SCIENCE OPERATIONS WITH THE INSIGHT WEBGIS. F. J. Calef III[1], T. Soliman[1], H. E. Abarca[1], R. Deen[1], N. Ruoff[1], N. Williams[1], L. Berger[1], H. Lethcoe[1], R. Hausmann[1] [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr, Pasadena, CA 91109, Fred.Calef@jpl.caltech.edu, Hallie.Gengl@jpl.caltech.edu, Robert.Deen@jpl.caltech.edu, Nick.Ruoff@jpl.caltech.edu, Nathan.Williams@jpl.caltech.edu,

Introduction: The InSight lander major science mission goals are to investigate the formation of rocky planets and detect seismic activity on Mars [1]. Two scientific instruments were built and deployed to the surface to achieve these goals: a seismometer (SEIS) and a heat probe (HP3). The Instrument Sight Selection Working Group (ISSWG) was formed by the mission to quantify and qualify the instrument placement on the surface. Constraints on instrument tilt, rock size under the instruments, surface materials, distance from the lander, and noise characterization (both vibrational and thermal) were all taken into account to select the best location for these instruments to deploy to and meet their scientific objections within the primary mission timeline of one Mars year. A web-based GIS tool was developed that incorporated multi-layered mosaics, measurement tools, and placement visualization to allow science team members to evaluate suggested placements against a known list of 'constraints' ("must meet") and 'desirements' ("would be nice").

Tool Development: The InSight webGIS was built off of the Multi-Mission Geographic Information System (MMGIS), a NASA Advanced Multi-Mission Operations System (AMMOS) funded project, that provides spatial data infrastructure for planetary missions [2]. MMGIS provides 2D, 3D, and in situ visualization as well as layer control, measurement, and drawing tools in a web-based distributed system built from free and open source software (FOSS) components. A 'Layer' tool allowed switching between mapping layers generated by the ICC and IDC cameras as well as from the science team. For raw data measurements, the "Indentifier" tool was modified to allow point measurements from categorical and numerical datasetsand the built-in Measure tool for generating elevation data cross-sections, both to millimeter precision.

We coded a Placement tool to simulate the positioning of SEIS and HP3 on the surface (Figure 1). The Placement tool provided interactive visualization to evaluate instrument location based on nominal locations and offsets related to uncertainty in both the absolute position and clocking of the instruments during deployment. This tool simulated not only the instrument footprints generated from CAD models, but also the tethers and other significant components like the 'pinning mass' and 'field joint' on SEIS as well as the 'feet' for all instruments and 'grapple points'. Suggested instrument placements were saved to a remote relational database that could recalled by other software programs used by the science and engineering teams (e.g. MarsViewer and RSVP, the software that sequences commands for the robotic arm). Instruments could be placed by dragging the instrument footprint with the mouse or manually by entering in coordinates. An interactive tether was simulated in both 2D and 3D views using the actual attachment points on the deck and instruments in a 'rubber band' like fashion. Instrument offset and clocking could be adjusted. The 'wind shield', WTS, could be placed independently or along the SEIS tether at 5 cm towards the lander. The instrument footprint would also change color according to the 'goodness' map as read from the grapple point location. Each saved placement recorded the 'author', coordinates, and offset/clocking parameters, and dataset used to make the placement.

Data: The majority of the datasets used in the webGIS were generated by the Mars Imaging Processing Laboratory (MIPL). A fixed monoscopic camera (ICC) and arm deployed camera (IDC) were used to generate vertically projected (mostly for ICC images) and orthomosaics (IDC stereo pairs). From the IDC stereo pairs, several overlays were generated: roughness, instrument footplane tilt, and others including a 'goodness' map layer the combined several parameters that could be calculated from the elevation data mosaic. Mosaic datasets were generated in both IDA frame in the coordinate system of the lander, or in SITE frame with coordinates defined according to true north relative to the lander origin at the arm. SITE frame was the preferred coordinate system for taking measurements as it report elevation data relative to gravity, which was necessary for measuring constraints, as opposed to IDA frame that measure elevation relative to the plane of the lander deck.

Five unique datasets were imported into the webGIS:

1. ICAP_ON_: ICC vertical projection image with 'lens cap on' in IDA frame
2. SCAP_ON2: ICC vertical projection image with 'lens cap on' in SITE frame
3. 2MMVRT: ICC vertical projection image with 'lens cap of' in SITE frame
4. F2MMWKSM1: full IDC orthophoto mosaic and related layers in SITE frame
5. F2MMWKLM1: full IDC orthophoto mosaic and related layers in SITE frame

6. 1MMBOTH: high resolution orthophoto mosaic of potential instrument placement locations.

The science and instrument teams also provided several critical datasets for evaluating instrument placements:

1. soil, terrain, rock, and rock heights from the GEO group
2. Sound noise estimates from the SEIS team
3. Thermal 'noise' estimates from shadowing caused by the lander and seasonal effects from the HP3 team.

Together, the MIPL and science team datasets were used in concert to qualify and quantify instrument placement with the highest chance for collecting critical science data with minimal impact for external sources for the lifetime of the mission.

Operations: As data was processed and delivered from MIPL, we used the Geographic Data Abstraction Library (GDAL) tools to convert VICAR datasets into GeoTIFFs used by the ISSWG team, process them to 8-bit versions for visualization, tile datasets, upload them to the webserver, and enter their location into configuration files on the webserver. Once MIPL was finished processing, it took <1 hour to upload all MIPL dataset layers, <10 minutes for critical layers (visible, elevation model, goodness map) to begin site selection activities. Science and instrument team specific layers could be processed, in total, in ~30 minutes, but was dependent on the input product state upon delivery.

Conclusion: We successfully deployed a web-based GIS system for science operations by the 20 member (?) InSight ISSWG group to choose a location for the SEIS and HP3 instruments on the surface of Mars. The webGIS interface allowed interactive instrument placement and cross-team collaboration. Data was served rapidly and the tools performed nominally. The web-based interface provided a unified mapping, operating system independent, platform for science operations.

References: [1] Banerdt et al. [2] Calef et al. (2016) *LPSC2017 abstract 2541.*

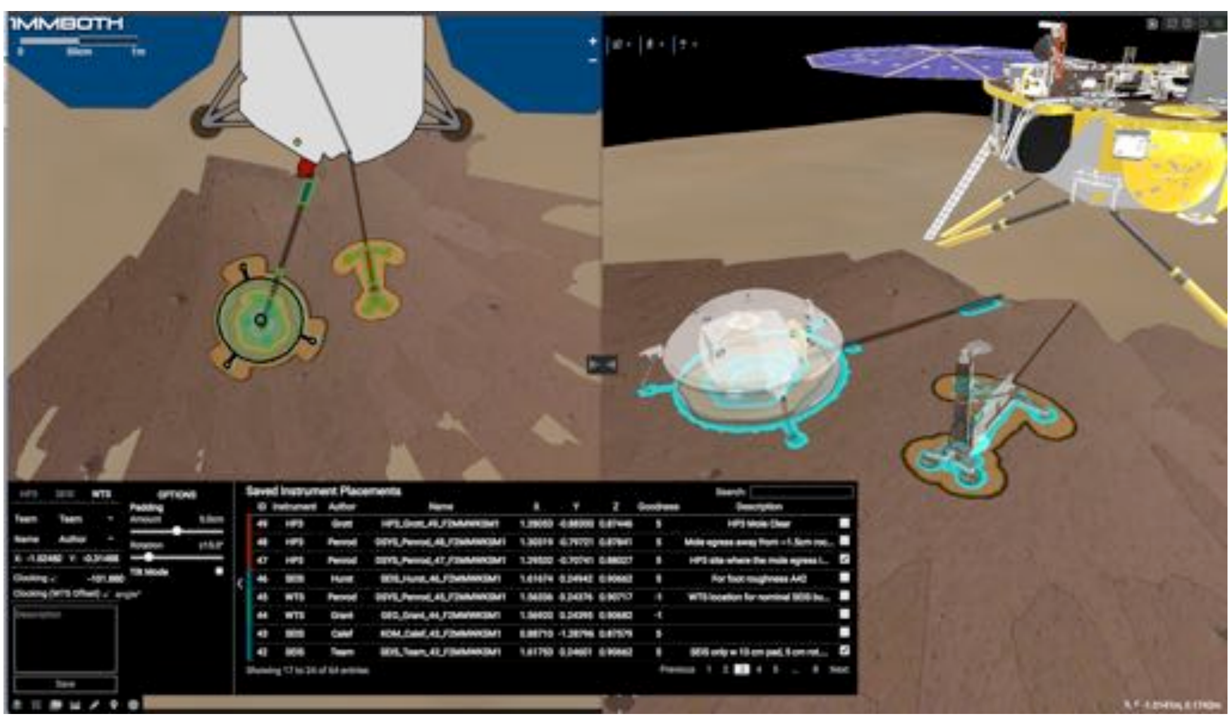

Figure 1: InSight WebGIS 2D and 3D views showing the instrument placement tool interface.