


# CS486C –Senior Capstone Design in Computer Science Project Description

<b>Project Title:</b> Planetary CartoCosmo for STAC for Planetary Mapping	
<b>Sponsor Information:</b> 	<b>Trent Hare (thare@usgs.gov)</b> <b>Jay Laura (jlaura@usgs.gov)</b>  Astrogeology, United States Geological Survey (USGS)

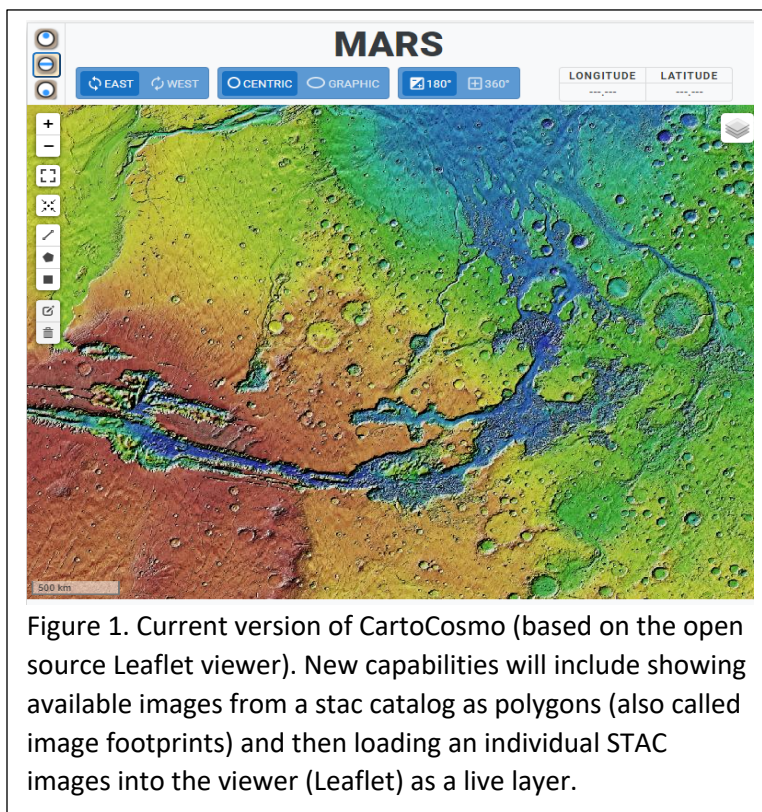
## Project Overview:

The Astrogeology Science Center, part of the United States Geological Survey, provides support for several NASA satellite and robotic planetary missions (Mars, the Moon, Europa, Titan, etc.). Not only do we support the data processing software for the gathered data, but we also support the infrastructure required to serve the data to scientists, students and the general public. These data sets are generally huge global image mosaics and can include thousands of individual images showing the surface of Mars or topographic data showing the elevation heights of the Moon.

Based on a successful NAU capstone from 2019-2020, we would like to extend their enhanced viewer called [CartoCosmo](#). The CartoCosmo viewer is great for visualizing large planetary image mosaics but does not support visualizing individual images or image catalogs. Thus, for this capstone, we would like to, first, add the ability to visualize individual image locations (using simple polygons) as provided from a SpatioTemporal Asset Catalogs (STAC) and second, load the actual selected image into CartoCosmo.



What is STAC: The STAC specification provides a method to describe a range of geospatial data sets, so it can more easily be indexed and discovered (c.f. <http://stacspec.org/>). STAC assets are typically individual images provided in the STAC-preferred Cloud Optimized GeoTiff format



(COG) but can also be entire packages of related images called *catalogues*. A JavaScript Object Notation (JSON) document based on the STAC metadata specification is created for each asset, which is simple and straightforward description of the image.



What is Leaflet: Leaflet is a web-based viewing tool which was created for (Earth-based) mapping applications. Here is a brief overview drawn from their website <https://leafletjs.com/>: *Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps. Weighing just about 38 KB of JS, it has all the mapping features most developers ever need. Leaflet is designed with simplicity, performance and usability in mind. It works efficiently across all major desktop and mobile platforms, can be extended with lots of plugins, has a beautiful, easy to use and well-documented API and a simple, readable source code that is a joy to contribute to.*

To clarify our vision of the capstone, consider this typical usage scenario: A planetary researcher is presented with a website referencing a large STAC catalog of Mars images (really just an ASCII listing in JSON). To visualize where the images are located on Mars, the user will open a modified version of CartoCosmo (Leaflet) displaying the location of each image from the STAC catalog as a simple polygon (also called the image's footprint). The user now wants to investigate a particular image further. By clicking on the polygon, the researcher can choose one of the listed images which is loaded into the viewer. The user can now zoom in and out of the loaded image. Once they are done, they dismiss the loaded image, select another polygon to load another image for visual inspection.

## **Project Details:**

While the CartoCosmo Team was already able to extend an existing open-source Leaflet map viewer to better support our planetary basemap services, it lacks the capability to load individual STAC assets (catalog locations and actual images). Thus, the technical goals for this project include modifying existing Leaflet functions and/or adding new Leaflet function to allow loading a STAC catalog as visible polygons. Once a polygon is selected, load an available STAC image into the viewer. The language to be used is JavaScript (JS) and may require using available JS TIFF libraries to display these images. USGS will provide all the STAC test layers which are available from existing online services, as well as technical support in terms of understanding the basics of planetary mapping and the functions that need to be implemented. Specific features to be supported in a new Leaflet Plugin and incorporated within CartoCosmo include:

The new Leaflet (CartoCosmo) plugin for STAC will be able to:

- Ingest a USGS STAC catalog (JSON ASCII listing) showing image locations using simple polygons (also called image footprints). Note image locations (polygons) are predefined as ASCII GeoJSON geometries within STAC catalogs.
- The ability to load Cloud Optimized GeoTIFF asset from selected polygon.
- Enhanced: load multiple images into single viewer with the ability to write out loaded STAC images as sorted table or GDAL virtual mosaic (text file).
- Enhanced: Continue to support this capability within a Jupyter Notebook (already supported by CartoCosmo).

## **Knowledge, skills, and expertise required for this project:**

- Basic knowledge of web application and use of modern web application frameworks, sufficient to understand integration on Leaflet.
- Knowledge of Leaflet, the technologies it relies on, and how to modify/extend Leaflet applications. Available from their website and numerous user forums.
- Basic knowledge of planetary mapping and map-making functions. Support will be provided by USGS professional staff to get the team up to speed.

## **Equipment Requirements:**

- There should be no equipment or software required other than a development platform and software/tools freely available online.
- The team should develop on their own machines/platforms during the development phase; access to necessary USGS computing environments will be provided to support testing and final deployment.

## **Deliverables:**

- The software applications as described above, deployed in a designated USGS environment, and tested successfully with real data and real users. Must include a complete and clear User Manual for configuring and operating the software; preference will be for online version to attach to the Leaflet extension.
- A detailed report describing the design and implementation of the product in a complete, clear, and professional manner. This document should provide a strong basis for future development of the product.
- Professionally documented codebase delivered in a repository like GitHub or BitBucket.
- Enhanced goal: Successful submission, following a full open-source cycle, i.e., application for review and push of this module, into the official Leaflet project as an extension.
- Enhanced goal: From within CartoCosmo, support simple API calls to the current STAC API to help search for images. We can provide simple examples to implement based on current specification: <https://github.com/radiantearth/stac-api-spec>.