pendently for many varied analysis tasks, or used in conjunction with other orbit analysis tools.

By basing the tools purely on first principles and 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.). The image projection tools begin with a simple description of the imaging system to be analyzed. This description is based on the highest level of imaging parameters (system F-number, pixel pitch, aperture size, etc.), which are among the first parameters settled upon when contemplating a new system. The tools are structured this way to allow for early analysis of the highest level requirements and the performance of rather detailed trade studies to best settle upon these high-level requirements early on.

Using these high-level parameters and the imaging geometry of the proposed system, one can geometrically project the imaging system onto the ground and determine many of the features of the collected imagery. These features include ground sample distances, actual image size and geolocation, image stretching and warping, etc. With these features calculated, there is a direct link between imaging system hardware parameters and performance requirements. Additionally, the same tools can be used to do some level of image processing. Existing image data

sets can be processed and re-projected to simulate what they would look like had they been taken with an imaging system with different parameters. The functions provide a robust toolset to quickly answer several types of imaging questions that typically arise when considering missions around framing imaging systems.

This work was done by Benjamin M. Haber and Joseph J. Green of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47281.

Σ Coded Modulation in C and MATLAB

This software, written separately in C and MATLAB as stand-alone packages with equivalent functionality, implements encoders and decoders for a set of nine error-correcting codes and modulators and demodulators for five modulation types. The software can be used as a single program to simulate the performance of such coded modulation.

The error-correcting codes implemented are the nine accumulate repeat-4 jagged accumulate (AR4JA) low-density parity-check (LDPC) codes, which have been approved for international standardization by the Consultative Committee for Space Data Systems, and

which are scheduled to fly on a series of NASA missions in the Constellation Program. The software implements the encoder and decoder functions, and contains compressed versions of generator and parity-check matrices used in these operations.

The software supports the modulations of binary phase-shift keying (BPSK), quadrature PSK (QPSK), 8-PSK, 16-ary 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. The software supports hard and soft demodulation, and when soft, it supports both an exact log likelihood computation and an approximate log likelihood computation based on nearest neighbors.

The software supports all nine AR4JA LDPC codes of the CCSDS standard and all five modulations of the DVB-S2 standard, in any combination.

This work was done by Jon Hamkins and Kenneth S. Andrews of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47171.