Caching Maps and Vector Tile Layers: Best Practices

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Where the science of caching
...gives you long awkward hugs
Goals for Today

- Differences between Raster Tiles and Vector Tiles
- When to use either option
- How to cook them
- How to share them
- How to consume them
Roadmap
Raster / Vector Tile Best Practices

1. Overview
2. Compare and contrast
3. Use cases
4. Authoring raster tile and vector tile projects
5. Share and Publish
6. Optimizing raster tile generation
7. Restyling multiple maps from one tileset
Raster and Vector Tiles

...an overview
Tiles

• What are Raster Tiles?
  - Pre-rendered snapshots of your map
  - JPEG’s and PNG’s

• Tiling Scheme:
  - Origin
  - Tile Dimension and Format
  - Extent
  - CRS
  - LOD’s

• Generate Cache
  - Cooking
Web GIS and Mobile Mapping

The times they are a changin’

- Technology is forcing us to evolve how we deliver content

- The landscape has changed
  - GPU and CPU
  - High resolution displays

- Devices and browsers are more capable of handling advanced graphics processing
Do we have to rasterize them?

- What if we could leverage the processing power of our mobile devices and advances in web browser technology?
  - Keep vector data as vector
  - Ask the device to take on the rendering load

- Vector tiles (data and rendering instructions)
  - Tileset components:
    - Tiles
    - Styles
    - Sprites
    - Fonts
    - Index
Vector tiles in ArcGIS

- Leverage several Open Source projects
  - Tiles use the Mapbox vector tile spec
  - Based on Google protocol buffers
  - Styling conforms to the Mapbox GL style spec

- More aggressive overzoom
  - Indexed tiling scheme
  - Support for traditional tiling also exists

- Any supported Coordinate System
Advantages of vector tiles

• **Display quality**
  - Best possible resolution for HD displays
  - Small efficient format

• **Dynamic labeling**
  - Clearer, more readable text
  - On the fly labeling for heads up display

• **Map Styling**
  - Streets, Topo, Canvas from one tileset
  - Day and Night mode
  - Restyling
Compare and Contrast
Raster Tiles and Vector Tiles
Authoring Clients / Tools

**Raster Tiles**
- MXD’s and Mosaic Datasets
- ArcGIS Desktop
  - Manage Tile Cache
  - Create Map Tile Package
  - Integrated sharing in ArcGIS Pro 1.4
- ArcGIS Server
  - Server tools / caching toolset

**Vector Tiles**
- Map Projects
- ArcGIS Pro v1.2+
  - Create Vector Tile Package
- ArcGIS Pro v1.4*
  - Integrated sharing workflow
Dataset structure

- **Raster Tiles:**
  - .bundle
  - JPEG
  - PNG8, PNG24, PNG32
  - PNG
  - MIXED
  - LERC

- **Vector Tiles:**
  - Mapbox vector tile spec
    - Google’s protocol buffers
    - Mapbox gl style spec
  - .bundle
Tile creation process: Esri basemaps

- **Raster Tiles for entire world**
  - ~ many weeks on a server cluster per map style
  - Tiles ~ 20 TB

- **Compared to vector tiles**
  - ~ 8hrs on a desktop machine
  - Tiles ~ 20 GB
  - Multiple styles can use the same tileset
## Summary: Compare and Contrast

<table>
<thead>
<tr>
<th>Feature</th>
<th>Raster Tiles</th>
<th>Vector Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imagery</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Projection</td>
<td>All Supported CRS</td>
<td>All Supported CRS</td>
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<tr>
<td>Updating AOI</td>
<td>✓</td>
<td>Future Release</td>
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<tr>
<td>Changing styles</td>
<td>×</td>
<td>✓</td>
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<tr>
<td>Tile format</td>
<td>JPEG, PNG, LERC</td>
<td>PBF</td>
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<tr>
<td>Tile consumption</td>
<td>ArcGIS Pro, ArcGIS Desktop, Runtime, JSAPI, ArcGIS Earth</td>
<td>ArcGIS Pro 1.3+, Modern Browsers with WebGL support*, Runtime 100.0+, JSAPI 3.15+</td>
</tr>
<tr>
<td>Authoring Clients</td>
<td>ArcGIS Pro, ArcGIS Desktop</td>
<td>ArcGIS Pro 1.2+</td>
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<td>Hosting Components</td>
<td>ArcGIS Online, ArcGIS Enterprise, ArcGIS for Server</td>
<td>ArcGIS Online, ArcGIS Enterprise 10.4+</td>
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<tr>
<td>Export Packages</td>
<td>✓</td>
<td>Available in ArcGIS Online</td>
</tr>
</tbody>
</table>

* Current Display Driver
Use Cases
Raster Tiles and Vector Tiles
Use cases

TensorTiles:
- Imagery Basemap
- CADRG / ECRG (Scanned Maps)
- Hillshade / Shaded Relief
- 3D Terrain
- StreetMap
- Canvas Maps
- Boundaries and Places
- Transportation

VectorTiles:
Authoring Maps
A Professional approach for Raster and Vector Tiles
Re-Author your Map documents using ArcGIS Pro
Create efficient and cartographically rich tilesets

- Cartography enhancements
  - Improved scale logic
  - Scale-based symbol classes
  - Alternate symbols
  - Scale-based symbol sizing
  - Display filters
  - Arcade label expressions
  - Symbol layer drawing - Basic Mode*
  - Annotation Support*
  - SVG’s as shape marker symbols*

*New at ArcGIS Pro 2.0
Re-Author your Map documents using ArcGIS Pro
Create efficient and cartographically rich tilesets

• Limit...
  - number of layers
  - duplication of content

• Be mindful of users that want to re-style your maps
Re-Author your Map documents using ArcGIS Pro
Create efficient and cartographically rich tilesets

• Quality of life changes
  - Can open multiple projects simultaneously*
  - Catalog is BACK!*
Cartography Enhancements
ArcGIS Pro 2.0
Scale logic changes

• ArcMap and ArcGIS Pro 1.1
  - Layers will draw AT and BETWEEN minimum and maximum scales

• ArcGIS Pro 1.2+, layers don’t draw at max scale by default
  - Check “Draw up to and including the maximum scale in scale ranges” to revert to old behavior
    - This is checked for old Pro projects or imported ArcMap maps
  - Uncheck the box...trust me
Scale logic changes

- Draw up to and including
- Vector Tiles = unchecked
Scale-based symbology

- Each symbol class can be assigned a scale range
  - Unique Values
  - Graduated Colors
- Allows a multiscale map to be authored without duplicating content
Alternate symbols for scale-based symbology

- Symbol classes can switch symbols at scales
  - Unique value

- Allows you to change the appearance of a symbol without duplicating layer
Scale-based symbol sizing

- Each symbol can have scale based sizing configured
  - Single symbol
  - Unique value
  - Class breaks

- Allows for small changes to symbol size across scales
Display filters

- **Scale-based definition queries**

- **Useful for layers like roads or cities**
  - Single layer, single label class, without labeling everything at every scale

- **Labeled features: If something isn’t symbolized and not removed by a def query, it’ll label. Use Display Filter to reduce the number of scale dependent label classes**

- When do you use display filters vs duplicate layers in the toc?
Symbol level drawing - Basic Mode

- ArcGIS Pro 2.0 now offers a basic mode for symbol layer drawing
  - Join / Join and Merge

- Improved layer naming
  - Stacked symbols:
    - Layer 1 = lowest symbol in the stack

- Advanced mode
  - Can join and merge layers from other symbol classes
Annotation
Raster Tiles only

- ArcGIS Pro 2.0 now supports annotation features
Highlight Fields
Vector Tiles only

• Adding attributes to vector tiles to enable things like
  - Style based filtering
  - Alternate names / local languages

• Too much of a good thing can be bad for you
  - Can negatively affect tile payload size
Migrating to Pro
ArcGIS Pro 2.0
Sharing and Cooking

...is caring
Sharing and publishing Cached Map Image Layers
Sharing and publishing Tile/Vector Tile Layers

- **General**
  - Name: Map
  - Data:
    - Reference registered data
    - Copy all data
  - Layer Type:
    - Vector Tile
  - Item Description:
    - Publishing Tile/Vector Tile Layers using Tpk/VTpk is integrated now.
    - Tags: Tile Layers, Hosted Servers, ArcGIS online, Disconnected from Map data
  - Sharing Options:
    - My Content
    - Portal for ArcGIS
    - Everyone
    - Groups

- **Configuration**
  - Caching
    - ArcGIS Online / Bing Map
  - Levels of Detail:
    - Minimum: 0, Maximum: 19
    - Scale: 1:2055,1025,764
    - Temporal cache location: C:\Users\g004000\AppData\Local\ESRI\ArcGIS Pro\Temp

- **Content**
  - Vector Tile Properties
    - Tiling Scheme: ArcGIS Online / Bing Map
    - Levels of Detail
      - Minimum: 0, Maximum: 19
      - Scale: 1:2055,1025,764
    - World
    - Houses

The screenshots show the process of sharing and publishing Tile and Vector Tile Layers within a software interface.
Are Raster Tiles still relevant?

Absolutely…

Map Services

Image Services

Elevation Services

3D Terrain Services
Tiles: JPEG 75 @ 256x256
Test: 1:147M – 1:9K
Continental U.S. AOI
2677 Bundles, 42,831,784 Tiles
Bare Metal Server x 16:
Windows 2008R2 SP1
32 cores, 500GB hdd, 256GB RAM
Caching Tools: 512 instances total
Raster Tiles

Cache smarter...not harder

- Only cache what is necessary
- Use AOI’s with decreasing coverage as you increase LOD’s
- Break your basemap project into multiple cache jobs by bracketing LOD’s
  - Each job can / should have a unique AOI
- Only update what has changed
  - You don’t need to re-cache everything if you have partial updates to your data
Raster Tiles
ArcGIS Server Configuration

- Don’t use Fine, Verbose, or Debug logging.
- Size your Caching Tools Instances:
  - $N = \# \text{ of cores per machine}$
  - Min and Max = $N$
  - 2 - 4GB of RAM $\times N$
  - Decrease $N$ if necessary

Cache smarter...not harder
Raster Tiles

Imagery Basemaps / Image Services

• Use JPEG or MIXED tile type
• Copy FGDB and Mosaic Datasets local
• Map or Image Service?
  - Fixed draw order
  - Complex cartographic treatments
• Build pyramids?
  - Time and storage
• Use footprints for cache extents
  - Dissolve footprints
  - Use higher resolution footprints to constrain cache at larger scales
• Prep Mosaic Datasets for caching:
  - Use the analyze tools
  - Spatial Index
  - Increase max number of rasters
  - Increase max number of rows / columns
Raster Tiles
3D Terrain Image Services

• ArcMap
  - Use LERC (.1 compression)
  - CRS:
    - Web Mercator - 10.3.1+
    - GCS-WGS84 - 10.5
  - Build overviews
  - Use footprints for cache extents

• ArcGIS Pro

• Publish WebSceneLayers
  - Creates the Cached Elevation layer
Raster Tiles
Vector Basemaps

• Use JPEG-90
  - Lots of color variation

• PNG tile type
  - Support transparency
  - Canvas style maps

• Copy FGDB local
  - Compact and compress

• Use selections of grids
  - Use higher resolution data
  - Dissolve selected grids

• Optimize your MXD / APRX
Summary: Optimizing Raster Tile Generation

- ArcGIS Server scales / leverages system resources

- Optimize your data:
  - spatial index, compact and compress FGDB, copy data local

- Configure ArcGIS Server Caching instances

- Optimize MXD / APRX and Imagery Projects:
  - analyzer results, scale dependencies, Maplex when needed, Mosaic Dataset tuning

- Optimize cache jobs:
  - AOI’s per LOD, only cache what is necessary

Cache smarter…not harder
Restyling

multiple maps from one tileset
Summary
Raster Tiles and Vector Tiles…go forth and conquer
Summary

Raster Tiles:
• Rasters and elevation datasets
• Any client
• Big Footprint
  - TB’s of cache data
• Generation can consumes lots of resources
  - nCPU x Time = Weeks

Vector Tiles
• All vector datasets
• Modern browsers with WebGL
• ArcGIS Pro 1.3+
• Small footprint
  - ~20 GB for whole world
• Generation consumes less resources
  - CPU x Time = hours
Final Checkup

- Differences between Raster Tiles and Vector Tiles
- When to use either option
- How to cook them
- How to share them
- How to consume them
- Long awkward hug…annnnnnd check!
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<td>Desktop Mapping: Creating Vector Tiles</td>
<td>Tuesday, July 11, 10:15 am - 11:30 am</td>
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<td>Corporate Brand Your Vector Basemap</td>
<td>Tuesday, July 11, 11:30 am - 12:15 pm</td>
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<tr>
<td>Designing Esri’s Vector Tile Basemaps</td>
<td>Tuesday, July 11, 2:00 pm - 2:30 pm</td>
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<td>Best Practices for Managing and Serving Processed Ortho Imagery</td>
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<td>Administering Your ArcGIS Portal</td>
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<td>Creative Vector Basemaps</td>
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Questions?