dust Dynamics Modeling for MIRO

NPO-46507-1

This tool is used to perform the scientific analysis of MIRO measurements and study the evolution of the comet coma. The effort contributes to one of NASA's research objectives: learning how the Sun's family of planets and minor bodies originated and evolved. A lightweight, uncooled dual-frequency heterodyne radiometer has been developed for the European Space Agency's Rosetta mission to Comet 67P/Churyumov-Gerasimenko.

**U.S. Government Purpose Release**



**Confidence Intervals for the Bit-Error Rate of Coded Communications Systems** **NPO-49400-1**

Previous methods to compute confidence intervals for the BER of a coded system fail if they rely on standard techniques that assume error events are independent. This new method provides a robust, rigorous confidence interval that is a foundation on which communications performance and system risk may be determined.

**U.S. Government Purpose Release**

**Configurable Real-Time Analysis System (CRANS) Software Program, Version 7** **MSC-25673-1**

CRANS provides status of an avionics system utilizing an expert system for standard failure and correction options for potential failures. The program provides a means of representing logically interconnected items in a matrix format.

**U.S. Government Purpose Release**

**Constellation PRACA Extension of the Bugzilla Application** **ARC-16033-1**

The Constellation PRACA I-1 system is a modified version of an open-source, Web-based defect tracking tool called Bugzilla. Bugzilla allows software developers to document and track outstanding bugs in their products; in the Constellation PRACA I-1 system, these core capabilities have been extended to provide the necessary functionality and usability defined in the PRACA processing requirements.

**Open Source**

**Constructing a Database of 3D Localized Landmarks from Multiple 2D Images for Camera Pose Estimation and Robot Localization** **NPO-47845-1**

This software adds value to robotic simultaneous localization and mapping (SLAM) routines employed on exploration rovers and manned/unmanned aerial vehicles. It identifies features in scenes that best serve as landmarks.

**U.S. Government Purpose Release**

**Core Hierarchical Segmentation (HSEG) Software Package** **GSC-15855-1**

This version of HSEG is not subject to patent restrictions. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/HSEG/>

**Open Source**

**Cover Crop Remotely Observed Performance (CCROP)** **LAR-19113-1**

The source code extracts NDVI values from Landsat 5, Landsat 8, and Sentinel-2 images. NDVI values are averaged within field boundaries for each image and exported as a table with field ID and average NDVI value (with image date as the column header) for each date in a given range.

**Open Source**

**DailyPlanet: A system for Continuous Delivery of MODIS Imagery to Internet Mapping Applications** **NPO-45778-1**

This software has great value for aeronautical and space activities (from climate and weather monitoring to real-time navigation and disaster response) by making satellite imagery easily available for mapping applications.

**U.S. Government Purpose Release**

**Data Management Applications for the Service Preparation Subsystem** **NPO-45021-1**

The SPS UIP is currently being used in direct support of spacecraft tracking activities in the Deep Space Network. This suite of UIs could be adapted to support operations environments requiring the uploading and management of complex, interdependent input data.

**U.S. Government Purpose Release**



**Dayside Ionospheric Superfountain****NPO-47209-1**

This software provides an estimate of low-altitude satellite drag during intense magnetic storm events. Such a capability aids in tracking spacecraft, communicating with them, and applying correction effects.

**U.S. Government Purpose Release****DDOR SASF to APF Tool (ddor\_sasf2apf)****NPO-45413-1**

This tool reduces costs and risks associated with the sequencing of delta-door observations with the MRO spacecraft (and ODY spacecraft for MSPA DDOR).

**U.S. Government Purpose Release****Deep Space Network Tracking Data Visualization****NPO-45758-1**

For ongoing efforts to track spacecraft, this software suite is used in the Network Operations and Control Center (DSCC) at the Jet Propulsion Laboratory, as well as the Deep Space Communication Complexes in Goldstone, Canberra, and Madrid. It is also used in the NG-DSN research and technology development task for monitoring and controlling an antenna array using the Temporal Constraints Network.

**U.S. Government Purpose Release****Delivering Images for Mars Rover Science Planning****NPO-45671-1**

With this software, Images are tiled at multiple levels of detail and an image browsing application makes requests for tiles instead of entire images, dramatically speeding up image delivery. This solution scales up to images of arbitrary size.

**U.S. Government Purpose Release****DEVELOP National Program Python Package****LAR-18583-1**

This package creates a Python programming environment for simple processing of large NASA data sets to prepare them for further analysis in an ESRI ArcMap environment. It includes an instructional framework to guide users.

**Open Source****Development of a Multi-User Modem for Space Telecommunications****NPO-49717-1**

The multi-user modem provides multiple data streams for each user. Supportable data rates depend on the processing throughput capabilities of the AD converter, as well as the FPGAs. A single wideband AGC is used to prevent saturation at the output of the AD. Multiple digital AGCs are used to regulate the loop bandwidths for each user demodulator. The AGCs can provide inputs for individual adaptive data rate (ADR) control.

**U.S. Government Purpose Release****Digital Elevation Model Maker (DEMmaker)****MSC-24722-1**

This software suite produces data products containing surface shape, reflectivity, and geomorphology for a desired planetary surface. The technology produces seamless sets of digital elevation models (DEMs) at virtually any resolution or size to provide the desired levels of terrain feature detail as a spacecraft approaches a planetary surface. The innovation enables researchers to study a wide variety of problem domains, as the DEMs incorporate observed data, as well as mathematical models of planet morphology.

**U.S. Government Purpose Release****Direct-Solve Image-Based Wavefront Sensing****GSC-15208-1**

This technology solves for the wavefront directly from a single image and does not require defocusing or a nonlinear iterative algorithm.

**U.S. Government Purpose Release**

**Discontinuous Galerkin Spectral Element Solver (Eddy)****ARC-17373-1**

Eddy is a fundamental research code for advancing spectral methods for complex geometry. This software is intended to enable researchers to collaborate through a common framework that enables three-dimensional simulations on practical problems. Areas of interest include advanced numerical algorithms, computational optimization, scale-resolving turbulence models, and high-order mesh generation.

**General Public Release****Distributed Observer Network (DON), Version 3.1****KSC-13775**

DON3 is the innovative combination of NASA simulation technologies, NASA information technologies, and commercial video game technology to provide a unique system that leverages the strengths of all three. A key component is a standardized data interface for simulation-related information that is coupled with custom software integrated into the game environment.

**U.S. and Foreign Release****DRIP and SLIP Landslide Detection Package (DRIP-SLIP)****LAR-18789-1**

The DRIP-SLIP model automatically analyzes red band spectral information and soil moisture information derived from Landsat 8 and ASTER and SRTM data (at fine to moderate resolutions) to determine possible new landslide areas. This software increases the temporal latency for landslide products that emergency managers, planners, and scientists are able to use in their work.

**Open Source****Drought Severity Assessment Decision Support Tool****LAR-18731-1**

Within a user-specified boundary, this tool allows a user to calculate standardized precipitation index (SPI) values for each cell of a set of monthly precipitation raster's that span at least thirty years. The tool calculates basic SPI statistics within a user specified boundary and allows for visualization of calculated SPI rasters over time.

**Open Source****DSN Simulator****NPO-45513-1**

This software is designed to reduce risk and design/implementation costs of the DSN modernization. This development effort has a direct impact on the available volume of space communications, which is a major driver of mission design and NASA planning.

**U.S. Government Purpose Release****DspaceOgre 3D Graphics Visualization Tool****NPO-47380-1**

DspaceOgre is a general-purpose C++ 3D graphics tool designed for the visualization of simulation and analysis data for articulated mechanisms. Examples of such systems include space vehicles, robotic arms, biomechanics models, and bio-molecular structures.

**U.S. Government Purpose Release****DthData Armstrong Time-History Software Utility****DRC-012-024**

A standalone command-line-driven utility program, DthData processes time-history format data files generated by the Armstrong Core Simulation Software.

**U.S. and Foreign Release****DthDiff Armstrong Time-History Difference Software Utility****DRC-012-025**

A standalone command-line-driven utility program, DthDiff is used to compare two Armstrong time-history format data files generated by the Armstrong Core Simulation Software.

**U.S. and Foreign Release**

**Dynamic Hurricane Data Analysis Tool for the JPL  
Tropical Cyclone Information System (TCIS)**

**NPO-46417-1**

This software is a prototype of a comprehensive hurricane information system of high-resolution satellites, airborne and in-situ observations, and model outputs pertaining to: (1) the thermodynamic and microphysical structure of the storms; (2) the air-sea interaction processes; and (3) the larger-scale environment as depicted by the SST, ocean heat content, and the aerosol loading of the environment.

**U.S. Government Purpose Release**

**Dynamic Onboard Ubiquitous Graphics (DOUG) Software Application**

**MSC-23586-1**

The Dynamic Onboard Ubiquitous Graphics (DOUG) is a 3D rendering software package used for simulation and virtual reality display systems.

**General Public Release**

**Elimination of Parameter Input Requirement  
for Elliptic Grid-Generation Methods in Engineering**

**ARC-14710-1**

This software implements an enhanced method of elliptic grid generation.

**U.S. Government Purpose Release**

**Elkhorn Slough Vegetation Imagery Assessment (ESVIA)**

**LAR-19012-1**

This script conducts marsh vegetation health analyses using remotely sensed imagery sources. It analyzes vegetation change in a historical time-series using Landsat imagery, as well as current day vegetation productivity using Sentinel 2A imagery. Included in the script are operations such as image acquisition, image processing, and applications of vegetation indices with band combinations.

**Open Source**

**Encoders and Decoders for the AR4JA Family of LDPC Codes**

**NPO-47162-1**

Research at the Jet Propulsion Laboratory (JPL) over the last several years has resulted in the AR4JA family of LDPC codes. Nine members of this family have been selected for standardization by the Consultative Committee for Space Data Systems (CCSDS) and are under consideration for a variety of spacecraft missions and other projects. These codes have three block lengths (1024, 4096, and 16384 information bits) and three code rates (1/2, 2/3, and 4/5). Encoders and decoders for these codes have been written in the Verilog hardware description language, with exactly equivalent versions written in the C and MATLAB software programming languages.

**U.S. Government Purpose Release**

**Ethernet-to-HRDL Conversion Design**

**GSC-16513-1**

The International Space Station (ISS) uses a fiber-optic High Rate Data Link (HRDL) standard for transferring data. Those designing ISS experiments, however, may prefer an Ethernet interface. This design allows ISS instruments to keep their Ethernet interface by converting the Ethernet data format into a format compatible with the ISS.

**U.S. Government Purpose Release**

**Explicitly Filtered LES for the Grid-Spacing-Independent  
and Discretization-Order-Independent Prediction of a Conserved Scalar**

**NPO-49509-1**

In this effort, conventional large-eddy simulation equations have been modified by using an additional explicit filter for the non-linear terms. The additional filter removes the spurious small scales formed by aliasing.

**U.S. Government Purpose Release**



**Fast Block Transforms on Large Binary Datasets in the Cloud Using Hadoop Streaming** NPO-48908-1

Binary data is partitioned into chunks that are kept in a persistent data storage medium. A textual list of filenames for these chunks is piped into a Hadoop streaming mapper program, which then reads the corresponding files, computes block transforms locally, and writes the results back to persistent data storage. The mapper program is stored on all compute nodes, and the filenames are distributed in parallel across the cluster so that the workload is evenly distributed.

**U.S. Government Purpose Release**

**File Exchange Interface (FEI), Version 5** NPO-47089-1

The File Exchange Interface (FEI) service offers secure file transaction, store, transport, and management services. The latest distribution (code name Komodo) is a complete redesign from its predecessors, incorporating the latest computing technologies and standards.

**Open Source**

**File Plotting Tools** LAR-18314-1

This Excel plugin written in VB.net allows rapid post-processing of thermal analysis data from text files or from SINDA-formatted SAV files. The software can be adapted to other data formats as well.

**Open Source**

**Flightspeed Integral Image Analysis Toolbox (FIAT)** NPO-46871-1

The Flightspeed Integral Image Analysis Toolkit (FIAT) is a C library for image processing. It provides basic low-level filtering, texture analysis, and subwindow descriptors for applications dealing with image interpretation and object recognition. The library is designed with spaceflight applications in mind. Specifically, it addresses the following requirements: ease of integration (minimal external dependencies), fast real-time operation, and using integer arithmetic when possible.

**U.S. Government Purpose Release**

**Flood Analysis Utilizing Landsat and ArcMap Tools (FAULT)** LAR-19127-1

An automated script performs high-level flood analysis to relieve work load for end-users. It incorporates Landsat 8 Operational Land Imager (OLI) tiles and utilizes computer-learning techniques to generate accurate water extent maps. The script, referencing the Moderate Resolution Imaging Spectroradiometer (MODIS) land-water mask, isolates areas of flood-induced waters.

**Open Source**

**FPGA Phasemeter Firmware** NPO-45575-1

The phasemeter is an important part of a laser metrology system for measuring absolute distances. This software is used to build a precision structure (e.g., a very large telescope), which would deploy in space. Since lightweight deployment mechanisms aren't accurate enough for high-resolution optical telescopes, the laser metrology system measure distances on the deployed structure. The phasemeter is the stage of the metrology system that laser relative phases into distance measurements, which are used to actively control the structure with sub-micron accuracy.

**U.S. Government Purpose Release**

**Frequency Correction for MIRO Chirp Transformation Spectroscopy Spectrum** NPO-47304-1

The MIRO CTS measures direct outgassing of four major volatile species from the cometary nucleus ( $H_2O$ ,  $CO$ ,  $CH_3OH$ , and  $NH_3$ ). It also measures fundamental isotopo ratios ( $^{17}O/^{16}O$  and  $^{18}O/^{16}O$ ), using the isotopologues  $H_2^{16}O$ ,  $H_2^{17}O$ , and  $H_2^{18}O$ .

**U.S. Government Purpose Release**



### **Functional Enhancements to the FPGA Implementation of the Advanced Orbiting System (AOS) Data Link Protocol**

**NPO-49672-1**

This software allows both multiplexing and demultiplexing functions based on the Global Virtual Channel ID (GVCID), which is a combination of the spacecraft ID and virtual channel ID. In addition, the Transmit and Receive AOS Packet Service FPGA implementation has been modified to dynamically accept an input to change the transfer frame size.

**U.S. Government Purpose Release**

### **Geo-Correction for Airborne Platforms (GCAP), Version 1.0**

**GSC-16786-1**

The GCAP software was developed to provide the user with the ability to geo-reference a raster image using the Inertial Measurement Unit data. The output image is then further processed by other software functions to generate higher-level data products such as flood, fire, water, and oil classifications.

**U.S. Government Purpose Release**

### **Geodetic Strain Analysis Tool**

**NPO-47504-1**

This software enhances the usability of ground GPS networks which rely on space-based GPS satellites. JPL has developed a strain analysis interactive application for the derivation and exploration of strain from geodetic data.

**U.S. Government Purpose Release**

### **Geographic Applications for Transitioning Everglades Regions (GATER)**

**LAR-18943-1**

This code provides an algorithm for cloud removal from Landsat scenes and runs a classification scheme that classifies mangrove extent within Everglades National Park.

**Open Source**

### **Geometry Manipulation Protocol (GMP) for Computational Fluid Dynamics (CFD) Applications, Version 1.0**

**ARC-15193-1**

GMP serializes data types between XML and ANSI C data structures to support CFD applications. The library currently provides a description of geometric configurations, general moving-body scenarios (prescribed and/or 6-DOF), and control surface settings.

**Open Source**

### **Global Assimilative Ionosphere Model (GAIM)**

**NPO-40584-1**

GAIM is used to estimate the three-dimensional electron density distribution of the Earth's ionosphere as a function of time. To achieve high accuracy for users, the software accepts a wide variety of ionospheric measurements as input and produces output either in real time or in post-processing. The software can also generate predictions of the electron density structure for several hours or days into the future.

**U.S. and Foreign Release**

### **GNEIMO Advanced Techniques for Constrained Internal Coordinate Molecular Dynamics**

**NPO-48712-1**

The GNEIMO methods and algorithms build up on the Spatial Operator Algebra (SOA) multibody dynamics framework. The specific problems addressed in this work are velocity initialization techniques that are consistent with the CICMD equipartition principle, techniques for nulling momentum drift, analysis and solutions for the flying ice-cube effect, and performance of integration schemes.

**Open Source**

### **GOATS: Image Projections Component**

**NPO-47281-1**

This software affords a first-principles analysis of the geometric image projections involved in image capture from space. By utilizing a high degree of generalization, the same set of tools can be applied to imaging systems not in orbit (i.e., helicopters, high-altitude planes, etc.).

**U.S. Government Purpose Release**



**GPS Occultation Analysis System (GOAS)****NPO-30596-1**

GOAS processes atmospheric and ionospheric occultation data obtained from low-Earth-orbiting global positioning systems transmission receivers. The technology obtains input from a variety of receiver types and satellites and outputs full atmospheric and ionospheric retrievals.

**U.S. and Foreign Release****Grand Canyon Regions of Drought Impact (GC-ReDI)****LAR-19017-1**

Beginning in 1998, a drought in the Southwestern United States caused water levels in Lake Mead to fall to historic lows, uncovering thousands of acres of lakebed sediment along the shoreline. This software quantifies and visualizes the decreasing water levels and land cover changes in the lower Grand Canyon as it provides images, statistics, and graphs to understand these changes.

**Open Source****Ground and Space Radar Volume Matching and Comparison Software****GSC-15738-1**

This software enables easy comparison of ground- and space-based radar observations for validation purposes. It can be accessed at: <http://opensource.gsfc.nasa.gov/projects/GSRadar/>

**Open Source****Ground Resource Allocation Planning Environment (GRAPE), Version 1.0****NPO-45988-1**

DSN antennas are used to track most of NASA's and its foreign partners' deep space missions. This software ensures efficient team collaboration in the DSN utilization planning phase. GRAPE provides single-point access for documents and team knowledge.

**U.S. Government Purpose Release****Hierarchical Data Format-Earth Observing System (HDF-EOS) to NetCDF Converter****GSC-15007-1**

This C-language computer program accepts a set of scientific data/metadata from an Earth Observing System (EOS) satellite and converts it from the format in which it was created and delivered into another format for data processing and exchange on Earth. The converter can be downloaded at: [http://www.hdfeos.org/software/convert\\_hdfeos5.php](http://www.hdfeos.org/software/convert_hdfeos5.php)

**Open Source****High-Definition Earth Viewing (HDEV) Payload Ground Software (Commander and Redirector)****MSC-25815-1**

HDEV starts commands, receives/displays health and status information, and enables the viewing of converted data packets from HDEV as video. The software also has the ability to record the video and save it as a file.

**U.S. Government Purpose Release****High-Performance 3D Articulated Robot Display****NPO-47945-1**

The 3D visualization can render an articulated 3D model of a robotic platform for any environment. Given the model, the software receives real-time telemetry from the avionics system onboard the vehicle and animates the robot visualization to reflect the telemetered physical state. This can be used to track the position and attitude in real time to monitor the progress of the vehicle as it traverses its environment.

**U.S. Government Purpose Release****Highly Scalable Matching Pursuit Signal Decomposition Algorithm (MPD)****ARC-16345-1**

MPD is a powerful and effective iterative algorithm for signal decomposition and feature extraction. The technology decomposes any signal into linear combinations of its dictionary elements, or "atoms."

**Open Source**

### **HiMAP: Portable 3-Level Super-Modular Parallel High-Fidelity Multidisciplinary Analysis Process**

**ARC-14504-1**

HiMAP solves static and dynamic problems by tightly coupling the Euler/Navier-Stokes flow solutions with modal/finite-element structural solutions using built-in moving grids.

**U.S. Government Purpose Release**

### **Homography Warp Image: FPGA Implementation**

**NPO-48890-1**

A homography is a 3x3 floating point matrix. The process of mapping a pixel location (x,y) to the corresponding position (x',y') in a new image involves performing a dot product of the rows of the homography H by the vector (x,y,1), and calculating ratios of the various dot product results. Floating point operations are very resource-intensive on an FPGA. This implementation uses a hybrid fixed/floating point representation of H.

**U.S. Government Purpose Release**

### **Hybrid-PIC Computer Simulation of the Plasma and Erosion Processes in Hall thrusters (HPHall)**

**NPO-46513-1**

This code predicts the life of a given thruster design based on the actual mission profile. HPHall is an axisymmetric solver that employs a hybrid-fluid/particle-in-cell numerical approach to simulate the evolution of plasma inside the discharge chamber and near-field plume of a Hall thruster.

**U.S. Government Purpose Release**

### **Hydrological Anomaly Engine (HAE)**

**LAR-19151-1**

Using the cloud-based computing power of Google Earth Engine (GEE), the Hydrologic Anomaly Index (HAE) is capable of uploading and analyzing large amounts of Earth-observation climate data for the purposes of hydrologic analysis and monitoring. The end-user can pull from and modify a library of scripts that are stored in Earth Engine, as well as upload and access data stored on a private data catalog.

**Open Source**

### **Hypatheon-Searchable Database Capability for Formalized Mathematics**

**LAR-18232-1**

The Hypatheon suite of software tools provides a searchable database capability for the specialized domain of formalized mathematics. The technology is designed to be a companion to a specific tool called PVS, which supports an emerging type of advanced software verification intended for safety-critical systems. Hypatheon aims to enhance PVS users' productivity by first indexing the mathematical theories rendered in the PVS specification language, then making their contents searchable by an interactive software tool.

**Open Source**

### **Image Capture to Stereo Correlation in an FPGA**

**NPO-47190-1**

This software is composed of Cameralink image acquisition, rectification, filtering, and correlation.

**U.S. Government Purpose Release**

### **Inductive Monitoring System (IMS), Version 5: System Health-Monitoring Software That Learns System Behavior from Data**

**ARC-15058-1A**

IMS software utilizes techniques from the fields of model-based reasoning, machine learning, and data mining to build system-monitoring knowledge bases from archived or simulated sensor data. The technology automatically analyzes the nominal system data to form general classes of expected system sensor values; these classes are used to build a monitoring knowledge base. When monitoring a system, IMS simply checks to see how well the incoming sensor data fit into the classes derived from the training data.

**U.S. Government Purpose Release**



**Inference Kernel for Open Static (IKOS) Analyzers:  
A High-Performance Static Analysis Engine to Build Automated Code  
Analysis Tools for the Formal Verification of Critical Software Properties** **ARC-16789-1**

IKOS is a kernel for the construction of open-static analyzers based on Patrick Cousot and Radhia Cousot's theory of abstract interpretation, which states that computations can be abstracted and reduced to a generalized set of objects and still exhibit the same critical properties of the parent program. By reducing the set of objects through abstraction, IKOS is scalable to large complex computer programs and presents a sound approach to verification of such programs.

**Open Source**

**Information Sharing Protocol (ISP)** **MSC-22530-1**

These libraries and executables support the use of the ISP protocol.

**U.S. Government Purpose Release**

**Information Sharing Protocol Advanced Tool of Math (ISPATOM), Version 02.03.07** **MSC-25714-1**

ISPATOM is a generic computational software program (comps). Most comps that are run in the NASA Mission Control Center (MCC) must be defined and hard-coded into C or some other programming language. ISPATOM runs on the MCC Linux workstations and can run any computations that can be represented as a mathematical equation without prior configuration. An equation or several equations are simply entered on the command line, the values are calculated, the computed values are saved in output symbols, and the output symbols are published.

**U.S. Government Purpose Release**

**Interactive 3D Mars Visualization** **NPO-47311-1**

The Mars terrain browsing software interface encompasses the entire region of exploration for a Mars surface exploration mission. The view is interactive, allowing the user to pan in any direction by clicking and dragging or to zoom in or out by scrolling the mouse or touchpad. This set currently includes tools for selecting a point of interest and a ruler capability for displaying the distance between and positions of two points of interest.

**U.S. Government Purpose Release**

**Ionospheric Slant TEC Analysis Using GPS-Based Estimation (IonoSTAGE)** **NPO-43504-1**

The Ionospheric Slant TEC Analysis Using GNSS-Based Estimation (IonoSTAGE) software package is a MATLAB platform for performing analysis and visualization of ionospheric slant total electron content (TEC) using measurements of global navigation satellite systems.

**U.S. Government Purpose Release**

**IPv6 Python Extension Module** **LEW-19323-1**

IPv6 Extension module for Python allows a user to enable IPv6 features not yet available for any Python versions. It allows for IPv6 flow labels to be enabled for a given Python socket object.

**Open Source**

**ISS\_Camera\_Geolocate** **MFS-33558-1**

This Python software library facilitates the geolocation of photographs and video frames from the International Space Station (ISS). It provides functions that take camera and pointing information along with publicly available ISS position information and geolocate every pixel of the photograph in latitude and longitude. The library enables geospatial analysis of astronaut photography from Earth, including pictures of clouds, lightning, coastlines, city lights, etc.

**Open Source**



### **Java Pathfinder (JPF) Core System (JPF-Core)**

**ARC-17487-1**

JPF-Core, is a model checker for Java bytecode. The technology takes a binary Java program and executes it in a user-configurable way to detect defects such as deadlocks and unhandled exceptions, providing significantly higher confidence in correct program behavior than conventional testing.

**Open Source**

### **Java Program to Promote an Open-Source “E Standard” for Mass Properties Engineering**

**LAR-17635-1**

This open-source Java software helps develop electronic standards (E-Standards) for mass properties engineering. An E-Standard is a highly descriptive dataset that includes standardizing functions for data manipulation, interrogation, and formatting. With this tool, any number of users can interface with the proposed E-Standard datasets and still seamlessly utilize their own software methods.

**Open Source**

### **Java-Based Software Tool for Dynamic Aerospace Vehicle Exchange Markup Files**

**LAR-17460-1**

An update to software originally named DAVEtools 0.5, this software-based technology is used for manipulating standard Dynamic Aerospace Vehicle Exchange Markup Language (DAVE-ML) models. The improved technology embeds the necessary initialization data into a data structure to keep the MATLAB workspace uncluttered and creates Simulink models from a generated MATLAB script.

**Open Source**

### **JPLFineCal: Automated Camera Array Fine Calibration**

**NPO-45715-1**

This software is part of a program that collects synchronized images from an array of cameras mounted in parallel on a gimballed frame attached to an aircraft. Synchronized images are captured from each camera in the array and are stitched together into a single very high-resolution image that is projected onto an elevation map of the ground. The algorithm assumes that features found in imagery are at infinity, so it is not well suited to ground applications.

**U.S. Government Purpose Release**

### **JWST Backgrounds**

**GSC-17919-1**

For use in proposal planning, this simple Python program predicts the levels of background emission that will appear in JWST observations. It accesses a precompiled background cache that is already hosted online for JWST users.

**Open Source**

### **Kepler Robovetter**

**ARC-17981-1**

The Kepler mission observed approximately 200,000 stars for four years and identified over 34,000 transit-like events. The Kepler Robovetter translates the logic used to discriminate between “likely planet candidates” and “false positives” and automates the evaluation of large Kepler data sets that are available at the public archive. NASA acknowledges the SETI Institutes primary role in authoring and producing the Kepler Robovetter under Cooperative Agreement Number NNX13AD01A.

**Open Source**

### **Kepler Science Data Processing Pipeline**

**ARC-16332-1A**

The Data Processing Pipeline is a central element of the Kepler Ground Data System. It analyzes stellar photometric data from the Kepler spacecraft and reports search results for planets within the Kepler photometric dataset. The pipeline performs pixel-level calibration, photometric analysis, systematic error correction, transiting planet detection, modeling and diagnostic testing of potential transit signatures, attitude determination, stellar target management, and monitoring of instrument health and performance.

**Open Source**



**KeplerPORTs (Kepler Planet Occurrence Rate Tools)****ARC-17979-1**

The Kepler Plotting Program was developed as an aid to understanding the publicly available data files that have been released by the Kepler project. This tool allows end users to reproduce plots utilized in project documentation, facilitates the user's scientific understanding, and promotes the utilization of the Kepler science data products. NASA acknowledges the SETI Institutes primary role in authoring and producing the KeplerPORTs (Kepler Planet Occurrence Rate Tools) under Cooperative Agreement Number NNX13AD01A.

**Open Source****Kodiak: A Software Library for Verifying Nonlinear Arithmetic Statements****LAR-18268-1**

Kodiak is a software implementation of an algorithm for verifying expressions involving nonlinear real arithmetic. It includes an optimizer for nonlinear real functions, a solver for nonlinear inequalities, and an application programming interface (API) for integrating other software verification tools.

**Open Source****Kodiak's Boolean Checker Software Module****LAR-19222-1**

Kodiak is a software implementation of a branch-and-bound algorithm for rigorous approximations of expressions involving nonlinear real arithmetic. It includes an optimizer for nonlinear real functions, a solver for nonlinear inequalities, and an application programming interface to integrate directly with other software verification tools. Kodiak's Boolean Checker Software Module is an implementation of a general mixed Boolean/real-expression checker that is integrated into Kodiak's global optimization solver.

**Open Source****Land Surface Temperature MODIS Visualization (LaSTMoV)****LAR-18877-1**

Extreme heat causes and exacerbates a number of health problems leading to hospitalization and death in some cases. The problem of severe heat is notably felt in Maricopa County, Arizona, where the socially disadvantaged and physically vulnerable are especially susceptible to the effects of extreme heat. Several organizations, including the Arizona Department of Health Services and the Phoenix Heat Relief Network, are working to create more effectively placed cooling centers and heat warning systems to aid those with the highest risk of exposure. This project created a Python tool using Aqua Moderate Resolution Imaging Spectrometer (MODIS) land surface temperature parameters to generate heat maps that reference demographics data on extreme hot days.

**Open Source****Link Complexity Scheduling Algorithm****NPO-49879-1**

Not all activities are equally demanding, and when link control operators (LCOs) are managing multiple activities at once it is easy to see that inadvertent overloading of the operations staff is a potential risk. As a result, a new approach to model the complexity of individual activities has been developed to avoid overloading individual LCOs with too much work at one time.

The approach: (1) predicts the occurrence of "spikes" in loading and provides feedback to users so they can make adjustments early in the process before a schedule is considered firm; and (2) determines an appropriate assignment of work to operators that does not exceed threshold values for the number of links or overall link complexity.

**U.S. Government Purpose Release****Lossless Hyper-/Multi-Spectral Data Compression Software****GSC-15992-1**

This software performs lossless hyper-spectral and multi-spectral data compression. It can be downloaded at: <http://opensource.gsfc.nasa.gov/projects/LHD/>

**Open Source**

**Low-Density Parity Check Fault-Programmable Gate Array (FPGA) Decoder for the (8176,7154) Code Specified in the Consultative Committee for Space Data Systems (CCSDS) Orange Book 131.1-O-2**

**GSC-15454-1**

VHDL code has been written to implement the (8176,7154) LDPC code in the CCSDS Orange Book 131.1-O-2. The design has been tested using a Virtex 4 LX200 FGPA running at 66 MHz for various signal-to-noise ratios with on-chip random normal generators. The decoder core will run at 100 MHz giving a sustained throughput of 650 Mbits/second. The decoder uses the minimum sum algorithm with an attenuation multiplier of 0.75 and 6-bit saturating arithmetic. The decoder does 14 iterations per block and generates a dot product for the last iteration. Data are input and output as 7-bit probabilities of 6 bits each per cycle.

**U.S. Government Purpose Release**

**Mariana: Text Classification System**

**ARC-16070-1**

Mariana is an algorithm that efficiently optimizes the hyperparameters for support vector machines for regression and classification. It currently uses simulated annealing for optimization but can be extended to use a variety of stochastic optimization techniques, including Markov Chain Monte Carlo, Sequential Monte Carlo, and genetic algorithms.

**Open Source**

**Mars Reconnaissance Orbiter (MRO) DKF Post-Processing Tool**

**NPO-45481-1**

This tool is used by the Mission Planning Sequencing Team (MPST) team to post-process the key word file for commanding DSN ground equipment in support of the MRO spacecraft.

**U.S. Government Purpose Release**

**Mars Reconnaissance Orbiter (MRO) Mega-Check Tool**

**NPO-45480-1**

This tool is used by the MRO Mission Planning Sequencing Team (MPST) team to inspect and validate every background sequence. It provides considerable cost savings and risk reduction by automating many tedious and error-prone checks required in the review process.

**U.S. Government Purpose Release**

**Mars Science Laboratory Workstation Test Set (WSTS)**

**NPO-45690-1**

WSTS is currently being used in the mainline flight software development process for the MSL project. It provides PCI-card-level simulation for avionics hardware, allowing testing of all but the lowest layers of the software. It uses POSIX shared memory and synchronization in a Linux environment to provide high-resolution simulation time-slicing.

**U.S. Government Purpose Release**

**Mars Terrain Generation, 2008**

**NPO-46659-1**

This program suite produces XYZ images that are fundamental in creating the terrain meshes employed by Rover planners for safe driving and conducting arm operations.

**U.S. Government Purpose Release**

**MaRSHE- Marsh Remote Sensing Health Evaluation**

**LAR-19211-1**

This tool includes three general types of scripts: one for extracting average NDVI values from Landsat 5 and Landsat 8 image collections for specified reference dates (typically a period of 10–15 years); another for performing unsupervised classifications to determine marsh extent for a variety of years; and a third for statistics regarding the maps generated in the classification scripts.

**Open Source**



**MarsViewer, 2008****NPO-46698-1**

MarsViewer enables quality control, browsing, and operational and science analysis of images and derived image products returned by spacecraft for in-situ missions (e.g., MER, PHX, and MSL). It allows all derived products associated with each original image to be viewed in various ways (including in stereo) depending on the type of image. The program features a pluggable interface.

**U.S. Government Purpose Release****MATLAB-Code V Toolkit****GSC-15140-1**

This toolkit is a set of MATLAB scripts and functions that enable rapid transfer of optical system and performance data from Code V optical software into the MATLAB environment. Typical applications include: extracting prescription data into MATLAB to confirm consistency of various delivered models; perturbing the models and performing various analyses such as ray tracing or generation of point-spread functions in support of integrated modeling activities; and enabling a MATLAB-driven optical model for integrated system-level modeling of wavefront sensing and control. The toolkit can be downloaded at:

[http://opensource.gsfc.nasa.gov/projects/Matlab\\_Code\\_V/index.php](http://opensource.gsfc.nasa.gov/projects/Matlab_Code_V/index.php)

**Open Source****MATLAB-Oslo Toolkit****GSC-15138-1**

This toolkit is a set of MATLAB scripts and functions that enable rapid transfer of optical system and performance data from Oslo optical software into the MATLAB environment. Typical applications include: extracting prescription data into MATLAB to confirm consistency of various delivered models; perturbing the models and performing various analyses in support of integrated modeling activities; and enabling a MATLAB-driven optical model for integrated system-level modeling of wavefront sensing and control. The toolkit can be downloaded at <http://opensource.gsfc.nasa.gov/projects/Matlab/index.php>

**Open Source****MATLAB-Zemax Toolkit****GSC-15151-1**

The MATLAB-Zemax toolkit is a set of MATLAB scripts and functions that enable rapid transfer of optical system and performance data from Zemax optical software into the MATLAB environment. Typical applications include: extracting prescription data into MATLAB to confirm consistency of various delivered models; perturbing the models and performing various analyses in support of integrated modeling activities; and enabling a MATLAB-driven optical model for integrated system-level modeling of wavefront sensing and control. The toolkit can be downloaded at: [http://opensource.gsfc.nasa.gov/projects/Matlab\\_Zemax/index.php](http://opensource.gsfc.nasa.gov/projects/Matlab_Zemax/index.php)

**Open Source****Metric Learning to Enhance Hyperspectral Image Segmentation****NPO-48092-1**

In this effort, a hyperspectral segmentation algorithm is augmented with a task-specific Mahalanobis distance metric. By leveraging a small set of labeled pixels with known mineralogical interpretations, a metric suppresses uninformative spectral content. Multiclass linear discriminant analysis (LDA) is used to maximize the ratio of between-class vs. within-class separation (as defined by the Rayleigh quotient computed over labeled training data). Other distance metrics and segmentation strategies are possible, and can be substituted for these choices in modular fashion as different applications demand.

**U.S. Government Purpose Release****Mirador: A Fast, Minimalist Search Tool for Remote Sensing Data****GSC-15291-1**

Mirador is a search tool that emphasizes speed and simplicity in searching remotely sensed Earth science data. The search execution is accelerated by initially presenting dataset results with an estimated number of hits for each dataset. The simplicity of the search form makes the tool easy to learn and use, and the speed of the searches enables an iterative form of data discovery.

**U.S. Government Purpose Release**

**MISR Interactive eXplorer****NPO-45744-1**

This software functions both as a general-purpose tool to visualize MISR data and as a specialized tool to analyze properties of smoke and volcanic plumes.

**U.S. Government Purpose Release****MISR Interactive eXplorer****NPO-47098-1**

MISR is a NASA instrument onboard an Earth-orbiting satellite that provides new types of information for scientists studying the Earth's climate, such as the partitioning of energy and carbon between the land surface and the atmosphere and the regional and global impacts of different types of atmospheric particles and clouds on climate. This software functions both as a general-purpose tool to visualize MISR data and as a specialized tool to analyze properties of smoke and volcanic plumes.

**U.S. Government Purpose Release****Mobile Multi-System Overview****NPO-47634-1**

This software provides engineers with an efficient overview of multiple systems at any time so that they can respond quickly to problems. The information can be relayed to mobile phones, thereby increasing efficiency.

**U.S. Government Purpose Release****Modified Snowmelt Runoff Model for Forecasting Water Availability in Chile****LAR-18602-1**

This software models the daily stream flow of snowmelt runoff as a function of temperature, elevation, snow-covered area, precipitation rate, and experimentally determined coefficients. Using MODIS and TRMM data, it provides tools for synthesizing daily fractional snow cover and daily precipitation measurements, as well as flow estimates for three months beyond the start of the growing season.

**Open Source****Move Away Superfluous Clouds (MASC)****LAR-19032-1**

This source code removes clouds, cloud shadow, water, and snow pixels from Landsat scenes using the cloud mask layer that is provided with Landsat data.

**Open Source****MPS Editor****NPO-47237-1**

The MPS editor is written in Java using the Eclipse Rich Client Platform. The software allows users to start in the early development phase and continue on through the operations phases. It is currently built with four perspectives: the activity dictionary perspective, the project adaptation perspective, the sequence building perspective, and the sequence modeling perspective.

**U.S. Government Purpose Release****MRO Relay SASF/PTF Generation Software****NPO-46512-1**

This tool supports the relay activities of all NASA and non-NASA assets on the surface of Mars. The software utilizes an input file provided by the lander team, along with a managed configuration file, to run MRO's MTT software recursively to construct the Relay PTF.

**U.S. Government Purpose Release****MRO SOW Daily****NPO-45439-1**

The MRO SOW daily tool is used to monitor file system capacity and ensure that required space is available for performing day-to-day spacecraft operations and commanding.

**U.S. Government Purpose Release**

**Multi-Mission Automated Task Invocation Subsystem (MATIS)****NPO-45630-1**

This software benefits flight projects by lowering development and operations costs and reducing risks while increasing reliability. Although implemented to support instrument product generation, other project teams or subsystems requiring timely and reliable execution of programs and applications across all mission phases could utilize these capabilities. MATIS is a workflow manager that executes programs in a specific order and under specific conditions.

**U.S. Government Purpose Release****Multichannel Monitor-Stabilizer for Injection-Locked Lasers****NPO-45907-1**

These programs have been designed to support the stable operation of injection-locked slave lasers in an autonomous regime.

**U.S. Government Purpose Release****Multivariate Time Series Search Capability to Identify Complex Patterns in Large Datasets****ARC-16452-1**

This software allows the user to specify a time series over multiple variables to search within massive datasets. The tool will return a listing of events (a time series) from the database that spans multiple variables and is within a threshold distance from the query. Experiments on numerous real aviation datasets have demonstrated the algorithm's capability to uncover potential aircraft safety events (as validated by multiple aviation safety experts and airlines).

**Open Source****MYSTRAN****GSC-17173-1**

MYSTRAN is a finite element analysis (FEA) processor that takes NASTRAN data decks as input and processes them to generate results files.

**Open Source****NASA App****ARC-16325-1A**

The NASA App delivers near-real-time NASA content to phones and tablets. The technology features missions, images, videos, tweets, a live stream of NASA TV, and news topics. The app can be downloaded at: <http://www.nasa.gov/centers/ames/iphone>

**General Public Release****NASA Vision Workbench (VW), Version 3****ARC-15761-1A**

Vision Workbench (VW) is a modular, extensible computer vision framework that supports a range of tasks, including automated science and engineering analysis, large satellite image processing, and 2D/3D environment reconstruction. The framework provides a rapid C++ development environment, as well as a flexible, multi-platform system to deploy computer vision applications. The module interface allows new capabilities to be rapidly integrated, and the dataflow architecture allows image-processing pipelines to be quickly developed and reconfigured.

**Open Source****nu-Anomica (Previously Sparse One-Class Support Vector Machines (SOC-SVMs))****ARC-16346-1**

nu-Anomica is an anomaly detector that can run faster than traditional OC-SVMs. The technology can handle large training sets and works with a well-defined target function. The program utilizes the OSU SVMs code (which is a MATLAB version of Lib-SVMs) as the baseline.

**Open Source**

### **Observation Scheduling System**

**NPO-47189-1**

This software is for mission planning in the presence of spacecraft operations constraints (e.g., data volume, thermal, pointing maneuvers, and others). It is in operational use on the Earth-Observing One mission and can improve efficiency of future space missions.

**U.S. Government Purpose Release**

### **OCO-2 Level 2 Retrieval Algorithm**

**NPO-49044-1**

The primary purpose of the Level 2 retrieval software is to derive estimates of the column-averaged atmospheric CO<sub>2</sub> dry air mole fraction, XCO<sub>2</sub> (defined as the ratio of the column abundances of CO<sub>2</sub> and the column abundance of dry air), and other Level 2 data products from the spectra returned by the OCO-2 mission.

**Open Source**

### **ODL to XML Converter**

**GSC-15013-1**

This command-line Java-based utility converts an ODL Hierarchical Data Format-Earth Observing Satellite (HDFEOS) metadata file to an HDFEOS XML file. The tool utilizes an all-Java ODL library that includes a syntax and grammar parser. The software can be downloaded at: [http://opensource.gsfc.nasa.gov/projects/ODL\\_XML/index.php](http://opensource.gsfc.nasa.gov/projects/ODL_XML/index.php)

**Open Source**

### **OMG Tool Infrastructure Working Group Workflow Automation and Modeling Tool Extensions**

**NPO-49757-1**

The Jet Propulsion Laboratory led the production of official machine-readable artifacts for several cycles of the official task forces that develop the Unified Modeling Language (UML) and Systems Modeling Language (SysML) specification standards published by the Object Management Group (OMG). This technology focuses on capturing JPL's experience into extensions of various tools for replacing labor-intensive manual workflows typically involved in standards development at the OMG with automated workflow processes.

**U.S. Government Purpose Release**

### **OnMars MOC-NA: A Composite of the Mars Observer Camera's Narrow-Angle Image Collection**

**NPO-45960-1**

The MOC-NA mosaic offers one of the highest-resolution views of Mars. The technology used to build this mosaic can be used for other data applications including change detection.

**U.S. Government Purpose Release**

### **OnMars, Web Map Service Server for Martian Raster Data**

**NPO-45959-1**

By providing mapping support, as well as data access for a variety of users, this server is a significant contributor to NASA's Mars exploration activities.

**U.S. Government Purpose Release**

### **OnMoon, Lunar Web Map Service Server**

**NPO-45951-1**

By providing mapping support, as well as data access for a variety of users, this software can be a significant contributor to NASA's Lunar exploration activities.

**U.S. Government Purpose Release**

### **Outlier Detection Via Estimating Clusters (ODVEC)**

**ARC-16467-1**

The Outlier Detection Via Estimating Clusters (ODVEC) software provides an efficient method for real-time or offline analysis of multivariate sensor data for use in anomaly detection, fault detection, and system health monitoring. ODVEC uses models automatically derived from archived system data to identify unusual, out-of-family data samples (outliers) that indicate possible system failure or degradation.

**U.S. Government Purpose Release**



**Palm Oil Plantation Predictor (POPP)****LAR-18862-1**

This software is designed to simplify the process of manipulating and converting both satellite data and ancillary data so that they can be used within the Maxent modeling software. The tool converts vector or raster data into the correct format and processes all files in order to have identical rows, columns, and resolution.

**Open Source****Parallel Computing for Computed-Tomography Imaging Spectrometer****NPO-45831-1**

This instrument can be used for the spectral imaging necessary to survey planetary landscapes as well as battlefield surveillance and analysis of live tissues for disease detection. The Computed Tomography Imaging Spectrometer is a novel instrument that enables transient-level multi-spectral imaging by capturing spatial and spectral information in a single snapshot.

**U.S. Government Purpose Release****Perilog, Version 3.0****ARC-15310-1**

Perilog software capabilities include keyword-in-context search, flexible phrase search, search by example, phrase generation, and phrase extraction. The technology's keyword-in-context search feature retrieves documents that contain one or more user-specified keywords in context, ranks documents on their relevance to the keywords in context, and displays the documents with the query words highlighted and, optionally, with strongly associated words also highlighted.

**U.S. Government Purpose Release****Phoenix Telemetry Processor****NPO-47801-1**

This software has been part of the Multi-mission Image Processing Laboratory system, producing Level 1 products used to analyze images returned by in-situ spacecraft. It ultimately assisted in operations, planning, commanding, science, and outreach.

**U.S. Government Purpose Release****Photogrammetry Pyramid****KSC-14027**

The Photogrammetry Pyramid software is a 3D photogrammetry Windows application intended to support the use of a standalone reference target system. The software requires images from two or more camera views. For static scenes, a single camera can be used by taking pictures from different viewpoints (two or more). The reference target is composed of seven spheres connected by equal-length rods. A sphere is located at each of the four vertices of the pyramid. Three additional spheres are located at the midpoint of the three vertical rods. The distance between any set of vertices-spheres defines the characteristic pyramid length. This length is the only value needed by the user during reference target generation.

**General Public Release****PixelLearn****NPO-42082-1**

PixelLearn is a tool for classifying the pixels in scientific image data sets. Based on one or more images on the same grid, the tool uses cutting-edge clustering algorithms to automatically find structures in the image, or to label individual classes and use supervised classification methods to extend the labels to the rest of the image.

**U.S. Government Purpose Release**

### **Pixelwise Correlation-Based Landscape Classification (PiCo)**

**LAR-19015-1**

PiCo was written in an effort to automate and regionalize the Climate Landscape Response (CLaRe) metrics developed by Wallace, et al, 2016. CLaRe maps invasive buffelgrass in the Southwestern United States. This grass both propagates and benefits from increased wildfire events, and it is a threat to the local ecosystems within the Sonoran Desert. Buffelgrass responds to precipitation quicker than native vegetation. This behavior is what CLaRe captures. Correlation values derived from regression analysis between Normalized Difference Vegetation Index (NDVI) and precipitation values are used to separate pixels invaded by buffelgrass from those that are not. PiCo, written in R, performs a pixelwise regression analysis.

**Open Source**

### **Planetary Image Geometry (PIG), 2008**

**NPO-46658-1**

The PIG library is a multimission library used for projecting images (experiment data records) and managing their geometry. A collection of models describes cameras and their articulation, allowing application programs such as mosaickers, terrain generators, and pointing correction tools to be written in a multimission manner, without any knowledge of parameters specific to the supported missions.

**U.S. Government Purpose Release**

### **Plotting Program for Kepler Planet Detection Efficiency Products**

**ARC-17980-1**

The Kepler Plotting Program was developed as an aid to understanding the publicly available data files that have been released by the Kepler project. This tool allows end users to reproduce plots utilized in project documentation, facilitates the user's scientific understanding, and promotes the utilization of the Kepler science data products. NASA acknowledges the SETI Institutes primary role in authoring and producing the KeplerPORTs (Kepler Planet Occurrence Rate Tools) under Cooperative Agreement Number NNX13AD01A.

**Open Source**

### **Portable Environment for Quick Image Processing (QulP)**

**ARC-16295-1A**

The QulP interpreter, a software environment for QUick image processing, uses an interactive scripting language designed to facilitate use for non-expert users. It features context-sensitive automatic response completion and integrated documentation, and also includes a number of script packages that implement high-, medium-, and low-level functions (e.g., analysis of eye images for human gaze tracking, feature tracking, and image filtering).

**Open Source**

### **POSSUM: Product Operations Status Summary Metrics**

**NPO-46664-1**

For the Phoenix lander mission, POSSUM provides graphical tracking/accountability of the existence/version of expected reduced data records (RDRs) for a given experiment data record (EDR). By using POSSUM, operations personnel can easily determine if any RDRs are missing during and after OPGS processing. A variety of sorting options is available.

**U.S. Government Purpose Release**

### **Pour: A Framework for Periodic, On-Demand, and User-Specified Information Reconciliation**

**ARC-15468-1**

Pour is a general-purpose information service framework for periodic, on-demand, and user-specified information reconciliation. The technology is designed to accommodate a wide variety of information types with support for high-volume, low-frequency periodic updates, user-specified updates, and automatic updates collected on demand when needed.

**Open Source**



### Projection of Stabilized Aerial Imagery onto Digital Elevation Maps for Geo-Rectified and Jitter-Free Viewing

NPO-46920-1

This code finds a mapping from points on the ground (DEM) to pixels in the image. The user can effectively “paint” a projection of an image onto the ground.

**U.S. Government Purpose Release**

### Propulsive Reaction Control System (RCS) Model

NPO-46978-1

This RCS Model is a C language program. It contains two main functions: (1) the RCS electronics that model RCS FPGA processing and commanding of the RCS valve; and (2) the RCS dynamic function, which models the valve and combustion dynamics. The software also provides support functions to initialize a model, set parameters, access model telemetry, and access calculated thruster forcers.

**U.S. Government Purpose Release**

### pyCMR

MFS-33409-1

Python client library (pyCMR) abstracts CMR search application program interface calls to a simple set of Python functions that can be incorporated into client applications. The search responses are stored in the Python dictionary for easy manipulation on the client side.

**Open Source**

### Quick-Plot General-Purpose Plotting Tool

DRC-012-022

Quick-Plot is a general-purpose tool used to plot Armstrong time-history data files and data files in the MATLAB format. The graphical user interface allows commands to be scripted and read from an input script file; input signals can be modified using algebraic expressions.

**U.S. and Foreign Release**

### Radiometric Calibration of UAVSAR Images

NPO-47969-1

UAVSAR backscatter data contain both geometric and radiometric distortions due to underlying topography and the radar viewing geometry. Currently, backscatter variation due to topography is the single largest error source when estimating biomass over steep or hilly terrain. This software affords proper calibration, which normalizes the backscatter images so that only contributions from the parameters of interest remain.

**Open Source**

### Reachability Maps for In-Situ Operations

NPO-47731-1

This software is composed of two sub-programs (one for MER and one for Phoenix). They create a “reachability map” from stereo imagery that tells operators of a robotic arm whether or not the arm can reach/touch a surface.

**U.S. Government Purpose Release**

### Requirements Tracing on Target (RETRO)

GSC-14976-1

RETRO offers methods and techniques for information retrieval (IR), including vector retrieval and probabilistic retrieval. The technology can be downloaded at: <http://opensource.gsfc.nasa.gov/projects/RETRO/index.php>

**Open Source**

### Rocket Plume Spectroscopy Simulation for Hydrocarbon-Fueled Rocket Engines

SSC-00281

Enhancements and modifications to a code developed for plume spectral data analysis in 1994 have made the original computer program applicable to the space shuttle main engine and the Diagnostic Test-bed Facility Thruster (DTFT). The new code can now handle the non-uniform wavelength intervals at which spectral computations are made.

**U.S. Government Purpose Release**



### **SAD5 Stereo Correlation Line Striping in an FPGA**

**NPO-47245-1**

This software performs stereo correlation line striping for an FPGA. Line-width striping can be accomplished any number of times. Each stripe reduces the BRAM needed, allowing even larger images or even smaller resource usage.

**U.S. Government Purpose Release**

### **Scalable Gaussian Process Regression (Block GP)**

**ARC-16864-1**

Block GP is a Gaussian process regression framework for multimodal data that can be an order of magnitude more scalable than existing state-of-the-art nonlinear regression algorithms. The framework builds local Gaussian processes on semantically meaningful partitions of the data and provides higher prediction accuracy than a single global model with very high confidence. The method relies on approximating the covariance matrix of the entire input space by smaller covariance matrices that can be modeled independently, and can therefore be parallelized for faster execution.

**Open Source**

### **SEQ Diff Suite**

**NPO-45438-1**

This software reduces costs and risks associated with the sequencing and review of command products for spacecraft operated by the MGSS/MMO MPST operations teams.

**U.S. Government Purpose Release**

### **SequenceMiner: Anomaly Detection in Large Sets of High-Dimensional Symbol Sequences**

**ARC-16053-1**

SequenceMiner was developed to address the problem of detecting and describing anomalies in large sets of high-dimensional symbol sequences. The technology performs unsupervised clustering (grouping) of sequences using the normalized longest common subsequence (LCS) as a similarity measure, followed by a detailed analysis of outliers to detect anomalies. SequenceMiner utilizes a new hybrid algorithm for computing the LCS that has been shown to outperform existing algorithms by a factor of five.

**Open Source**

### **SITH: Stereo Imaging Tactical Helper**

**NPO-46669-1]**

SITH was the only available program to display the color stereo images that were produced for Phoenix. As image pipeline parameters are tuned before a mission to balance correlation performance vs. accuracy, a tool such as this is invaluable.

**U.S. Government Purpose Release**

### **Small Object-Detection Via Fast Discrete Curvelet Transform**

**NPO-49288-1**

Each ROI should contain an object of interest or information that is pertinent to the user or system. Therefore, the goal of this framework is to reduce the number of ROIs without the unintended loss of an object of interest. The Fast Discrete Curvelet Transform (FDCT) is implemented as the first stage in this systems framework in order to have a collection of sufficient Curvelet coefficients. The coefficients sparsify the input image, providing the ability to locate and extract ROIs. Once the ROIs have been extracted, they are then passed to the second stage of the framework, which is the classification stage.

**U.S. Government Purpose Release**

### **Social Tagging of Mission Data**

**NPO-46827-1**

This software provides a method for creating arbitrary tags for mission data. Two items with the same tag are related to each other and can be searched (or recalled) through the tag. These tags are shared by all users.

**U.S. Government Purpose Release**



**Software for Losslessly Compressing One-Dimensional Data Samples into Fixed-Length Data Packets****NPO-45942-1**

This software could be used for the compression of one-dimensional data sources that must be transmitted in fixed-length packets under significantly complex constraints. It was designed for seismic and ultrasound applications.

**U.S. Government Purpose Release****Space Images for NASA JPL****NPO-47264-1**

The Space Images for NASA JPL is an iPhone application system that allows the General Public to view and rate images directly from an individual's iPhone. This system consists of four distinguishing components: image repository, database, server-side logic, and iPhone application. The image repository contains JPL planetary and mission images from various projects. The database stores the image information, as well as the user rating. The server-side logic retrieves the image information from the database and categorizes each image for display.

**U.S. Government Purpose Release****Space Packetized Telemetry System (SPoTS)****MSC-25183-1**

The Space Packetized Telemetry System (SPoTS) is a real-time telemetry viewer. Display screens are built using a custom display builder with telemetry data fields, plot objects, data widgets, and standard objects. Measurement IDs are loaded from XTCE files.

**U.S. Government Purpose Release****SPACKLE: Scripts Providing a Cool Kit of Telemetry Enhancing Tools****NPO-45700-1**

This software consists of a set of individual tools (written in Perl, C, and C++) to perform a variety of useful searches and shortcuts that help streamline MER mission operations. Functions include: generating text-only, annotated, and Web-enhanced views of command sequences; labeling integer enumerations with their symbolic meanings in text messages and engineering channels; systematic detection of corruption within data products; text-only displays of data product catalogs and downlink status; validation and labeling of commands related to data products; and simplified construction and simulation of command sequences.

**U.S. Government Purpose Release****Sparse Superpixel Unmixing for Hyperspectral Image Analysis****NPO-47038-1**

This algorithm computes statistically likely combinations of constituents based on a set of possible constituent minerals (with uncertain abundances). The approach uses a library of source spectra from laboratory experiments or previous remote observations. A superpixel segmentation strategy improves analysis time by orders of magnitude.

**U.S. Government Purpose Release****Spatial Resolution Verification Tool (SRVT)****SSC-00339**

An automated Spatial Resolution Verification Tool (SRVT) was developed to rapidly determine the spatial resolution characteristics of remotely sensed aerial and satellite imagery. Most current methods for assessing spatial resolution characteristics of imagery rely on pre-deployed engineered targets and are performed only at selected times within pre-selected scenes. The SRVT addresses these insufficiencies by finding uniform, high-contrast edges from urban scenes and then using these edges to determine standard estimators of spatial resolution, such as the modulation transfer function (MTF) and the relative edge response (RER).

**U.S. Government Purpose Release**

### **Spatial Standard Observer**

**ARC-14569-1**

The Spatial Standard Observer (SSO) is a computer program for measurement and specification of the perceptual intensity of a visual image, or of the perceptual distance between two visual images. The SSO operates on a digital image or a pair of digital images. It computes a numerical measure of the perceptual strength of the single image, or of the difference between the images.

**U.S. Government Purpose Release**

### **Spectral Analysis Tool (SAT), Version 6.2**

**NPO-43129-1**

The SAT computer program calculates signal spectra, bandwidths, and interference effects for several families of modulation schemes found commonly in radio, satellites, and space communications. It is primarily used for spectrum management purposes to examine the effects of radio frequency interference on a satellite communication system.

**U.S. Government Purpose Release**

### **Spitzer Telemetry Processing System**

**NPO-47803-1**

Multi-mission Image Processing Lab Software (MIPL) processes spacecraft telemetry and distributes the resulting data products to the science community in a timely fashion. The Spitzer telemetry processing system (SirtfTImProc) processes telemetry from the Spitzer spacecraft and delivers Level 0 products to the Spitzer Science Center (SSC) and Ball Aerospace. SirtfTImProc is a unique system with automated error-notification and recovery with a real-time continuous service that can go quiescent after periods of inactivity. This software accomplishes the following: (1) processes 2 gigabytes of telemetry and delivers Level 0 science products to the end user in 4 hours; (2) provides analysis tools so the operator can manage the system and trouble-shoot problems; and (3) automates telemetry processing in order to reduce staffing costs.

**U.S. Government Purpose Release**

### **Stata Code for Finding the “Optimal Alpha” for Several Statistical Tests**

**MSC-25682-1**

Two main types of errors occur in statistical hypothesis testing: type I errors reject a default hypothesis when it is actually correct, and type II errors fail to reject the default hypothesis when it is incorrect. The probability of type I errors is conventionally denoted as alpha, while the probability of type II errors is conventionally denoted as beta. The NASA code developed in this effort calculates the optimal alpha in Stata statistical software for several versions of statistical hypothesis tests.

**U.S. Government Purpose Release**

### **Structural Analysis Routines (STARS)**

**DRC-011-003**

Structural Analysis Routines (STARS) is an efficient, cost-effective, and unique computer program that analyzes a variety of practical engineering problems. The software is a fully integrated, multidisciplinary, finite-element-based, graphic-oriented analysis tool that combines individual modules to solve complex engineering problems. STARS can be used for a range of applications, including structural analysis, heat transfer, linear aerodynamics, and computational fluid dynamics (CFD), as well as coupled linear and CFD-based (aeroelastic, aeroacoustic, and aerothermoelastic) analysis. Because of the tool's highly integrated nature, it has broad application across many engineering disciplines.

**U.S. and Foreign Release**

### **Sun Format Database (SunAcc) File Read/Write Library**

**MFS-32397-1**

The Sun Format Database (SunAcc) was developed to fulfill a need for local native storage of space shuttle main engine (SSME) test data. While the file format itself is native to the Sun UNIX platform, the read/write library was developed to be a cross-platform tool and is compatible with a variety of UNIX and Windows platforms.

**U.S. Release Only**



**Support Routines for In-Situ Image Processing****NPO-47728-1**

These programs are part of the operational image processing system as used by MER and Phoenix, and are baselined for use by MSL. As such, they are on the critical path for the daily command cycle of these missions, and the products they create are used by the Rover planners and others to understand the environment surrounding the spacecraft, plan operations, and ensure their safety.

**U.S. Government Purpose Release****Surface Water Indication Model (SWIM)****LAR-19013-1**

SWIM is a user-friendly tool that allows users to identify surface water from the most current imagery available or monitor temporal changes of surface water in their management areas. The code provides calculations for water indices and thresholding, as well as algorithms for slope and aspect creation.

**Open Source****Surfer: An Extensible Pull-Based Framework for Resource Selection and Ranking****ARC-15295-1**

Surfer examines the pool of potential grid resources and extracts the highest-ranking resources that meet user-specified constraints and preferences. The technology has been implemented as a grid service that is compliant with an Open Grid Services Infrastructure (OGSI), and it can also be embedded directly into Java applications through its application programming interface or into non-java applications through its XML-based command-line interface.

**Open Source****Swim: A Software Information Metacatalog for the Grid****ARC-15469-1**

Swim is a software information service for the grid built on top of the NASA-developed Pour framework. Software information is periodically gathered from native package managers on FreeBSD, Solaris, and IRIX, as well as the RPM, Perl, and Python package managers on multiple platforms.

**Open Source****TestEVAL: A Python Software Tool to Assist in Mechanical Testing****GSC-17288-1**

TestEVAL was generated to provide a tool for processing and plotting mechanical test data. It is used both for handling pre-test planning and post-test processing. The software provides plotting capability for different data formats, including NASTRAN xyplot punch files, Excel files, CSV files, MATLAB files, and network communication via pipes. The data can be plotted in linear, log, or semi-log scales.

**U.S. Government Purpose Release****Three-Dimensional Grids About Anything by Poisson Equations (3D GRAPE) AL, Version 3****LAR-17758-1**

The 3.0 suite of 3DGRAPE/AL software advances the state of the art in structured volume grid generation by implementing a new matching point block-to-block boundary condition on adjacent faces of two blocks. The software also has two preprocessors that enable rapid development of the input data to run 3DGRAPE/AL.

**U.S. Release Only****Thrust Impulse Measurement (TIM) Filter Software****NPO-45825-1**

The TIM filter is presently being used for small-force/thruster calibration during Phoenix mission flight operations, and it is a key component of orbit determination and maneuvering strategy to precisely navigate the spacecraft to the top of the "entry corridor" for its descent to the surface of Mars.

**U.S. Government Purpose Release****TIE 0.4: The Imagery Exchange for the NASA Global Imagery Browse Services (GIBS) Project****NPO-49883-1**

This software is an extension of the HORIZON 5 framework. It delivers horizontal scaling solutions for image capturing to automate the generation of the Meta Raster Format (MRF) imagery products.

**Open Source**

**Tiled Web Map Service (WMS) Server****NPO-44685-1**

This technology processes WMS requests that comply with a given request grid from an existing tile data set. It also generates the KML configuration files required to access WMS tiles.

**U.S. Government Purpose Release****Tiled WMS/KML Server, Version 2****NPO-47308-1**

Integrating tiled WMS and KML affords easier access to NASA satellite images or data. Because very high data rates can be achieved, this software is suitable for a public-access Web server.

**U.S. Government Purpose Release****Tolerance Domain Specific Language****LAR-17546-1**

This sensitivity task employs the Monte Carlo method. Thousands of simulations are run with randomly varied input parameters, and then statistical correlations are computed to determine the sensitivity of output parameters to each input parameter.

**Open Source****Tool for Interactive Plotting, Sonification, and 3D Orbit Display (TIPSOD)****GSC-14732-1**

TIPSOD is a software application designed for interactive, animated, 4D (space and time) visualization of satellite orbits. The technology is implemented in Java 3D and is an extension to the existing Satellite Situation Center Web (SSCWeb) 2D static orbit graphics. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/tipsod/index.php>

**Open Source****TrickFMI: A Functional Mockup Interface (FMI)****Standard Implementation for Trick Base Models and Simulations****MSC-26230-1**

This software supports FMI-based model exchange with Trick-based simulations.

**Open Source****Turbidity Assessment Over Water (TAOW)****LAR-19215-1**

This Python script pre-processes Landsat 8 and Sentinel-2 datasets that were atmospherically corrected by ACOLITE.

**Open Source****Using CTX Image Features to Predict HiRISE-Equivalent Rock Density****NPO-46989-1**

This software uses Gray Level Co-occurrence Matrix (GLCM) features to model the texture in CTX images. Local image intensity statistics are also extracted from the images. The geomorphology of the underlying terrain is taken into account by using geomorphic maps produced by geologists during the landing site selection process.

**U.S. Government Purpose Release****Using World Wide Web Metaphors for Search Mission Data****NPO-46832-1**

The search interface in the MSLICE program works via a ReST-based URL for any query that the user constructs. In other words, as the user adds and removes components of the search a URL is constructed that corresponds to that search. By leveraging this URL, it is possible to emulate much of the functionality of a Web browser within the search features of the desktop application MSLICE. Back and forward buttons allow the user to quickly and easily move through their search history, while the refresh button reloads the query to display any new data that may match the current query.

**U.S. Government Purpose Release**

**V-FASTR Radio Transient Classifier****NPO-49870-1**

The V-FASTR candidate classifier computes ten features to describe each candidate and generates a predicted class. It employs a trained random forest classifier to predict the class for each new candidate (pulse, artifact, or none), then consults a database of known pulsars to further refine its predictions. If a candidate classified as “pulse” matches a known pulsar (in location on the sky and dispersion measure), it is re-classified as “pulsar.” If there is no known match for a pulse, it is re-classified as “good candidate” since it may indicate the discovery of a new pulsar or other unknown phenomena. Predictions that are sufficiently confident are added to the meta-data associated with the candidate and used to reduce the number of candidates that require human review.

**U.S. Government Purpose Release****Vectorization of Global Flood Monitoring System Using Topojson****GSC-17169-1**

This capability allows for the generation of vectors by reading global flood monitoring data, processing the data, and generating aTopoJSON-encoded file for visualization on the Web.

**Open Source****VICAR: Video Image Communication and Retrieval****NPO-49845-1**

VICAR is a general-purpose image processing software system that has been developed since 1966 to digitally process multi-dimensional imaging data. It is used for a variety of other applications including biomedical image processing, cartography, Earth resources, astronomy, and geological exploration.

**Open Source****Viewpoints: Software for Visualization of Multivariate Data****ARC-16019-1**

This software application allows the interactive visualization of multivariate data using a variety of standard techniques. Viewpoints can be used with extremely large data sets.

**Open Source****Visual Environment for Remote Virtual Exploration (VERVE), Version 2****ARC-16457-1A**

VERVE is a 3D visualization system that provides situational awareness, science analysis tools, and data understanding capabilities for robotics researchers and exploration science operations. The technology is highly modular and extensible and includes a 3D scene-graph database, an interactive 3D viewer, and associated graphical user interfaces to OSGI plugin-based applications.

**Open Source****Visual PEF Reader (VIPER)****NPO-47509-1**

The PEF Viewer make it easy and quick to find and graphically display pertinent information for a sequence. The front-end of the tool contains much of the aesthetically appealing material for viewing. The timestamp is displayed in the top left corner and highlighted details are displayed in the bottom left corner. The time bar stretches along the top of the window, and the rest of the space is allotted for blocks and step-functions. A preferences window is used to control layout.

**U.S. Government Purpose Release****Visual System for Browsing, Analysis, and Retrieval of Data (ViSBARD)****GSC-15744-1**

ViSBARD provides a way of visualizing multiple vector and scalar quantities as measured by many space-craft at once. The data are displayed three-dimensionally; may be displayed either as connected lines or as points; and allow the rapid determination of vector configurations and correlations between many measurements at multiple points. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/visbard/index.php>

**Open Source**

**VOCAL****LAR-18710-1**

VOCAL offers an easy-to-use GUI interface that allows users to open CALIPSO satellite data and visualize that data on a plot. Users can then select areas of the plot by drawing “shapes” around those areas and label shapes with attributes and notes.

**Open Source****Water Detection Based on Color Variation****NPO-47088-1**

The primary goal of this software is to process a robust water and mud classifier for all terrain conditions for both day and night operations. This may be important for rover operations during exploration on other planetary bodies by future NASA missions.

**U.S. Government Purpose Release****Water Detection Based on Sky Reflections****NPO-47092-1**

Aerial water detection is important for tracking changes in water boundaries that occur due to changes in water elevation. From an aerial platform (manned or unmanned), new terrestrial water bodies can be automatically detected at far range and added to a database.

**U.S. Government Purpose Release****Water Rotational Level Excitation and Emission Line Spectrum Modeling for MIRO****NPO-46508-1**

This tool is used to determine the water molecule production rates at comet surface.

**U.S. Government Purpose Release****WinPlot Graphical Display System****MFS-31664-1**

WinPlot is a powerful desktop graphical analysis tool that allows the user to generate displays of unrestricted amounts of data. It was developed to fulfill the need for fast and easily managed graphical displays of NASA test articles and facilities. WinPlot features include seamless displays of real-time and post-test data with time and event-time synchronization of data from multiple sources.

**General Public Release****Worldview Satellite Imagery Browsing and Downloading Tool****GSC-17111-1**

Worldview is a software tool designed for interactively browsing and downloading imagery from NASA's Earth-observing satellites. Building upon a set of open-source mapping and user interface libraries, it provides an environment to visually discover interesting phenomena as observed by NASA satellites and then download the data for further analysis. The software was originally designed to address the needs of the near-real-time applications community to provide relevant information for time-critical scenarios such as wildfire and flood management. As such, satellite imagery is available to be viewed in Worldview within four hours of observation.

**Open Source****XML to HDF-EOS Convertor****GSC-15017-1**

This software program takes an XML representation of the contents of a Hierarchical Data Format-Earth Observing System (HDF-EOS) file and recreates the file from that description. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/xml2he/index.php>

**Open Source****XML to ODL Convertor****GSC-15006-1**

This program translates an XML representation of Hierarchical Data Format-Earth Observing System (HDF-EOS) ODL metadata back to the ODL format. Please visit the following URL for additional information: <http://opensource.gsfc.nasa.gov/projects/xml2odl/index.php>

**Open Source**

### **XML Translator for Interface Descriptions**

**NPO-46447-1**

This software addresses the inconsistency in interface implementation between FPGAs and software that can cause problems in testing, identifying, and fixing failures in NASA space flight systems.

**U.S. Government Purpose Release**

### **xvd Image Display Program**

**NPO-46412-1**

This program is designed to display large (multiple-gigabyte) images efficiently and includes several basic image processing functions. It has been the de-facto standard image display program used within the Jet Propulsion Laboratory's Multimission Image Processing Lab (MIPL) since 1995. It runs on UNIX systems that have X Windows and works well over remote X Windows connections.

**U.S. Government Purpose Release**

### **XvciImage: X Windows Widget for Image Display**

**NPO-46922-1**

XvciImage is a high-performance X Windows (Motif-compliant) user interface widget for displaying images. It handles all aspects of low-level image display.

**U.S. Government Purpose Release**





# 15

## Aeronautics

Air Traffic Management Tools, Modeling  
and Simulation Tools





## Featured Software

### **ARC2D (Efficient Two-Dimensional Solution Methods for Navier-Stokes Equations)**

**ARC-12112-1**

ARC2D is a computational fluid dynamics program developed at Ames Research Center specifically for two-dimensional airfoil and simply connected geometries. The program uses implicit finite-difference techniques to solve two-dimensional Euler equations and Navier-Stokes equations. It is based on the beam and warming implicit approximate factorization algorithm in generalized coordinates. Methods are either time-accurate or accelerated non-time-accurate steady-state schemes. The evolution of the solution through time is physically realistic; good solution accuracy is dependent on mesh spacing and boundary conditions.

**U.S. Release Only**

### **Chimera Grid Tools, Version 2.1**

**ARC-16025-1A**

The Chimera Grid Tools software package contains a collection of software tools for performing geometry processing, surface and volume grid generation, grid manipulation and diagnostics, flow solver input preparation, multi-body dynamics input preparation and animation, flow solution visualization, debris trajectory analysis input preparation, strand grid and AMR Cartesian grid visualization, flow solution post-processing analysis including forces and moments computation, and convergence history visualization.

**U.S. Release Only**

### **Future Air Traffic Management Concepts Evaluation Tool (FACET)**

**ARC-14653-1**

FACET provides a simulation environment for evaluating novel air traffic management concepts, including air traffic control and traffic flow management. Please visit the following URL for more information about the technology: <http://www.aviationsystemsdivision.arc.nasa.gov/research/modeling/facet.shtml>

**U.S. and Foreign Release (Academic)**

### **Langley Stability and Transition Analysis Code (LASTRAC)**

**LAR-16260-1**

LASTRAC is a C++ code that analyzes compressible boundary-layer stability and performs transition prediction using the state-of-the-art Linear Stability Theory (LST) or Parabolized Stability Equations (PSE) methods.

**U.S. Release Only**



### **Multi-Aircraft Control System (MACS) Software**

**ARC-14776-1**

MACS increases the overall realism of human-in-the-loop air traffic control (ATC) simulations. The system accommodates multiple onsite or offsite participants (e.g., pilots, controllers, airline dispatchers, or observers) and provides simulations from either a pilot's view or a controller's view.

**U.S. Government Purpose Release**

### **OVERFLOW 2: Overset Grid Computational Fluid Dynamics Flow Solver with Moving Body Capability (OVERFLOW)**

**LAR-17079-1**

OVERFLOW 2 is a computer code for simulating viscous, compressible fluid flow about complex aerodynamic configurations. The technology solves the Reynolds-averaged Navier-Stokes equations using structured, overset computational grids. It includes the capability for simulating multiple moving bodies acting under prescribed or aerodynamically forced motion. OVERFLOW 2 is a merge of the previously developed OVERFLOW 1.8 and OVERFLOW-D codes.

**U.S. Release Only**

### **Pegasus 5.2: Software for Automated Pre-processing of Overset CFD Grids**

**ARC-15117-1A**

The Pegasus software is used as a pre-processor for overset-grid computational fluid dynamics (CFD) simulations. It provides hole-cutting and connectivity information. Main features include: automated hole-cutting algorithms, a projection scheme for fixing small discretization errors in the overset surface; efficient interpolation search methods; hole-size optimization based on adding additional layers of fringe points; and an automatic restart capability. The code can run in parallel using the Message-Passing Interface (MPI) standard. Capabilities added in this version include: support for cell-centered grids; a triple-fringe option; automated domain decomposition into multiple hole-cutters; improved parallel execution load-balancing algorithm; and additional minor enhancements.

**U.S. Release Only**

### **PLOT3D, Version 4.1**

**ARC-14400-1**

PLOT3D is a computer graphics program designed to visualize the grid and solutions of structured computational fluid dynamics (CFD) datasets. Version 4.1 uses the OpenGL/GLUT graphics library. Several new features have been added to the code. These include: automatic computation of grid coordinate minimum/maximum; an orphan point plotting function; the ability to read double-precision unformatted data; negative grid index processing; random specification of colors for different walls; and simultaneous specification of walls and subsets for all zones.

**U.S. Release Only**



**Aeronautical Data Link and Radar Simulator (ADRS)****ARC-15390-1**

The ADRS distributed “simulation hub” allows multiple air traffic simulation components (e.g., pilot and controller operator stations and airborne and ground-based decision support tools) to be interconnected in the same simulation. The technology runs on both Windows and UNIX platforms.

**U.S. Government Purpose Release****Aircraft NOise Prediction Program (ANOPP)****LAR-16809-GS**

ANOPP provides a capability to predict noise from aircraft in flight, accounting for the effects of the aircraft configuration, its airframe, its engines, its operations, and the atmosphere. This is accomplished by computing the source noise from each aircraft component that composes the engine and airframe and propagating these results through the atmosphere to far-field observers. ANOPP computes the acoustic power of aircraft noise sources as a function of polar and azimuthal angles, frequency, and time along a user-defined flight path.

**U.S. Release Only****Aircraft NOise Prediction Program 2 (ANOPP2)****LAR-18567-1**

The next-generation Aircraft NOise Prediction Program (ANOPP), called ANOPP2, provides the capability and framework to integrate acoustic approaches for aircraft noise component prediction, propulsion system installation effects, and overall sound propagation to the far-field. The predictions from ANOPP2 include the fidelity and flexibility required to predict outside the current experience base. A focal point of ANOPP2 is a combination of acoustic approaches; that is, to offer several options depending on requested fidelity and execution speed. This allows ANOPP2 to include fast prediction methods for design optimization, as well as the fidelity required to provide insight into controlling noise physics.

**U.S. and Foreign Release****Airport Traffic Conflict Detection, Alerting, and Resolution for Collision Avoidance on and Near the Airport Surface****LAR-17679-1**

Based on airport traffic surveillance data, this software tool provides an onboard method for detecting potential conflicts and collisions between multiple classes of aircraft and vehicles on and near the airport surface and generates alerts and resolution advisories.

**U.S. Government Purpose Release****Airspace Concepts Evaluation System (ACES)****ARC-15068-1**

From gate departure to gate arrival, ACES is a dynamic, event-based computer simulation of aircraft operations in the National Airspace System (NAS). The technology’s software-agent infrastructure provides flexibility in configuring custom simulations and enables explicit modeling of command and control entities operating within the NAS.

**U.S. and Foreign Release (Academic)****Apparatus for Evaluating Software Decision Logic (ADEPT)****ARC-14928-1A**

The ADEPT design tool integrates a graphical user interface with an automation decision-logic application. The software generates testable prototypes for traditional usability evaluations. Exportable products can be added to the base architecture.

**U.S. and Foreign Release****ARC2D: Efficient Two-Dimensional Solution Methods for Navier-Stokes Equations****ARC-12112-1**

ARC2D is a computational fluid dynamics program developed at the Ames Research Center specifically for two-dimensional airfoil and simply connected geometries. The program uses implicit finite-difference techniques to solve two-dimensional Euler equations and Navier-Stokes equations. It is based on the Beam and Warming implicit approximate factorization algorithm in generalized coordinates. The methods are either time accurate or accelerated non-time accurate steady state schemes. The evolution of the solution through time is physically realistic; good solution accuracy is dependent on mesh spacing and boundary conditions.

**U.S. Release Only**

**Automated Conflict Resolution for Air Traffic Control (AAC), Versions 1 and 2** **ARC-15581-1A**

The AAC algorithm generates resolution trajectories through a multi-step iterative process: (1) a resolution generator performs the analytical and logical functions; (2) a 4D trajectory synthesizer integrates aircraft equations of motion using detailed models of aircraft performance, operational procedures, and atmospheric conditions; and (3) a conflict detector compares trial resolution trajectories against the 4D trajectories of all other aircraft in an airspace of interest.

**U.S. Government Purpose Release**

**BL2D: Two-Dimensional and Axisymmetric Boundary Layer Code** **LAR-16713-GS**

BL2D is an efficient and fourth-order-accurate method to compute two-dimensional and axisymmetric boundary layers on aerospace vehicle wings from low-speed to hypersonic speeds. Aerospace applications include boundary-layer stability analysis, transonic wing design, and laminar flow wing design.

**U.S. Release Only**

**Center TRACON Automation System (CTAS)** **ARC-15309-1**

CTAS provides automation tools for planning and controlling arrival air traffic. The technology generates advisories designed to increase fuel efficiency, reduce delays, and provide automation assistance to air traffic controllers. Please visit the following URL for additional information: <http://www.aviationsystemsdivision.arc.nasa.gov/research/foundations/index.shtml>

**U.S. Government Purpose Release**

**Cockpit Displays of Traffic Information (CDTI) Software Suite** **ARC-14581-1**

CDTI consists of two main components: (1) the Pulse Predictor for Traffic Display Tool, which allows a user to compare a representation of his own expected trajectory with those of other traffic elements; and (2) the Flight-Deck-Based Flight Plan Modification Tool, which allows flight crew members to display and modify their flight plans graphically, check for predicted conflicts, and load changes into the flight management system.

**U.S. Government Purpose Release**

**Control Allocation Technique to Recover from Pilot-Induced Oscillations (CAPIO)** **ARC-17115-1A**

The CAPIO system is designed to operate within an aircraft's flight control system to alleviate pilot-induced oscillation tendencies in an aircraft without adversely impacting aircraft efficiency. The main idea behind the concept is to minimize the phase lag introduced to the system due to control surface rate saturation. The CAPIO system is designed specifically for multi-input/multi-output applications. This implementation utilizes: (1) online estimation of phase lag introduced by control surface rate limiting, (2) online adjustment of control allocation weighting terms, and (3) an optimization algorithm that calculates the optimal control solution.

**U.S. and Foreign Release**

**Decelerator System Simulation (DSS)** **MSC-25936-1**

Decelerator System Simulation (DSS) is a FORTRAN software tool used to predict the motion of a vehicle coupled to a parachute. Separate equations of motion for the parachute and vehicle are employed. DSS was modified from an existing NASA software program for the space shuttle solid rocket booster (SRB) recovery system simulation.

**U.S. Government Purpose Release**

**Evolutionary Mission Trajectory Generator (EMTG)** **GSC-16824-1**

EMTG is a global trajectory optimization tool intended for interplanetary mission design. The technology automatically searches for the optimal sequence of planetary flybys and propulsive maneuvers for maximizing payload delivery at a destination. Designed for minimal user oversight, EMTG requires only start location, destination, allowable launch-date range, allowable flight time, and minimal spacecraft hardware information.

**Open Source**



**EZ4D****LAR-16798-GS**

NASA's EZ4D software is a time-accurate three-dimensional Navier-Stokes solver for unstructured meshes. The software framework utilizes generic template programming in C++ to allow users to extend the code for simulations of any general conservation laws. Shared-memory multi-thread, as well as distributed-memory MPI paradigms are implemented in EZ4D to facilitate efficient large-scale parallel numerical simulations.

**U.S. Release Only****EZASE: Easy Aeroservoelasticity****DRC-014-036**

This is an easy-to-use MATLAB-based finite element modeling and simulation tool for aeroservoelastic analysis of rectangular wings with trailing-edge control surfaces. It includes a tutorial on structural finite element modeling (FEM\_Tutorial.m) using elements such as 12-DOF plates and 6-DOF beams. The aero tutorial (DLM\_VLM\_Tutorial.m) shows how to code doublet lattice and vortex lattice (with symmetry capability). Together the tutorials can be used to compare to experimental studies such as ground vibration testing, cantilever beam analysis, as well as wind tunnel testing.

**Open Source****Finite-Rate Chemistry, Overset-Grid, Dual-Time Combustion-Reentry Code****ARC-15601-1**

This technology modifies the OVERFLOW code for finite rate and equilibrium chemistry by substituting the perfect gas model built into the code with a model assuming a gas made up of a mixture of thermally perfect gases. Four extra field variables were added, corresponding to pressure, temperature, coefficient of thermal conductivity, and the new pressure derivative X.

**U.S. Government Purpose Release****Flight Awareness Collaboration Tool (FACT)****ARC-17793-1**

The Flight Awareness Collaboration Tool (FACT) is designed to assist airline dispatchers and others in managing winter weather events. It gathers all of the necessary weather, air traffic, airport, and other information onto one screen. FACT can be used by airline dispatchers to manage the airline fleet prior to and including the day of the winter weather event. It also has built-in automation tools that can predict the impact of winter weather on airport capacity.

**U.S. Government Purpose Release****Flight Deck Predictive Weather Display and Decision Support Interface****ARC-16833-1**

This three-method suite supports the display of flight deck predictive weather and pilot weather avoidance decisions. Concepts behind the different methods can be combined and applied for manipulating and displaying predictive weather forecast information on different platforms for different end users.

**U.S. Government Purpose Release****Flight Optimization System (FLOPS) Software****LAR-18934-1**

FLOPS is a multidisciplinary system of computer programs for conceptual and preliminary design and evaluation of advanced aircraft concepts. It consists of six primary modules: weights, aerodynamics, propulsion data scaling and interpolation, mission performance, takeoff and landing, and program control.

**General Public Release****FUN3D, Version 13.3****LAR-19247-1**

FUN3D is a suite of computational fluid dynamics simulation and design tools that uses mixed-element unstructured grids in a large number of formats, including structured multiblock and overset grid systems. A discretely exact adjoint solver enables efficient gradient-based design and grid adaptation to reduce estimated discretization error.

**U.S. Release Only**

**FUN3D — Generic Gas Path****LAR-17778-1**

This software package includes FUN3D and Version 13 of the Generic Gas Path. The modules used in the generic gas path enable simulation of hypersonic flows on unstructured grids, including accurate resolution of heating and shear. The routines in PHYSICS\_MODULES enable simulation of mixtures of thermally perfect gases in thermo-chemical equilibrium and non-equilibrium. The routines in PHYSICS\_DEPS enable coupling of the new gas modules to the existing FUN3D infrastructure. These algorithms also address challenges in the simulation of shocks and boundary layers on tetrahedral grids in hypersonic flows.

**U.S. Release Only****Future Air Traffic Management Concepts Evaluation Tool (FACET)****ARC-14653-1**

FACET provides a simulation environment for evaluating novel air traffic management concepts, including air traffic control and traffic flow management. Please visit the following URL for more information about the technology: <http://www.aviationsystemsdivision.arc.nasa.gov/research/modeling/facet.shtml>

**U.S. and Foreign Release (Academic)****Generic Command and Telemetry Applications for the Core Flight Software Framework (CI-TO)****MSC-26175-1**

This set of applications provides general-purpose, configurable, and extensible spacecraft commanding and telemetry functionality supporting a wide variety of communications protocols.

**U.S. Government Purpose Release****Generic Transport Simulation Model (GTSM)****LAR-18909-1**

This simplified flight simulation model of a typical transport aircraft uses the Langley Standard Simulation in C++ framework. Containing no proprietary data, it has been designed to provide similar, but not exact, representation of aircraft performance. The emphasis is on flexibility and simplicity. Most of the coefficients are linearized and based on the set of parameters provided in Roskam, Airplane Flight Dynamics (Reference 1) when available.

**U.S. Government Purpose Release****GFR: Glenn Flux Reconstruction****LEW-19709-1**

GFR is a high-order computational fluid dynamics (CFD) Fortran code for large-eddy simulations. It is based on the simple and efficient flux reconstruction method and accurate to an arbitrary order through a user-supplied input parameter. It is currently capable of using unstructured grids containing quadrilateral or hexahedra elements.

**Open Source****Goddard Trajectory Determination System (GTDS), Release 2008.01****GSC-15539-1**

This technology addresses minor software change requests written against the 2002 release of the Goddard Trajectory Determination System.

**U.S. Government Purpose Release****Grid Express (GridEx): A Framework-Based Unstructured Grid Generation Tool****LAR-16423-1**

GridEx is an interactive software system developed by Geometry Laboratory of the NASA Langley Research Center for the generation of unstructured meshes. The software integrates native CAD geometry access, multiple unstructured meshing algorithms, and interactive 3D computer graphics through a graphical user interface (GUI) resulting in a package that is both powerful and easy to use.

**U.S. Release Only**

**Higher-Fidelity Conceptual Design and Structural Optimization (HCDstruct), Version 2.0 LAR-18901-1**

HCDstruct now includes an aerostructural modeling and optimization capability for generalized tube and wing aircraft configurations. This tool permits the rapid, parameterized creation of aeroservoelastic finite-element models for general tube and wing aircraft configurations and constructs all files required to perform the subsequent aerostructural optimization using NASTRAN software. The methods employed offer a novel physics-based sizing capability for unconventional aircraft configurations for conceptual design environments.

**U.S. Release Only**

**Inverse Heat Conduction Solver Using MATLAB (IHC Solve) LAR-18924-1**

This MATLAB software reads in temperature data measured from two thermocouples embedded in a heat-conducting specimen. The software then reads in the thermophysical properties for the heat-conducting specimen. After filtering noise from the measured temperature data, IHC Solve uses the filtered data and thermophysical properties to solve both a direct and inverse heat conduction problem to estimate both temperature and heat flux on the external surface of the specimen.

**U.S. Government Purpose Release**

**Langley Stability and Transition Analysis Code (LASTRAC) LAR-16260-1**

LASTRAC is a C++ code that analyzes compressible boundary-layer stability and performs transition prediction using the state-of-the-art Linear Stability Theory (LST) or Parabolized Stability Equations (PSE) methods.

**U.S. Release Only**

**Loudness Code for Asymmetric Sonic Booms (LCASB) LAR-16954-1**

LCASB is a computer code to calculate the loudness of a sonic boom time history. Calculations of several noise metrics are provided. The code can calculate the loudness of the front and back parts of the sonic boom separately.

**U.S. Release Only**

**MFSim: Multi-Fidelity Simulation ARC-17449-1**

MFS (Multi-Fidelity Simulator) is a pluggable framework for creating an air traffic flow simulator at multiple levels of fidelity. The framework is designed to allow low-fidelity simulations of the entire U.S. Airspace to be completed very quickly (on the order of seconds). The framework allows higher-fidelity plugins to be added to allow higher-fidelity simulations to occur in certain regions of the airspace concurrently with the low-fidelity simulation of the full airspace.

**Open Source**

**Modified Vortex Lattice (MVL-15) LAR-18774-1**

MVL-15 is a Modified Vortex-Lattice (MVL) aerodynamics analysis code. The primary modification is the incorporation and assignment of viscous aerodynamics data associated with the wing section geometry to the inviscid vortex-lattice solution via iterative computational procedures. The strategy essentially converts an inviscid and purely analytic linearized method to a semi-empirical blend that retains the rapid execution speed of the linearized method while empirically characterizing the viscous aerodynamics at all spanwise lattice points. For the analysis of airplane configurations consisting of more than one wing, the resulting spanwise section aerodynamics can be integrated to determine the aerodynamics of each wing, both separately and combined. As implemented, the methodology inherently provides the capability to determine the non-linear viscous effects on lift and drag at relatively high angles of attack to identify the maximum lift coefficient and characterize the onset of stall.

**U.S. Government Purpose Release**



### **Multiphysics Algorithm with Particles (MAP)**

**LAR-18801-1**

MAP is a multidimensional adaptive Cartesian implementation of the direct simulation Monte Carlo (DSMC) method with parallelization capabilities using MPI. The DSMC method is widely used for modeling of gas flows through the computation of motion and collisions of representative molecules. The software achieves a quality solution with minimal user input and control by performing dynamic adaptations of the grid, local time step, and surface temperature.

**U.S. Release Only**

### **NASA Design and Analysis of Rotorcraft (NDARC)**

**ARC-16265-1**

NDARC software is an aircraft system analysis tool that supports both conceptual design efforts and technology impact assessments of rotorcraft that meet specified requirements. The architecture of the NDARC code accommodates configuration flexibility, a hierarchy of models, and ultimately multidisciplinary design, analysis, and optimization.

**U.S. and Foreign Release**

### **“NASA Glenn Research Center: The Early Years” for iPad**

**LEW-18993-1**

This application contains imagery and descriptions from the Glenn Research Center image archive. Photos and data cover the period from 1941–1979. The software has been compiled and bundled as an iOS app for the iPad and intended for release through the Apple App Store.

**Open Source**

### **Orbit-Determination Toolbox**

**GSC-15728-1**

Based on MATLAB and Java, the flexible Orbit-Determination Toolbox is intended primarily for the advanced mission analysis that might be performed in the concept exploration, proposal, and early design phases.

Visit the following URL for more information: <http://opensource.gsfc.nasa.gov/projects/ODTBX/>

**Open Source**

### **OVERFLOW 2: Overset Grid Computational Fluid Dynamics Flow Solver with Moving Body Capability (OVERFLOW)**

**LAR-17079-1**

OVERFLOW 2 is a computer code for simulating viscous, compressible fluid flow about complex aerodynamic configurations. The technology solves the Reynolds-averaged Navier-Stokes equations using structured, overset computational grids. It includes the capability for simulating multiple moving bodies acting under prescribed or aerodynamically forced motion. OVERFLOW 2 is a merge of the previously developed OVERFLOW 1.8 and OVERFLOW-D codes.

**U.S. Release Only**

### **Ozone: Ordinary Differential Equation and Optimal Control Solver**

**LEW-19703-1**

Ozone is a Python software package that facilitates the solution of ordinary differential equations (ODEs) and optimal control problems. It is unique among similar libraries because of its capability to compute derivatives of the ODE-integrated outputs with respect to parameters, initial conditions, and time interval. The software allows Ozone-based ODE models to be integrated in larger, potentially multidisciplinary models while using adjoint-type methods to compute derivatives for the larger model. In terms of the ODE integration, Ozone adopts the general linear methods (GLM) equations, allowing it to easily support a large library of Runge-Kutta and linear multistep methods. Ozone also supports multiple integration formulations consisting of time-marching, solver-based, and optimizer-based approaches to solving the ODE.

**Open Source**

### **Parallel Dantzig-Wolfe Decomposition**

**ARC-16432-1**

This implementation of the Dantzig-Wolfe decomposition is built upon the GNU Linear Programming Kit. The technology provides a command-line tool for solving properly decomposed linear programs.

**Open Source**



## **PCBoom, Version 6**

**LAR-18623-1**

PCBoom is a full ray trace sonic boom program that calculates sonic boom footprints and signatures from flight vehicles performing arbitrary maneuvers. It computes detailed ground signature shapes starting from a variety of near-field signature definitions.

**U.S. and Foreign Release**

## **Pegasus 5.2: Software for Automated Pre-Processing of Overset CFD Grids**

**ARC-15117-1A**

The Pegasus software is used as a pre-processor for overset-grid computational fluid dynamics (CFD) simulations. It provides the hole-cutting and connectivity information between structured overset grids. The main features of the software include automated hole-cutting algorithms, a projection scheme for fixing small discretization errors in overset surface; efficient interpolation search methods; hole-size optimization based on adding additional layers of fringe points; and an automatic restart capability. The code can run in parallel using the Message-Passing Interface (MPI) standard. The parallel performance provides efficient speed-up of the execution time utilizing dozens or even hundreds of processors. Additional capabilities in version 5.2 include: support for cell-centered grids; a triple-fringe option; automated domain decomposition into multiple hole-cutters; an improved parallel execution load-balancing algorithm; and additional minor enhancements.

**U.S. Release Only**

## **PLOT3D, Version 4.1**

**ARC-14400-1**

PLOT3D is a computer graphics program designed to visualize the grid and solutions of structured computational fluid dynamics (CFD) datasets. Version 4.1 uses the OpenGL/GLUT graphics library. Several new features have been added to the code. These include: automatic computation of grid coordinate minimum/maximum; an orphan point plotting function; the ability to read double-precision unformatted data; negative grid index processing; random specification of colors for different walls; and simultaneous specification of walls and subsets for all zones.

**U.S. Release Only**

## **Quad-Channel Transport Class Model Simulation (Quad TCM)**

**DRC-014-004**

Quad TCM is a non-proprietary, non-sensitive aircraft Simulink model derived from Langley Research Center's Transport Class Model (TCM). Quad TCM is a flight control system (FCS) oriented simulation with multi-channel (FCS) components, including flight control computers (FCCs), sensors, actuators, and interconnects.

**General Public Release**

## **Rotorcraft Optimization Tools (RCOTOOLS)**

**ARC-18184-1**

RCOTOOLS provides utilities and application wrappers for the conceptual design of rotorcraft using an optimization framework. It currently has application wrappers for NASA Design and Analysis of Rotorcraft (NDARC), Comprehensive Analytical Model of Rotorcraft Aerodynamics (CAMRAD II), and Numerical Propulsion System Simulation (NPSS). These wrappers are currently designed for use with NASA's OpenMDAO optimization framework.

**U.S. and Foreign Release**

## **Runtime for Airspace Concept Evaluation (RACE)**

**ARC-17749-1**

RACE is a software architecture and framework for configurable, highly concurrent, and distributed message-based systems. It can be used to rapidly build simulations that span several machines (including synchronized displays), interface existing hardware simulators and other live data feeds, and incorporate sophisticated visualization components such as NASA's WorldWind viewer. RACE is implemented as a distributed actor system that runs within Java virtual machines.

**Open Source**



### **sBOOM: An Advanced Sonic Boom Propagation Tool**

**LAR-18012-1**

Very useful in the development of supersonic cruise aircraft, this NASA-developed propagation tool predicts sonic-boom ground signatures by numerically solving the Augmented Burgers equation. Efficient and accurate, sBoom can predict shock thicknesses, thereby improving the frequency spectrum of ground signatures. Because shock rise times are computed and not empirically adjusted or corrected, the tool affords more accurate loudness calculations than comparable linear-theory methods.

**General Public Release**

### **sBOOM2: An Advanced Sonic Boom Propagation and Design Tool**

**LAR-18477-1**

This innovation presents an approach to not only predict sonic boom ground signatures by numerically solving the Augmented Burgers' equation, but it also allows the crucial step of efficiently computing the sensitivities of various sonic boom metrics, both at the ground level and mid-field levels with respect to the aircraft outer mold line parameters. This unique new functionality represents a major milestone in sonic boom mitigation literature and offers a game-changing design methodology for commercial supersonic aircraft design.

**U.S. Release Only**

### **Sector 33 App**

**ARC-16853-1**

Offering a single user interface, Sector 33 is an air traffic control simulator game for Apple and Droid mobile devices. The technology includes introductory videos, an interactive air traffic control simulation of up to five airplanes; problem scoring; and integrated solution hints. The game can be downloaded at: <http://www.nasa.gov/connect/apps.html>

**General Public Release**

### **Sensor Uncertainty Mitigation (SUM)**

**LAR-18972-1**

In the Langley UAS Detect and Avoid (DAA) simulation environment, this sensor uncertainty mitigation software module compensates for the error and uncertainty in the output of the air traffic surveillance sensors onboard unmanned aircraft. Its purpose is to provide better alerts and maneuver guidance to the UAS operator.

**U.S. Government Purpose Release**

### **Shape Parameterization Algorithm (MASSOUD)**

**LAR-15968-1**

The MASSOUD and/or Bandaid software packages are geometry parameterization tools that may be used to perform design optimization with NASA's FUN3D and other CFD codes.

**U.S. Release Only**

### **SolFlyte**

**LAR-18203-1**

SolFlyte enables the analysis of solar-electric (SE) HALE aircraft and airship concepts and missions by uniquely modeling the complex interactions of time-dependent astronomical, geographical, and atmospheric factors on key metrics such as energy balance, shadowing, performance, on-site persistence, and design size. Separate functional utilities are linked using the PHX ModelCenter v9.0 integration framework to create the SolFlyte-HTA (airplane), SolFlyte-LTA (airship) analysis models, and the SolFlyte-WND wind data processing model. The flexible inputs and rapid execution of the SolFlyte models broaden the analysis scope and permit parametric design feedback.

**General Public Release**

### **Spatial Statistical Data Fusion (SSDF)**

**NPO-48131-1**

A key feature of this tool is the spatial mixed-effects statistical model that underlies it. The approach models the spatial covariance function of the underlying field using linear combinations of basic functions of fixed size.

**U.S. Government Purpose Release**



### **Static Loader Library for Real-Time Embedded Systems**

**GSC-17810-1**

The Static Loader Library for Real-Time Embedded Systems is a small software library written in the C programming language designed to allow individual software components to be linked to a specific memory location and loaded from an embedded file system. It is used as a lightweight replacement for the dynamic loader provided in many operating systems.

**U.S. Government Purpose Release**

### **Stochastic Terminal Area Scheduling Simulation (STASS)**

**ARC-17079-1**

STASS simulates air traffic in the terminal area and ground traffic on the terminal surface. The technology uses time-based queues at various locations along an aircraft's trajectory to model traffic. For arrivals, queue locations include the freeze horizon, metering fixes, and runways. For departures, queues are positioned at airport gates, runways, and metering fixes. Flight time uncertainty is modeled using probability distributions around queue arrival times.

**U.S. Government Purpose Release**

### **StormGen Weather Editor**

**ARC-16827-1**

The StormGen interactive editor facilitates the design and production of dynamic convective weather scenarios. The software exports weather data in formats compatible with widely used air- and ground-tool simulators.

**U.S. Release Only**

### **SUPKEM**

**ARC-16260-1**

SUPKEM is fully implicit, parabolic, partial-differential equation solver that can be used for the integration of unsteady 3D turbulence kinetic energy and dissipation-rate equations. The technology enables any laminar computational fluid dynamics (CFD) solver to compute a given unsteady turbulent flow of interest.

**U.S. Government Purpose Release**

### **Surface Operations Simulator and Scheduler (SOSS)**

**ARC-16808-1A**

A simulation of air traffic movement on an airport surface, SOSS can be used in developing, analyzing, and testing runway schedulers and resolution algorithms.

**U.S. Government Purpose Release**

### **T-infinity**

**LAR-19180-1**

T-infinity is an API platform for multidisciplinary computational aerospace applications.

**Open Source**

### **Taxiway Navigation and Situation Awareness (T-NASA) System Simulation Software**

**ARC-15246-1**

The T-NASA suite is composed of a collection of computer programs and libraries that enable the real-time simulation of head-up, out-the-window, and head-down moving map displays. The technology currently runs on a distributed IRIX system using the Performer graphics libraries and the X Windows graphical user interface.

**U.S. Government Purpose Release**

### **TLNS3D**

**LAR-16666-GS**

This software was developed to solve Reynolds-averaged Navier-Stokes equations to simulate turbulent, viscous flows over three-dimensional configurations. A general multiblock grid is used to model complex configurations. A multi-stage Runge-Kutta pseudo-time stepping scheme is coupled with residual smoothing and multigrid acceleration techniques to form an efficient algorithm. TLNS3D-MB was the first CFD code to demonstrate grid-independent convergence rate for transonic viscous flows over wing/fuselage configurations.

**Open Source**



### **Tool for Turbine Engine Closed-Loop Transient Analysis (TTECTrA)**

**LEW-19177-1**

TTECTrA is a tool, developed in the MATLAB/Simulink environment, intended to extend systems analysis by providing an estimate of the transient performance/capability of a conceptual engine design. The software is capable of designing a basic turbofan engine controller, with transient protection, based on the user's engine model and constraints.

**Open Source**

### **Traffic Situation Display (TSD)**

**ARC-16063-1A**

The Traffic Situation Display (TSD) is an integrated display of air traffic, weather, terrain, and special-use airspace. TSD was designed to serve as a primary graphical interface for ground operators/dispatchers supporting research simulation of single-pilot and/or reduced-crew operations. One key feature is the seamless transitional flow between the ego-referenced and position-referenced frames.

**U.S. Government Purpose Release**

### **Trajectory-Based Route Analysis and Control (TRAC)**

**ARC-16433-1**

TRAC is an extensible software platform that supports next-generation air traffic concept investigations. The software enables visualization of current-day airspace elements; graphical creation of new elements; and runway-to-runway agent-based simulation and analysis of air traffic concepts.

**U.S. and Foreign Release**

### **TRAJEX Binary File Reader**

**KSC-13564**

This MATLAB function opens a binary file generated by TRAJEX, reads and parses it, and outputs a structured data array that can be used in trajectory analysis.

**U.S. Government Purpose Release**

### **TURBO-AE: An Aeroelastic and Multi-Stage Aerodynamic Analysis Code Based on Unsteady Three-Dimensional Navier-Stokes Equations**

**LEW-17514-1**

An aeroelastic and unsteady aerodynamic analysis code has been developed for prediction of flutter, forced response, performance, and rotor-stator interaction effects. The analysis provides a high-fidelity modeling of subsonic, transonic, and supersonic flow regimes with attached and separated flow fields. The code calculates performance quantities such as efficiency, mass flow, pressure ratio, temperature ratio, distribution of flowfield properties in the entire domain of calculation, aerodynamic damping to assess flutter stability and unsteady aerodynamic forces arising from rotor-stator interaction for calculation of forced response. This information can be used in high-cycle fatigue analysis of blade rows.

**U.S. Release Only**

### **Unsteady Flow Analysis Toolkit (UFAT)**

**ARC-14800-1**

UFAT is a software program for analyzing time-dependent flow fields. The technology automatically processes large-scale computer simulations to reveal salient flow features (e.g., vortices and shock waves) with little or no human interventions. UFAT effectively reduces the analysis time of multi-gigabyte datasets from weeks to hours using state-of-the-art particle tracking and feature detection algorithms.

**U.S. Release Only**

### **Upwind Parabolized Navier-Stokes Solver (UPS) for Supersonic and Hypersonic Flow Simulation, Version 6.1**

**ARC-15250-1**

This software provides a means for simulating supersonic and hypersonic flows efficiently and accurately (under certain restrictions). The parabolized Navier-Stokes (PNS) equations are solved using an upwind finite-volume algorithm that is implicit in the marching direction. The solver includes models for turbulent flow and equilibrium-rate and finite-rate air chemistry.

**U.S. Government Purpose Release**



**Virtual Airspace Simulation Technology, Real Time (VAST-RT), Capability Two****ARC-15658-1**

Designed to assess advanced automation concepts and procedures being considered for the next-generation air traffic management system, VAST-RT offers real-time simulations across all air traffic control domains. Gate-to-gate simulations can involve piloted flight simulators, multiple NASA centers, TRACONS, and towers. The software's architecture links disparate legacy facilities together with simulation components developed in house.

**U.S. and Foreign Release****VULCAN-CFD****LAR-18512-1**

VULCAN-CFD offers a comprehensive set of capabilities to enable the simulation of continuum flowfields from subsonic to hypersonic conditions. The governing equations employed include allowances for both chemical and thermal non-equilibrium processes, coupled with a wide variety of turbulence models for both Reynolds-averaged and large eddy simulations. The software package can simulate two-dimensional, axisymmetric, or three-dimensional problems on structured multi-block meshes or unstructured meshes. It also allows one to invoke a parabolic (i.e., space-marching) treatment for any subset of a problem that can accommodate this solution strategy.

**U.S. Release Only****X-Plane Communication Toolbox (XPC)****ARC-17185-1**

The X-Plane Connect Toolbox enables users to (1) receive real-time information on one or more simulated vehicle's state from the X-Plane flight simulator and (2) control vehicles running in the X-Plane simulation environment. The toolbox can be used to record simulated flight data, visualize flight profiles, create out-the-window visuals, test autopilots, and test control algorithms. Additionally, the toolbox enables the display of ghost traffic flying predefined flight paths in the simulated airspace and the visualization of flight plans in the form of waypoints.

**Open Source**

# Technology Transfer Program Network Directory

## **NASA Headquarters**

National Aeronautics and Space Administration  
300 E Street, SW  
Washington, DC 20546

Technology Transfer Program Executive:

### ***Daniel Lockney***

Phone: 202-358-2037

Email: daniel.p.lockney@nasa.gov



## **Johnson Space Center**

National Aeronautics and Space Administration  
Houston, Texas 77058

Technology Transfer Office Chief:

### ***Kris Romig***

Phone: 281-483-9039

Email: kris.a.romig@nasa.gov



## **Field Centers**

### **Ames Research Center**

National Aeronautics and Space Administration  
Moffett Field, California 94035

Technology Transfer Office Chief:

### ***Karen Bradford***

Phone: 650-604-2251

Email: karen.c.bradford@nasa.gov



### **Kennedy Space Center**

National Aeronautics and Space Administration  
Kennedy Space Center, Florida 32899

Technology Transfer Office Chief:

### ***Dave Makufka***

Phone: 321-867-6227

Email: david.r.makufka@nasa.gov



### **Armstrong Flight Research Center**

National Aeronautics and Space Administration  
4800 Lilly Drive, Building 4839

Edwards, California 93523-0273

Technology Transfer Office Chief:

### ***Laura Fobel***

Phone: 661-276-3967

Email: laura.j.fobel@nasa.gov



### **Langley Research Center**

National Aeronautics and Space Administration  
Hampton, Virginia 23681-2199

Technology Transfer Office Chief:

### ***Carrie Rhoades***

Phone: 757-864-8793

Email: carrie.m.rhoades@nasa.gov



### **Glenn Research Center**

National Aeronautics and Space Administration  
21000 Brookpark Road

Cleveland, Ohio 44135

Technology Transfer Office Chief:

### ***Harvey Schabes***

Phone: 216-433-8047

Email: harvey.l.schabes@nasa.gov



### **Marshall Space Flight Center**

National Aeronautics and Space Administration  
Marshall Space Flight Center

Huntsville, Alabama 35812

Technology Transfer Office Chief:

### ***Terry Taylor***

Phone: 256-544-5916

Email: terry.taylor@nasa.gov



### **Goddard Space Flight Center**

National Aeronautics and Space Administration  
Greenbelt, Maryland 20771

Technology Transfer Office Chief:

### ***Darryl Mitchell (acting)***

Phone: 301-286-5169

Email: darryl.r.mitchell@nasa.gov



### **Stennis Space Center**

National Aeronautics and Space Administration  
Stennis Space Center, Mississippi 39529

Technology Transfer Office Chief:

### ***Duane Armstrong***

Phone: 228-688-2180

Email: curtis.d.armstrong@nasa.gov



### **Jet Propulsion Laboratory**

National Aeronautics and Space Administration  
4800 Oak Grove Drive

Pasadena, California 91109

Technology Transfer Office Chief:

### ***Debora Wolfenbarger***

Phone: 818-354-3829

Email: debora.l.wolfenbarger@jpl.nasa.gov



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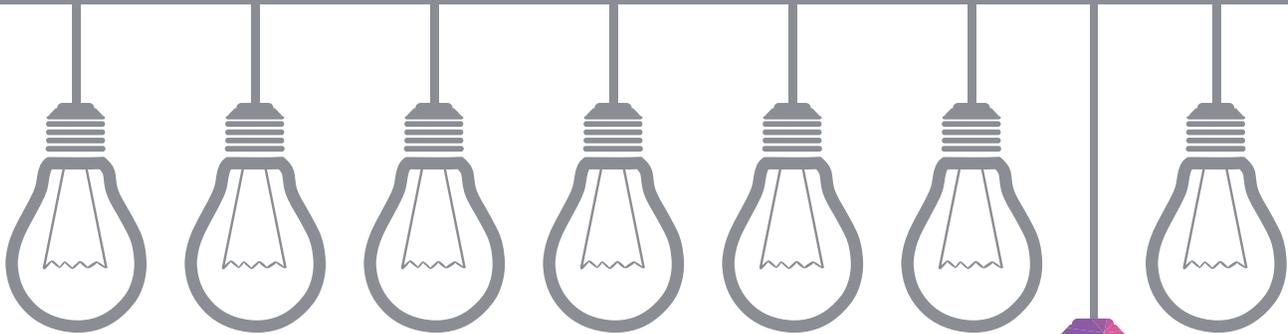


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Optics



Power Generation  
and Storage



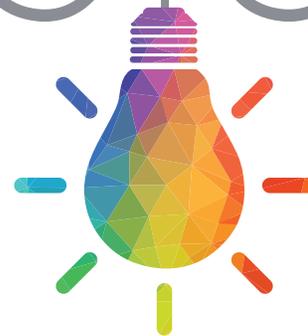
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National Aeronautics and Space Administration

**NASA Headquarters**  
300 E Street SW  
Washington, DC 20546

[www.nasa.gov](http://www.nasa.gov)

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