current problems and ultimately producing a system capable of continuous operation at moderate temperatures that can be scaled over a large capacity range depending on the ISRU process.

The goal of the LGA research project is to design, build, and test a new type of greenhouse that could be used on the moon or Mars. The LGA uses super greenhouse gases (SGGs) to absorb long-wavelength radiation, thus creating a highly efficient greenhouse at a future lunar or Mars outpost. Silica-based glass, although highly efficient at trapping heat, is heavy, fragile, and not suitable for space greenhouse applications.

Plastics are much lighter and resilient, but are not efficient for absorbing long-wavelength infrared radiation and therefore will lose more heat to the environment compared to glass. The LGA unit uses a transparent polymer "antechamber" that surrounds part of the greenhouse and encases the SGGs, thereby minimizing infrared losses through the plastic windows. With ambient temperatures at the lunar poles at –50 ºC, the LGA should provide a substantial enhancement to currently conceived lunar greenhouses. Positive results obtained from this project could lead to a future large-scale system capa-

ble of running autonomously on the Moon, Mars, and beyond.

The software for both applications needs to run the entire units and all sub-processes; however, throughout testing, many variables and parameters need to be changed as more is learned about the system operation. The software provides the versatility to permit the software operation to change as the user requirements evolve.

This work was done by Stephen Perusich, Thomas Moss, and Anthony Muscatello of Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-13539

Graphical Language for Data Processing

Stennis Space Center, Mississippi

A graphical language for processing data allows processing elements to be connected with virtual "wires" that represent data flows between processing modules. The processing of complex data, such as lidar data, requires many different algorithms to be applied. The purpose of this innovation is to automate the processing of complex data, such as LIDAR, without the need for complex scripting and programming languages.

The system consists of a set of user-interface components that allow the user to drag and drop various algorithmic and processing components onto a

process graph. By working graphically, the user can completely visualize the process flow and create complex diagrams. This innovation supports the nesting of graphs, such that a graph can be included in another graph as a single step for processing.

In addition to the user interface components, the system includes a set of .NET classes that represent the graph internally. These classes provide the internal system representation of the graphical user interface. The system includes a graph execution component that reads the internal representation of the graph (as described above) and

executes that graph. The execution of the graph follows the interpreted model of execution in that each node is traversed and executed from the original internal representation. In addition, there are components that allow external code elements, such as algorithms, to be easily integrated into the system, thus making the system infinitely expandable.

This work was done by Keith Alphonso of Diamond Data Systems for Stennis Space Center. For more information, contact Keith Alphonso, Director Diamond Data Systems, a Geocent Company at kalphonso@Geocent.com, (228) 688-3145. SSC-00324

Monitoring Areal Snow Cover Using NASA Satellite Imagery

Goddard Space Flight Center, Greenbelt, Maryland

The objective of this project is to develop products and tools to assist in the hydrologic modeling process, including tools to help prepare inputs for hydrologic models and improved methods for the visualization of streamflow forecasts. In addition, this project will facilitate the use of NASA satellite imagery (primarily snow cover imagery) by other federal and state agencies with operational streamflow forecasting responsibilities.

A GIS software toolkit for monitoring areal snow cover extent and producing streamflow forecasts is being developed. This toolkit will be packaged as multiple extensions for ArcGIS 9.x and an open-source GIS software package. The toolkit will provide users with a means

for ingesting NASA EOS satellite imagery (snow cover analysis), preparing hydrologic model inputs, and visualizing streamflow forecasts. Primary products include a software tool for predicting the presence of snow under clouds in satellite images; a software tool for producing gridded temperature and precipitation forecasts; and a suite of tools for visualizing hydrologic model forecasting results. The toolkit will be an expert system designed for operational users that need to generate accurate streamflow forecasts in a timely manner.

The Remote Sensing of Snow Cover Toolbar will ingest snow cover imagery from multiple sources, including the MODIS Operational Snowcover Data

and convert them to gridded datasets that can be readily used. Statistical techniques will then be applied to the gridded snow cover data to predict the presence of snow under cloud cover. The toolbar has the ability to ingest both binary and fractional snow cover data. Binary mapping techniques use a set of thresholds to determine whether a pixel contains snow or no snow. Fractional mapping techniques provide information regarding the percentage of each pixel that is covered with snow. After the imagery has been ingested, physiographic data is attached to each cell in the snow cover image. This data can be obtained from a digital elevation model (DEM) for the area of interest. If

the snow cover image contains cloud cover, regression tree analysis is used to predict the presence of snow cover under clouds.

The Gridded Temperature and Precipitation Forecast Toolbar will ingest forecasts from numerical weather prediction models and produce gridded forecasts that can be used as input for distributed hydrologic models. This toolbar will enable users to easily produce gridded fields of temperature and precipitation from location-specific forecasts, which is needed since a majority of hydrologic models are run on a distrib-uted basis. This is completed using temperature data, and will be expanded in the future to include precipitation data.

The Streamflow Forecast Visualization Toolbar will generate visualizations of streamflow forecasts. Outputs include a variety of tables, charts, and figures depicting streamflow forecasts in formats that can be easily interpreted by the general public.

The interpolation process entails: (1) obtaining a DEM for the watershed (basin) of interest; (2) obtaining temperature (forecasted or observed) and elevation values for an individual weather station (base station) located within the watershed; and (3) applying the monthly temperature lapse rates to create gridded values. After a DEM is selected for the area of interest, the GIS tools essentially complete the interpolation process for any specified day automatically. Tools are included to assist in the validation of the forecast grids.

Adaptation of G-TAG Software for Validating Touch-and-Go Comet Surface Sampling Design Methodology

NASA's Jet Propulsion Laboratory, Pasadena, California

The G-TAG software tool was developed under the R&TD on Integrated Autonomous Guidance, Navigation, and Control for Comet Sample Return, and represents a novel, multi-body dynamics simulation software tool for studying TAG sampling.

The G-TAG multi-body simulation tool provides a simulation environment in which a Touch-and-Go (TAG) sampling event can be extensively tested. TAG sampling requires the spacecraft to descend to the surface, contact the surface with a sampling collection device, and then to ascend to a safe altitude. The TAG event lasts only a few seconds but is mission-critical with potentially high risk. Consequently, there is a need for the TAG event to be well characterized and studied by simulation and analysis in order for the proposal teams to converge on a reliable spacecraft design.

This adaptation of the G-TAG tool was developed to support the Comet Odyssey proposal effort, and is specifically focused to address comet sample return missions. In this application, the spacecraft descends to and samples from the surface of a comet. Performance of the spacecraft during TAG is assessed based on survivability and sample collection performance.

For the adaptation of the G-TAG simulation tool to comet scenarios, models are developed that accurately describe the properties of the spacecraft, approach trajectories, and descent velocities, as well as the models of the external forces and torques acting on the spacecraft. The adapted models of the space-
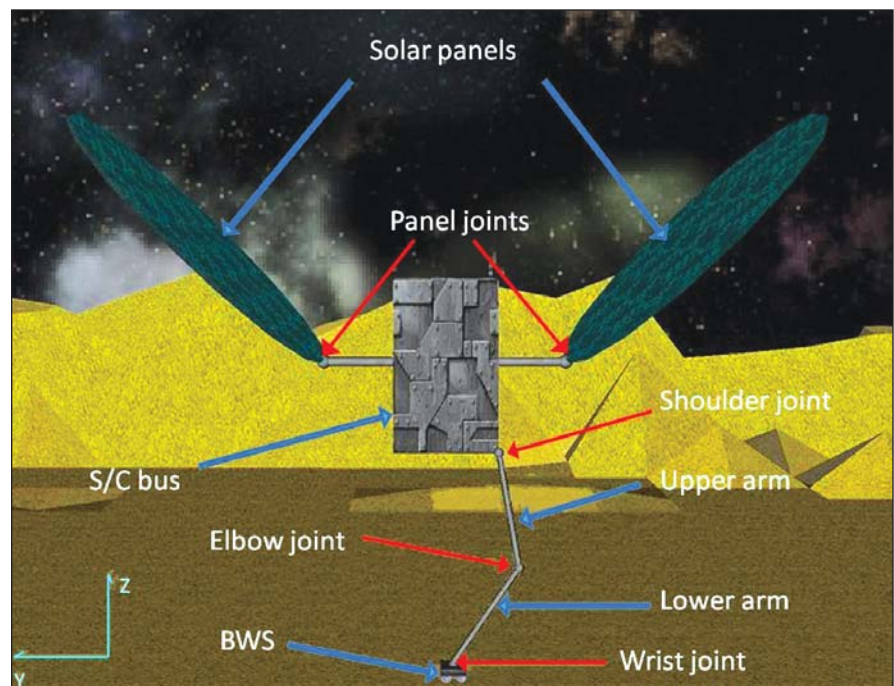
Comet Spacecraft Concept: Red arrows point to joints, blue arrows to spacecraft body components. The frame used for the simulation and for creating simulation movies is shown in the lower-left corner (x-axis completes coordinate system using the right-hand rule).

craft, descent profiles, and external sampling forces/torques were more sophisticated and customized for comets than those available in the basic G-TAG simulation tool.

Scenarios implemented include the study of variations in requirements, spacecraft design (size, locations, etc. of the spacecraft components), and the environment (surface properties, slope, disturbances, etc.). The simulations, along with their visual representations using G-View, contributed to the Comet Odyssey New Frontiers proposal effort by indicating problems and/or benefits of different approaches and designs.