Managing and Serving Imagery in the Cloud Using ArcGIS Image Server

Peter Becker
Make Imagery Accessible for Visualization and Analysis Using Cloud

Don’t just copy your data into the cloud and expect it all to work
What is Cloud Computing?

- Use network of remote servers hosted on the internet to store, manage and process data, rather than a local server or personal computer

What is different in Cloud?

- Implementation and Management of Infrastructure (EC2, ELB, Storage)
- Object Storage (Https) vs Local (SAN/NAS)
- Elasticity in scaling
- Security
- Cost: Pay for the use
- Test and Scale as required
Why Manage and Serve Imagery in the Cloud?

- You have large collection of imagery
- Infrastructure is getting expensive
- Have heard that Cloud is: Cheap, Secure, Elastic, Resilient, Simple, ... ??
- Organization is going “Cloud First”
Cloud Infrastructure

- **ArcGIS Online (SaaS)**
  - Imagery currently limited to Tile Cache (Base Maps & Elevation) for imagery
- **AWS – EC2, S3**
- **Azure – VMs, BlobStore**
- **Other – VMs, CloudStorage**
5 Key Imagery Capabilities of ArcGIS
ArcGIS Support for All Imagery and Raster Formats

- Different sensor platforms – Satellite, Aerial, Drones, Categorical, Scientific, …
- Different sensors – Optical, Thermal, Radar, Lidar, Scanned, Generated – Categorical,…
- Different modalities – Multispectral, Panchromatic, Complex,
- Different levels and ‘Products’ from vendors (Imagery+Metadata)
- Different formats. TIF, NITF, NetCDF, JP2, MrSID, ….. Some are better than others
Mosaic Datasets
Enable Management of Large Collections

- **Optimum Data Model for Image Management**
- **Highly Scalable, from Small to Massive Volumes of Imagery**
- **Defined in GeoDatabase (File or Enterprise)**
- **References sources**
- **Maintains metadata**
- **Defines processing to be applied at Item and Service Level**
- **Defines mosaicking rules**
- **Defines overview to be used at small scale**
- **Provides:**
  - Dynamic Mosaicking
  - On-the-fly processing
- **Access as Image or Catalog**
ArcGIS Image Server
Key Capabilities

• Imagery hosting
  - Enables users within organization to upload imagery into ArcGIS Enterprise and serve it as dynamic imagery layers

• Dynamic image services
  - Web accessible imagery which can have processing applied on-the-fly

• Raster Analytics
  - Quickly process and persist data to create new information products

• Ortho mapping
  - Processing of satellite, aerial or drone imagery into digital elevation models and ortho mosaics
Scaling ArcGIS Image Server with Raster Analytics

Enterprise GIS

Web GIS Layers

New Web GIS Layers

analysis results as a new Web GIS Layers

Model Execution Distribution

Distributed raster datastore

GIS Data & Imagery

Files

GDB

Cloud Store

Distributed raster datastore

Design & Run Models

Run Portal Analytics

Portal UX

Developers & System Integrators

ArcGIS Pro
Components of a Complete Imagery Solution

On Premises or Cloud

- Storage (Source and Optimized)
- Management
- Generate TileCache
- Serve TileCache
- Serve Dynamic Image Services
- Perform Analytics
- Access Control (Portal or ArcGIS Online)

Where should each of these be performed? On premises or cloud?

Need to ensure that storage and processing are at same location (region)
<table>
<thead>
<tr>
<th></th>
<th>On-Premises</th>
<th>In-Cloud</th>
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<tbody>
<tr>
<td><strong>Store Imagery</strong></td>
<td>File System</td>
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<td>Object Store</td>
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<td><strong>Manage Imagery</strong></td>
<td>ArcGIS Pro</td>
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<td>Automated</td>
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<td><strong>Serve Tile Cache</strong></td>
<td>ArcGIS Online</td>
<td>ArcGIS Enterprise</td>
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<td><strong>Serve Dynamic Image Services</strong></td>
<td>ArcGIS Enterprise + ArcGIS Image Server</td>
<td>ArcGIS Image Server stand alone</td>
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<tr>
<td><strong>Analysis + Ortho Mapping</strong></td>
<td>ArcGIS Pro</td>
<td>ArcGIS Enterprise + Image Server</td>
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<td><strong>Portal</strong></td>
<td>ArcGIS Enterprise</td>
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### On Premises vs On Cloud Options

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<thead>
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### Best Practices

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Best Practice – 1
Manage Local / TileCacheToArcGIS Online

Only for 3band RGB compressed + Elevation

- Keep imagery on Local File Systems
- Manage using Mosaic Datasets, Review and do QA
- Generate Tile Cache Using ArcGIS Pro 2.4
- Package (TPKX) and Upload to ArcGIS Online
- Publish to ArcGIS Online (C1.2/GB/Month)
  (Very roughly: 100SqMiles@6” - $5/Month, 10,000Km2@15cm - $20/Month)

- Access as BaseMaps in all applications + Elevation in Scenes
- Advantage
  - Simple, Inexpensive
  - No server to install
- Disadvantage
  - Need to pre-process all data
  Only for 3band RGB compressed + Elevation
  Not usable for analysis (but can be used for deep learning based)
  No dynamic mosaicking, processing functions
Tile Cache Tools

• Use: ArcGIS Pro 2.4
  - Generate Tile Cache Tiling Scheme to define the tiling grid and image format
  - Manage Tile Cache to build the tiles
  - Export Tile Cache to create the tile package
  - Share Package to upload the tiles to ArcGIS Online or your ArcGIS Enterprise portal

• Note
  - Tile cache can be used as a large raster
  - TPKX can be used as a large raster

Recommend to use ArcGIS Pro 2.4
Includes number of enhancements with TPKX
Raster Tile Cache Tools  (Custom GPTool)
Custom tool to simplify caching – From Imagery Workflows

- Use: Raster Tile Cache Tools
  - Create Raster Tile Cache
  - Package & Publish
  - Create Cache Metadata
  - Update Tile Cache

Requires ArcGIS Pro 2.4
Utilizes enhancements with TPKX

For more details see:  http://doc.arcgis.com/en/imagery/workflows/resources/serving-cached-imagery.htm
Create and Publish Tile Cache
Best Practice – 2
ArcGIS Enterprise + Image Server 10.7.1 - Hosted Imagery

- Use: ArcGIS Enterprise Portal – Web
  - Source imagery can be local file or Referenced from Cloud Store (see later)
  - 3 Options: (One mosaic, Image Collection, Individual Layers)
  - Uses Shared instances (see later)
  - Utilize Raster Analytics for distribute processing

- Advantage
  - Simple: Anyone in organization can publish dynamic image services
  - Utilize full Raster Analytics and Ortho Mapping capabilities
  - Fully on-premises or on-cloud

- Disadvantage
  - Limited to simple mosaic dataset
  - No control over mosaic dataset properties
  - Limited Optimization
  - Requires DevOps
Hosted Imagery

• Portal User Interface
• Upload (or reference) imagery
• Create:
  - One imagery layer that is a mosaic of all the input images
    - Mosaics images into a CRF on raster store
  - One imagery layer that contains a collection of input images
    - Creates and publishes a mosaic dataset. Images remain in original format
  - Multiple imagery layers, one for each input image
    - Creates a single image layer for each. Remain in original format
• Optional Raster Types for some sensor products
Hosted Imagery in ArcGIS Enterprise 10.7.1 (With ArcGIS Image Server)
Best Practice – 3
ArcGIS Enterprise + Image Server – Use ArcGIS Pro

• Use: ArcGIS Enterprise + ArcGIS Pro (using RDP in cloud)
  - Source can be from Data store or Native cloud storage (eg public S3/BlobStore)
  - Use ArcGIS Pro to manage imagery and create mosaic dataset
    - Store mosaic dataset on Enterprise Geodatabase (eg RDS)
    - Reference imagery using (ACS, VSI or Raster Proxies)
    - Utilize Raster Analytics for distribute processing

• Advantage
  - Full capabilities of Mosaic Datasets
  - Utilize full Raster Analytics and Ortho Mapping capabilities

• Disadvantage
  - Requires separate cloud machine for ArcGIS Pro
  - Need DevOps
Share as Web Layer
Best Practice – 4
ArcGIS Image Server stand alone – Use ArcGIS Pro

• Use: ArcGIS Pro (running RDP in cloud)
  - Source can be from Data store or Native cloud storage (eg public S3/BlobStore)
  - Use ArcGIS Pro to manage imagery and create mosaic dataset
    - Store mosaic dataset on Enterprise Geodatabase (eg RDS) of fileshare
    - Reference imagery using (VSI, ACS or Raster Proxies)

• Advantage
  - Full capabilities of Mosaic Datasets
  - Lower infrastructure costs

• Disadvantage
  - Requires separate cloud machine for ArcGIS Pro
  - Not utilize Raster Analytics, OrthoMapping or Image Hosting
  - Need to user direct server connection / else Item on ArcGIS online
Publishing from Pro to Image Server Stand Alone

Two methods

• ArcGIS Pro 2.4
  - Share as Web Layer

• Publish Image Service Tool
  - Part of MDCS (see Imagery Workflows)
  - Will also create Imagery Layer Items in ArcGIS Online (or Portal)
  - Define if Dedicated or Shared Instance
Architecture & Implementation

Supporting Slides
www.esriurl.com/UC2019ImgMgmtCloud
ArcGIS Enterprise with ArcGIS Image Server on the Cloud (AWS sample)

- **Clients**
- **Data**
- **Professional Imagery / Geospatial Analysts**

**AWS Region**

- **Elastic IP for Portal**
- **GIS Server**
- **Dynamic Image Server**
- **RasterAnalytics Image Server**

**VPC**

- **Data Store**
- **Features**
- **S3 TileCache**

**EC2**

- **ArcGIS Portal**
- **ArcGIS Enterprise**
- **DynamoDB Config/item store**
- **NoteBook Server**
- **NB**
- **ArcGIS Pro**

**RDS**

- **Data Store**
- **Mosaic Datasets**

**S3 Public Raster Store**

**Required for Options 2 and 3**

- **Use RDS Postgres or Aurora for Mosaic Dataset**

- **Cluster**
- **Cluster**
- **EC2**

- **FileStore**
- **S3 Raster Store**
Prerequisites – Before deployment

- Amazon account with full access to EC2 and other resources.
- If you are using ArcGIS Amazon Image (AMI) for the first time accept terms in the AWS Marketplace.
- A valid domain name for your site.
- A TLS (SSL) certificate for your domain, obtained from a certifying authority.
- An Elastic IP address that you will associate with the EC2 instance; you must map your domain name to the Elastic IP address.
- License file for Portal, ArcGIS server, Image server
- If the amazon account is new we recommend creating the below things
  - VPC, ElasticIP, KeyPair. Elastic Load Balancer, S3 Buckets and Configure the security groups for SSH and RDP access
- Also note down the VPC id, SiteEIPAllocationID for the elasticIP, keypair

ArcGIS Enterprise + Image Server Deployment

- **Enterprise**
  - M5d.2xlarge (1 instance)
  - Readme: [https://arcgisstore1071.s3.amazonaws.com/11595/docs/ReadmeAllInOneVPC.html](https://arcgisstore1071.s3.amazonaws.com/11595/docs/ReadmeAllInOneVPC.html)

- **Image Server (Image Hosting)**
  - M5d.2xlarge (2 instance) (in autoscaling mode) (for image server stack)
  - db.r4.xlarge (RDS) for high 20gb+ Mosaic datasize, or db.m4.xlarge
  - You will need an ELB, you can use the below Cloudformation template to create an ELB
    - Then map the ELB name to the required domain name
  - Obtain following: Domain Name, SSL certificate, Image server License File (note you edit the file to mention your name and details)
  - If using RDS select DBengine and select postgres for it.
    - ReadMe: [https://s3.amazonaws.com/arcgisstore1071/11595/docs/ReadmeHAServerVPC.html](https://s3.amazonaws.com/arcgisstore1071/11595/docs/ReadmeHAServerVPC.html)

- **Image Server (Raster Analytics)** (Separate site, Separate server function)
  - Similar to Image server
  - No need to setup RDS, use the above one.
AWS Options to set up ArcGIS Enterprise

The below link gives an idea on what is ArcGIS Enterprise on AWS


- **Using AWS Cloud Formation Templates**

- **Using ArcGIS Server Cloud Builder**
  - https://enterprise.arcgis.com/en/server/latest/cloud/amazon/arcgis-server-architectures-on-aws.htm#ESRI_SECTION1_04B5C34B31D54B8AB29AE14DD0F30F2F

- **Using AWS management Console (setup Manually)**
  - https://enterprise.arcgis.com/en/server/latest/cloud/amazon/arcgis-server-architectures-on-aws.htm#ESRI_SECTION1_E0C2D729F89048FF87A93D2114486A66

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>CloudFormation Templates</td>
<td>Easy for Automation, Standard from Amazon, have better control on working with various AWS services, Easy to setup</td>
<td>Need Better understanding on how AWS services works, It’s for more advance users. Managing can become tricky in cases</td>
</tr>
<tr>
<td>ArcGIS Server Cloud Builder</td>
<td>Easy to setup, easy to start and stop the site, can templatize</td>
<td>Difficult to integrate with other AWS services, need Secret Keys, advance customization might be difficult</td>
</tr>
<tr>
<td>Management Console (Manual)</td>
<td>Full control on how the system works</td>
<td>Can be used only by advance users. Needs to setup all components and connect them. Need to be proficient in the ArcGIS Enterprise and AWS</td>
</tr>
</tbody>
</table>
Azure Options to set up ArcGIS Enterprise

The below link gives an idea on what is ArcGIS Enterprise on Azure


• Using ArcGIS Server Cloud Builder
ArcGIS Image Server stand alone on the Cloud (AWS sample)
Image Server Deployment

- **Image Server**
  - M5d.2xlarge (1 instance) (in autoscaling mode, siloed)
  - db.r4.xlarge (RDS) for high 20gb+ Mosaic dataset, or db.m4.xlarge
  - You will need a ELB, you can use the below Cloudformation template to create an ELB
    - Then map the ELB name to the required domain name
  - Obtain following: Domain Name, SSL certificate, Image server License File (note you edit the file to mention your name and details)
  - If using RDS select DBengine and select postgres for it.
Dedicated vs Shared Instances

**Dedicated Instances**
- Traditional Instances
- Each Image Services has defined pool of SOC
- Better for reduced number of high load services
- Publish using Pro/ArcMap or Server Admin API

**Shared Instances**
- Pool of SOCs used for all Hosted Image Services (inc RA output)
- Used by all Hosted Imagery
- Can be defined using Admin API
- Note there is warm up time for Mosaic Datasets (about 12seconds)
- Best used for large number of services
- Publish using Pro or Server Admin API

Service A  Service B  Service C

A,B,C,D,E,F,....
File vs Enterprise GeoDatabase

- File GeoDatabase
  - OK for smaller mosaic datasets
  - Good for local mosaic datasets
  - Very Chatty – Not good to store on a shared drive

- In Cloud
  - Best to use AWS RDS (Aurora, PostgreSQL, SQL Server) or Azure (SQL Server, PostgreSQL)
  - Typically do not use portal Enterprise geodatabase (security/setup/portal load)
  - Can use FileGeodatabase on FileShare, but does not scale well
  - Alternative use FileGeodatabase, but copy from S3 to Ephemeral drive (simpler in Siloed)
Cloud Storage Options

• File Storage
  - SMB access
  - Not Cloud Native
  - OK for smaller dataset, but does not scale well
  - Good for caching, if connected to directly server (eg Ephemeral)

• Object Storage - S3 / Azure Blob
  - Shared Access
  - REST Based (Http:)
  - Nearly unlimited size
  - Higher Latency/Higher throughput

Optimum is to use Cloud Storage for Large images with caching local on ephemeral disk
Using Cloud Storage

• **Native** (directly use S3/BlobStore)
  - Create using Cloud Provider Console. Use AIM Role or Profile on machines
  - Use VSI or Raster Proxies
  - Only single secured account per machine (Credential or IAM Role)
  - Can use Canonical IDs for access control
  - More control (policies/rules), Read Only

• **ACS** (Cloud storage connection file)
  - Create in Pro (embed credentials)
  - Supports Credentials or IAM Role
  - Use in Pro, Add Rasters to Mosaic Dataset
  - Publish to Server (credential passed in Mosaic Dataset)
  - Supports multiple accounts, Read Only

• **Cloud Raster Store**
  - Create with ArcGIS Server Manager
  - Used to store Imagery Hosting and output from Raster Analytics (Raster Store)
  - Read/Write

| IKONOS, QuickBird, GeoEye-1, WordView-1-4 |
| GF-1 PMS, GF-1 WFV, GF-2 PMS |
| Landsat 1-5 MSS, 4-5 TM, 7 ETM+, 8 |
| Pleiades-1, SPOT 5,6,7 |
| KOMPSAT-2, KOMPSAT-3 |
| Sentinel-2 |
| DubaiSat-2 |
| ZY3-SASMAC |
Cloud Native Security – Many Options

• Public – No security
• Public - No List - Obfuscate – Public but hide URLs
• Requestor Pays – Same as Public, but user must have account (who pays for Egress)
• IAM role (Identity & Access Management) / Role-Based Access control (RBAC)
  - Set permission by users
• Presigned URLs, Amazon Query String Request Authentication / SAS (Shared Access Signature)
  - Token based. Token has expiry
• Access Control List – File Level permissions (Difficult for large numbers of files)
• Bucket policies - Fine control. (E.g. can set access by canonical IDs, use xx*, IP Address etc.)

Note: Also Check Cross Origin Resource Sharing (CROS) if data accessed directly by apps.
What Affects Performance

• Volume of data read
  - Only read what is required (tiling/pyramids)
  - ArcGIS will only read pixels required
  - Use of Footprints vs. NoData

• Process Efficiency
  - Process only pixels required
  - Concatenate functions to reduce I/O
  - Use raster functions to speed processing

• Latency
  - Reduce number of requests (especially duplicate)
  - Tile Level Caching

• Bandwidth
  - Reduce data volume through compression (but don’t increase CPU)

• Data structure
  - Ensure efficient data access
## Raster Storage Formats & Compression

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<tr>
<th>Format</th>
<th>Advantage</th>
<th>Compression</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Raw, Stripped TIF</td>
<td>Advantage: Sequential access</td>
<td>None</td>
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<tr>
<td></td>
<td>Disadvantage: Sequential access</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Compression: None</td>
<td></td>
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<tr>
<td>NetCDF, GRIB</td>
<td>Advantage: Multidimension support</td>
<td>None or Lossy JPEG (8bit &amp; 12bit)</td>
<td>Optimum for larger rasters</td>
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<tr>
<td></td>
<td>Disadvantage: None</td>
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<tr>
<td></td>
<td>Compression: Varied</td>
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<tr>
<td>Tiled GeoTIFF</td>
<td>Advantage: Tiled Access, can include Pyramids</td>
<td>None or Lossy JPEG (8bit &amp; 12bit)</td>
<td>Best of compatibility with satellite scenes etc.</td>
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<tr>
<td></td>
<td>Disadvantage: Sequential access</td>
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<tr>
<td></td>
<td>Compression: Varied</td>
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<tr>
<td>COG (Cloud Optimized Geotiff)</td>
<td>Same as Tiled GeoTIF only index is move to front</td>
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<tr>
<td>MRF</td>
<td>Advantage: Tiled Access</td>
<td>As GeoTIFF, LERC – Controlled Lossy – Very Fast</td>
<td>Optimum for higher bit depth &amp; categorical</td>
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<tr>
<td></td>
<td>Compression</td>
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<tr>
<td>CRF</td>
<td>Advantage: Tiled into Bundles, Multi-process</td>
<td>None, LERC, JPEG</td>
<td>Optimum for larger rasters</td>
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Correctly structuring imagery can have a massive effect on performance.
Many datasets directly from vendors are very generic (and slow to access).
Can put high load on File System.
Often near impossible to use directly on Cloud storage.

Typically better to Optimize Imagery:
- Prior to Uploading to Cloud
- As part of uploading process
- Upload to Cloud and then Optimize

Multiple Cloud Optimizations (Also works very well on-premises)
Raster Format Considerations / Optimization

- Tiling of imagery – Enables partial access
- Compression – Reduce storage and transfer – Weigh against additional compute requirements
- Data access complexity – Reduce subsequent requests
- Pyramids – Provide faster access as smaller scales

---

**Slow**

- Striped TIF
  - Non optimum access

**Good**

- Tiled TIF
  - Enables partial access
- COG
  - Improved access to pyramids (often part of first request)

**Not Good**

- NetCDF/HDF/GRIB (gridded)
  - No Pyramid
Raster Format Considerations / Optimization

- Tiling of imagery – Enables partial access
- Compression – Reduce storage and transfer – Weigh against additional compute requirements
- Data access complexity – Reduce subsequent requests
- Pyramids

**Good**

**Optimum**

Separate files enable operating system caching
Files can be in separate locations (e.g., metadata and index on fast access)
CRF – Cloud Raster Format

- Similar to TPK, but multi-band, multi-bit depth
- Spit into bundles/packet each has set number of tiles. Each bundle has its own index
- Structure of tiles is inherent in the directory structure
- Supports various compression including LERC
- When accessed each bundle required is read and cached locally (managed)
- Advantage
  - Enables multi-processor write
  - Good for large rasters
- Disadvantage
  - Multiple files
  - Not good for many smaller rasters

Simplicity of data structure enables both MRF and CRF to be directly accessed through JavaScript etc
Transposed CRF

- Extension to CRF (at V2.4) to optimally handle additional dimension

GDAL has no suitable API for additional dimensions
CRF is not accessed through GDAL
Compression

- **Lossless**
  - Deflate
  - LZW
  - LERC *
  - PNG
  - JPEG2000

- **Lossy**
  - JPEG (RGB / YCbCr)
  - JPEG2000

- **Controlled Lossy**
  - LERC

The above are typical, Compression performance is dependent on source.

* LERC is Lossless when tolerance set lower than precision
Image Conversion

- Converting data options
  - ArcGIS Export – To TIF, CRF, MRF
  - Copy Raster (for CRF)
  - Use OptimizeRasters
    - [https://github.com/Esri/OptimizeRasters](https://github.com/Esri/OptimizeRasters)
  - GDAL
Optimize Raster

- Converts Raster to optimal formats
- Transfer data to and from cloud storage (AWS, Azure, Google, Alibaba) or enterprise storage
- Runs with in ArcGIS (ArcGIS Pro or ArcMap) or as a standalone utility
- Supports for Windows and Linux
- Parallel Processing is supported by default
- Creates Raster Proxies
- Logging support
- Converts the data using the best practices (templates provided)
- ...

https://github.com/Esri/OptimizeRasters
Getting data to the Cloud - How to transfer

- Upload using Portal (goes to raster store)
- CloudBerry, etc.
- Amazon cli Command or Console
- OptimizeRasters
- White Glove Services Snowball ($200/50TB), Snowmobile
Accessing Imagery from Cloud Storage

- **Directly use `\VSICurl` `\VSIS3` `\VSIAZ`**
  - As if local file. Multiple requests, No Caching.
- **ACS**
  - Advantage of multiple profiles
  - **Caching Optional** - The pixel cache for a mosaic dataset can be generated by running the Add Rasters to Mosaic Dataset tool with the *Enable Pixel Cache* parameter checked. (Issues, Not recommended in current version)
  - Managed Cache
- **Raster Proxies**  (See Optimize Rasters)
  - Can be batch produced
  - Non Managed Cache (Manage on own)
  - Option to use as local files and then embed
  - Further optimize by setting environment variables
Raster Proxies

- Work with most GDAL Readable formats
- More optimal with MRF
- Reference the source files
- Enables caching of data
  - Speed up subsequent reads
- Most optimum when referencing MRF
- Can have any raster extension
- Use like any other Rasters
- Need to consider cache location
- Need to manage cache

- Create using OptimizeRasters
- Read Optimize Rasters Help

When accessed, tiles + index to tiles are stored locally. Tiles are stored either uncompressed or using LERC.

When accessed, Tiles + index to tiles + index to source tiles are stored locally. Tiles are original tiles.
Referencing Rasters in a Mosaic Dataset
Where possible mosaic dataset should not reference files on disk

• Options
  - Files share – Same path for authoring & server
  - Create ASC, Add data to MD and publish (don’t use caching yet)
  - File Share to Raster Proxies (which have linked to cloud storage)
  - Create using Raster Proxies, then embed into MD before Publishing (MDTools)
  - Create directly with \VSI in paths (use table Raster)
  - Create directly with raster proxies embedded (user raster proxy as table in Optimize Rasters)
  - Use Raster Proxies then embed into mosaic dataset using MDTools (Part of MDCS)
Imagery Workflows

ArcGIS Imagery Workflows

Authoritative resources to help you manage, analyze, and use your imagery and rasters.

www.esriurl.com/imageryworkflows
Questions?

Supporting Slides
www.esriurl.com/UC2019ImgMgmtCloud
Please Share Your Feedback in the App

Download the Esri Events app and find your event

Select the session you attended

Scroll down to “Survey”

Log in to access the survey

Complete the survey and select “Submit”