

UC



Standing Up NAIP and Landsat Image Services as a Processing Resource

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NAIP and Landsat services

Differences

- Different general uses
 - Landsat
 - Available from USGS
 - Designed as an analytical service as well as archive of Landsat data
 - NAIP
 - Available from USDA/APFO
 - Designed as an analytical service as well as a basemap
- Both services
 - Have historical data
 - Make use of cloud storage
 - Fee to use

Landsat services



Landsat

Data specifications

- Data from Landsat 8 and GLS data downloaded from USGS
- USGS archive is adding approximately 500 images per day
- Each location is captured once every 16 days (about 22 observations/year)
- USGS started to reorganize and reprocess the Landsat archive into a formal tiered structure, this is known as Collection 1
 - Collection 1 data is currently being used for new data, with RT data used initially and replaced with T data once available
 - Post UC Esri will be looking at using Collection 1 data for older data

Landsat

Data

- Amazon S3 storage
- Data formatted to Tiled TIFF
- Cloud based compute environment
- Automatic mosaic generation
- Automatic service overview generation
- 15 services generated nightly, combining the following:
 - Multispectral, Panchromatic and Pansharpened
 - Landsat 8 and Landsat GLS
 - World, Arctic and Antarctic projections

Landsat

Design

- Images downloaded to cloud storage each night
 - Selection of images to download based on cloud cover metadata
- Data accessed via MRF to make use of cloud storage
- Automated daily ingest
- “Best of” service based on cloud cover and acquisition date
- Pan-sharpened and Multispectral services generated

Landsat

MRF/LERC

- MRF is an XML file format that allows for the separation between pixels and header information:
 - Number of rows / columns
 - Number of bands
 - Pixel depth
 - Projection system
 - Map information
 - Existence of pyramid levels
 - Location of caching file to improve performance
- LERC = Limited Error Raster Compression
 - Developed by Esri, but format has been made open via code on github
 - <https://github.com/Esri/lerc>

Landsat

Example MRF

```
1 <MRF_META>
2   <CachedSource>
3     <Source clone="true">/vsicurl/http://landsatarchive.s3.amazonaws.com/usgs/colorado/tm/35/32/1992/LT50350321992290XXX01/
    LT05_L1TP_035032_19921016_20160928_01_T1_B1.mrf</Source>
4   </CachedSource>
5   <Raster>
6     <Size x="8041" y="7331" c="1" />
7     <PageSize x="512" y="512" c="1" />
8     <DataFile>z:/MRFcache/landsatarchive/usgs/colorado/tm/35/32/1992/LT50350321992290XXX01/
    LT05_L1TP_035032_19921016_20160928_01_T1_B1.mrf_cache</DataFile>
9     <IndexFile>z:/MRFcache/landsatarchive/usgs/colorado/tm/35/32/1992/LT50350321992290XXX01/
    LT05_L1TP_035032_19921016_20160928_01_T1_B1.mrf_cache</IndexFile>
10    <Compression>LERC</Compression>
11  </Raster>
12  <GeoTags>
13    <BoundingBox minx="175785.00000000" miny="4357785.00000000" maxx="417015.00000000" maxy="4577715.00000000" />
14    <Projection>PROJCS["WGS 84 / UTM zone 13N",GEOGCS["WGS 84",DATUM["WGS_1984",SPHEROID["WGS 84",6378137,298.257223563,
    AUTHORITY["EPSG","7030"]],AUTHORITY["EPSG","6326"]],PRIMEM["Greenwich",0],UNIT["degree",0.0174532925199433],AUTHORITY["EPSG","
    4326"]],PROJECTION["Transverse_Mercator"],PARAMETER["latitude_of_origin",0],PARAMETER["central_meridian",-105],PARAMETER["
    scale_factor",0.9996],PARAMETER["false_easting",500000],PARAMETER["false_northing",0],UNIT["metre",1,AUTHORITY["EPSG","9001"]],
    AUTHORITY["EPSG","32613"]]</Projection>
15  </GeoTags>
16  <Options>V2=ON</Options>
17  <Rsets model="uniform" scale="2" />
18 </MRF_META>
```


Landsat

Workflows

- Workflow tools to created to automate generation of mosaic datasets
- These tools have been published on ArcGIS Online and Github
 - www.esriurl.com/imageryworkflows
 - <http://www.arcgis.com/home/group.html?id=b65f2601e0084e32afab3eb488fa8a67/&q=ManagingImagery&t=group&start=1>
 - <http://www.arcgis.com/home/item.html?id=53269a42628d4e99a150de01a179e8aa>
- These workflows are based on a set of tools called MDCS (Mosaic Dataset Configuration Script):
 - <https://github.com/Esri/mdcs-py>
- OptimizeRasters script used to convert rasters and create MRF files:
 - OptimizeRasters does not require an installation of ArcGIS
 - OptimizeRasters has a prebuilt template for creating proxy files from Amazon Landsat 8 archive
 - <https://github.com/Esri/OptimizeRasters>

Landsat

Processing templates

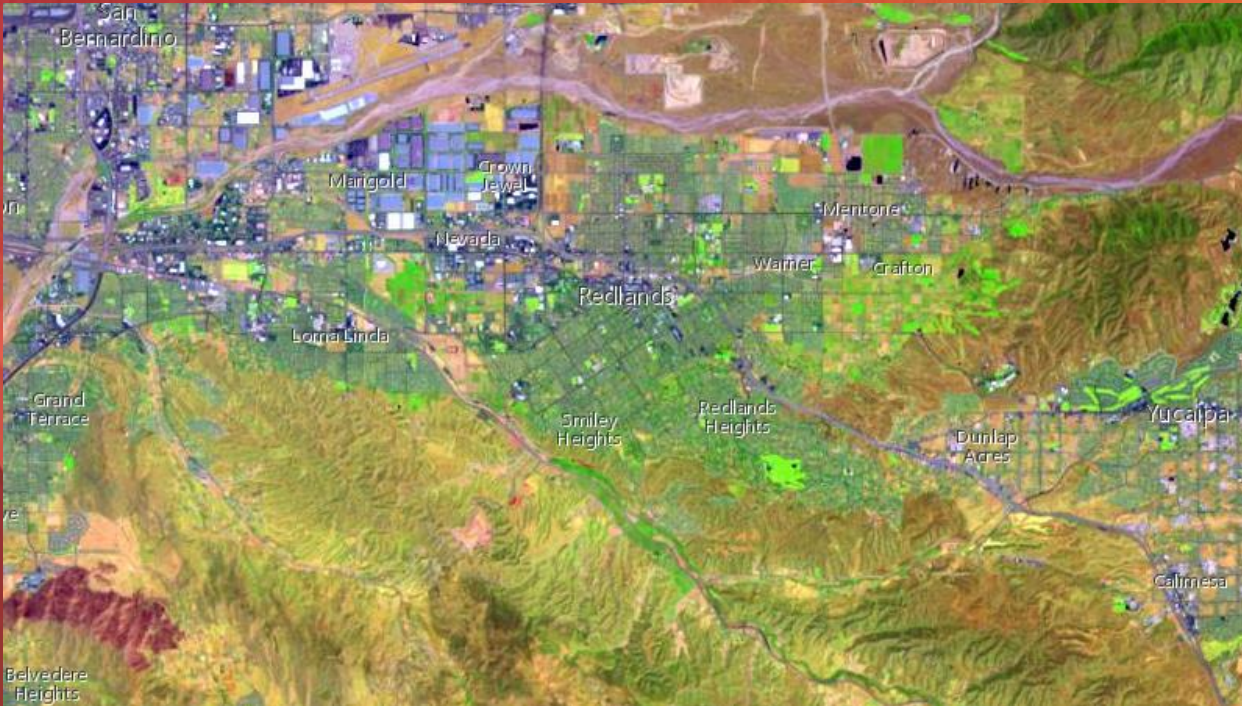
- Series of processing template added to service to allow for on-the-fly processing and information extraction
 - Agriculture (with DRA)
 - Bathymetric (with DRA)
 - Color Infrared (with DRA)
 - Natural Color (with DRA)
 - Short-wave Infrared (with DRA)
 - Geology (with DRA)
 - NDVI (Colorized)
 - Normalized Difference Moisture Index Colorized
 - Normalized Burn Ratio

Landsat

Release strategy

- Mosaic developed on a desktop cloud machine, then zipped and uploaded to S3
 - MRF files embedded into mosaic
 - gdb compressed
- Test consisting of multiple servers and a load balancer generated using CloudFormation template
 - Zip file downloaded from S3 and uncompressed into know location
- Production site created using same mechanism





Accessing Landsat service

Landsat service

- There is a plugin available for ArcGIS Desktop 10.2.1 to 10.5 - to quickly add and analyze Esri's Landsat 8 image service into ArcGIS Desktop. It provides a fast and easy method to add the Landsat 8 image service into ArcGIS Desktop, and includes advanced tools for selecting images by attributes such as date, cloud cover, etc., plotting spectral values across multiple dates (based on data available in the current image service), supervised classification, and more.
 - <http://www.arcgis.com/home/item.html?id=f331af8569fb4f19bd74954eddc44bd3>

NAIP service



NAIP

Data specifications

Data collected on a state-by-state basis with the following attributes:

- Each state is provided as a single dataset made up of TIFF images that conform to a uniform tiling scheme
- Data for each state is color balanced
- Original images are stitched together before tiles are generated
- Each tile has a given overlap, specified by APFO/USDA
- Data for each state extends beyond state boundary
- Metadata for each image is provided in a statewide shapefile
- Additional FGDC metadata for each image is available as a URL on APFO website

NAIP

Architecture

- Amazon S3 storage
 - To allow for scalable cost-efficient storage
 - Using the MRF format with LERC compression
- Cloud based compute environment
 - This allows ArcGIS Online to scale number of servers based on demand

NAIP

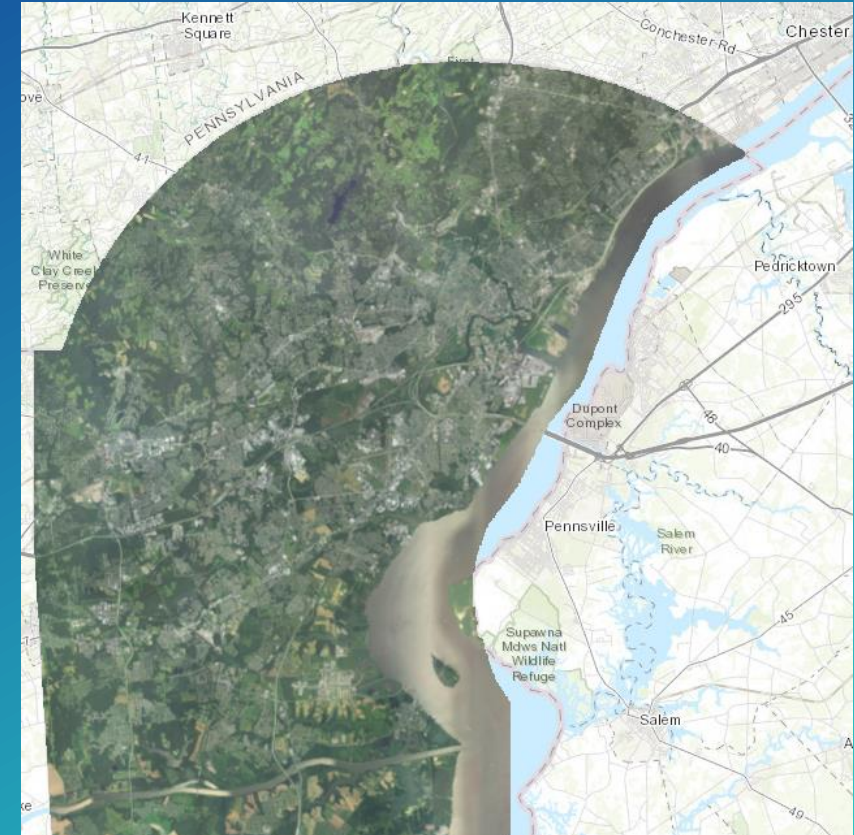
Design

- Data converted to MRF/LERC to make use of cloud storage
- A single mosaic is create for each state-year
- Service overviews generated for each mosaic (down to 1:288k scale)
- Each mosaic is clipped to a state boundary (excluding country boundary and coastline)
- MRF data embedded into mosaic datasets (for scales 1:577k and lower)
- National level service overviews color balanced (for scales
- Single mosaic created from all state-year mosaic to create a combined service
- Python scripting used for consistency

NAIP

Single state mosaics

- Enable users to filter based on state and year
- Add service overviews for each state/year combination so that these are visible at multiple resolutions
- Services available from federal agencies are all single state and latest year
- Performance considered when evaluating the service overview levels that can be supported for each state



NAIP

State Boundaries

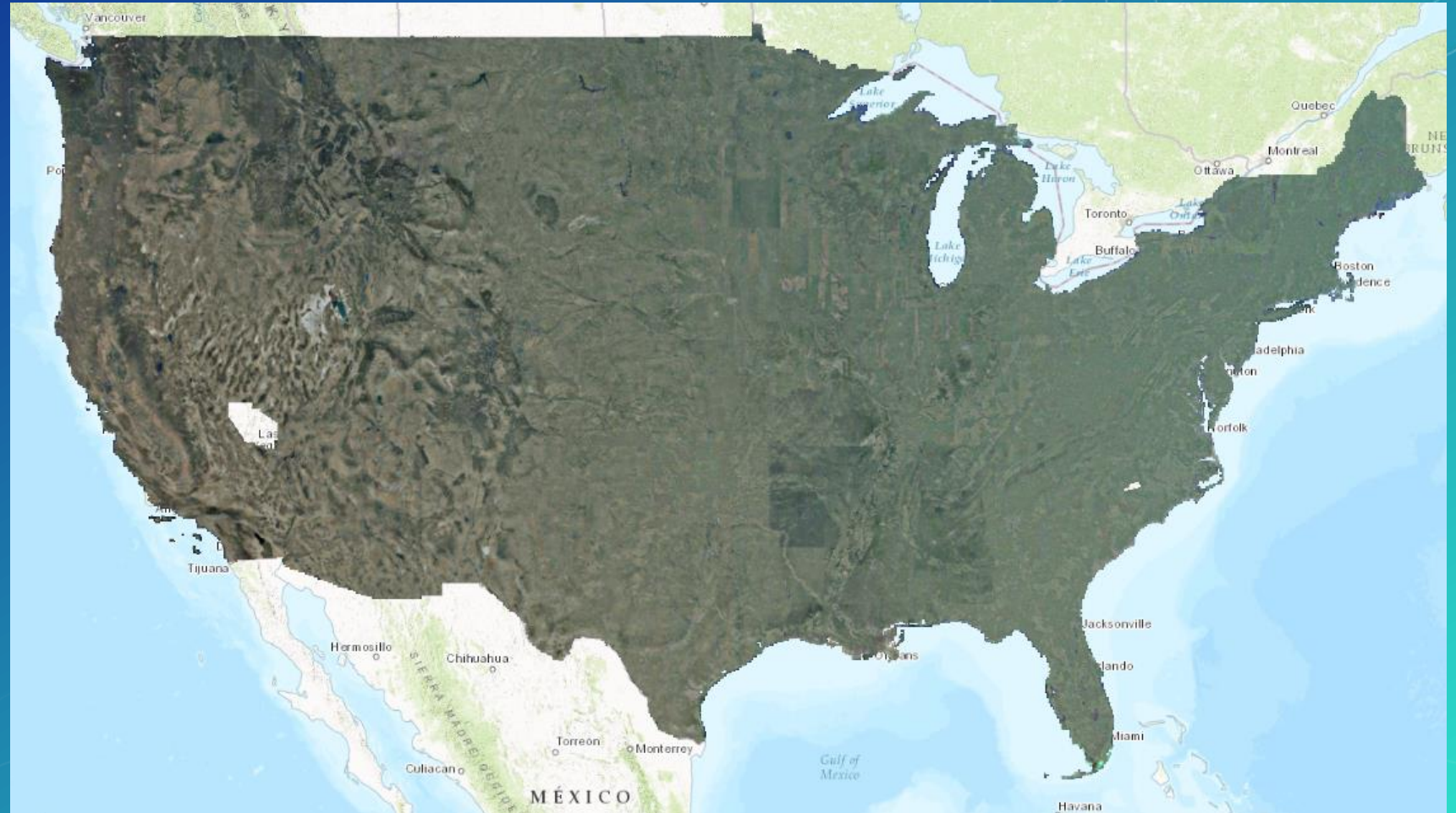
- Clip imagery to state boundaries to avoid issues at the boundaries with different collections



NAIP

National level Color Balancing

- National level service overviews are color-balanced to make a more consistent view of the country.
- Analysis should not be carried out at these levels.



NAIP

Workflows

- Python tools generated to do the following tasks:
 - Create single mosaic for each state-year
 - Check that the boundary matches neighboring states
 - Ensure that there are no issues with service overviews
 - Create a year mosaic with MRF information embedded
 - Use Optimize Rasters to store service overviews in S3
 - Service overview MRFs are not embedded to allow use of mask files
 - Create national level service overviews with color balancing
 - Same strategy as for state service overviews
 - Single mosaic of all years
 - This is the master master mosaic that is served
 - File geodatabase with single mosaic is compressed
 - Zip file created with file gdb and service overview .tif and .msk files

NAIP

Processing templates

- As this is a color-balanced and pre-stretched 4-band service only the following processing templates have been added:
 - Natural Color
 - Color Infrared
 - NDVI (Colorized)

NAIP

Release strategy

- Mosaic and associated files developed on a desktop cloud machine and uploaded to S3
- Site consisting of multiple servers and a load balancer created with automatic download of required files (gdb and service overview .tif and .msk files)
- The new site is swapped with the existing production servers using a DNS change





Accessing NAIP service

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