Best Practices for Caching Maps and Vector Tile Layers

Tommy Fauvell
Topics

- Raster tiles and vector tiles
- Raster tiles: relevance and best practices
- Vector tiles: authoring, sharing, and styling
- Please hold all questions until the end
Introduction to raster and vector tiles
Raster Tiles

• What are Raster Tiles?
  - Pre-rendered snapshots

• 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 tilesets deliver layers of geometry and rendering instructions
  - Tiles
  - Styles
  - Sprites
  - Fonts
  - Index
Tile creation process: Esri basemaps

- **Entire world**
  - ~ 8hrs on a desktop machine
  - Tiles ~ 13 GB
  - Multiple styles can use the same tiles

- **Compared to raster for the entire world**
  - ~ many weeks on a server cluster per map style
  - Tiles ~ 20 TB
What do each of the tile formats look like?

- **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
Authoring Clients / Generation Mechanics

- Raster Tiles:
  - MXD’s and Mosaic Datasets
  - ArcGIS Desktop
    - Manage Tile Cache
    - Package Tools
  - ArcGIS Pro
    - Manage Tile Cache
    - Create Map Tile Package
  - ArcGIS Server
    - Manage Map Server Cache Tiles

- Vector Tiles:
  - Map Projects
  - ArcGIS Pro v1.2+
    - Create Vector Tile Package
  - ArcGIS Pro v1.4*
    - Integrated sharing workflow
Use cases

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

• Vector Tiles:
  - StreetMap
  - Canvas Maps
  - Boundaries and Places
  - Transportation
## To Summarize

<table>
<thead>
<tr>
<th></th>
<th>Raster Tiles</th>
<th>Vector Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imagery</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Projection</td>
<td>All Supported CRS</td>
<td>All Supported CRS</td>
</tr>
<tr>
<td>Updating AOI</td>
<td>✓</td>
<td>Road Ahead</td>
</tr>
<tr>
<td>Changing styles</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Tile format</td>
<td>JPEG, PNG, LERC</td>
<td>PBF</td>
</tr>
<tr>
<td>Tile consumption</td>
<td>ArcGIS Pro</td>
<td>ArcGIS Pro 1.3+</td>
</tr>
<tr>
<td></td>
<td>ArcGIS Desktop</td>
<td>Modern Browsers with WebGL support*</td>
</tr>
<tr>
<td></td>
<td>Runtime</td>
<td>Runtime (Quartz Beta2)</td>
</tr>
<tr>
<td></td>
<td>Web API's</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ArcGIS Earth</td>
<td></td>
</tr>
<tr>
<td>Authoring Clients</td>
<td>ArcGIS Pro</td>
<td>ArcGIS Pro 1.2+</td>
</tr>
<tr>
<td>Hosting Components</td>
<td>ArcGIS for Server</td>
<td>Portal for ArcGIS</td>
</tr>
<tr>
<td></td>
<td>Portal for ArcGIS</td>
<td>Portal for ArcGIS.com</td>
</tr>
<tr>
<td></td>
<td>ArcGIS.com</td>
<td>ArcGIS.com</td>
</tr>
<tr>
<td>Export Packages</td>
<td>✓</td>
<td>Road Ahead</td>
</tr>
</tbody>
</table>

*Current Display Adaptor*
Raster Tiles
Relevance and Best Practices
Are Raster Tiles still relevant?

Absolutely…

- Map Services
- Image Services
- Elevation Services
- 3D Terrain Services
Scalable
Tiles: JPEG 75 @ 256x256
Test: 1:147M – 1:9K
Continental U.S. AOI
2677 Bundles, 42,831,784 Tiles
Bare Metal Server:
Windows 2008R2 SP1
32 cores, 500GB hdd, 256GB RAM
1 – 16 servers (32 – 512 cores)
Optimize Your Data

• File Geodatabase:
  - Spatial Index
  - Compact
  - Compress
  - Attribute Index

• Location:
  - If you have room, replicate your data onto each ArcGIS Server machine

• Coordinate reference system:
  - On-the-fly vs reproject data

Cache smarter…not harder
Imagery Basemaps / Image Services

- Use JPEG or MIXED tile type
- FGDB and Mosaic Datasets local vs shared file server location
- 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

Cache smarter…not harder
Imagery Basemaps / Image Services

- Prep Mosaic Datasets for caching:
  - Use the analyze tools
  - Spatial Index
  - Attribute Index (Mosaic Method fields)
  - Increase max number of rasters
  - Increase max number of rows / columns

Cache smarter…not harder
3D Terrain Image Services

- Use LERC
  - .1 compression
- CRS:
  - Web Mercator – 10.3.1+
  - GCS-WGS84 – 10.5
- Build overviews
- Use footprints for cache extents
  - Dissolve footprints
  - Use higher resolution footprints to constrain cache at larger scales
Map Documents / Map Service

• Use JPEG 90 or PNG
  - JPEG for large color variation
  - PNG with canvas maps / reference maps
• Annotations / Dynamic Labeling
• Scale Dependencies and Group Layers
• Value-based renderers and attribute indices
• Map Publishing analyzer
ArcGIS Server

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

- Size your Cache Controllers Instances:
  - Based on the number of simultaneous jobs you plan to run, ensure you have enough max instances.
Cache Jobs

- 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
Best Practices for Raster Tiles

• ArcGIS Server scales / leverages system resources

• Optimize your data:
  - spatial and attribute indices, compact and compress FGDB, local data

• Configure ArcGIS Server Caching instances

• Optimize MXD 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
Are Vector Tiles really a game changer?
Yes...yes they are!
Design considerations

• Only feature layers with simple, unique value, graduated, or class breaks symbology supported

• **New at Pro 1.4**
  - Support for Arcade label expressions
  - Support for Display filters

• **Maps should be re-authored for vector tiles**
  - Limit number of layers
  - Limit duplication of content
  - Be mindful of users that want to re-style your maps
Authoring maps

- Several improvements have been made in ArcGIS Pro to create efficient and cartographically rich tilesets
  - Scale dependent capabilities added to symbology
  - Alternate symbols added to symbology
  - Scale based sizing added to symbology
  - Improvement to scale logic
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
Authoring / Sharing
Scale dependent symbology

- Each symbol class can be assigned a scale range
  - Unique value
  - Class breaks

- Allows a multiscale map to be authored without duplicating content
Alternate symbols for 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
Styling vector tiles

• **Simple Style Copy**
  - Save tile layer to your Portal or Online account

• **Hand editing JSON**
  - Update map item

• **Two additional sample Vector Styling Apps simplify this:**
  - [Vector Style JSON Editor](https://github.com) - GitHub
  - [Vector Basemap Style Editor](https://github.com) - GitHub
Styling demo
Summary

Raster Tiles

- **Big Footprint**
  - TB’s of cache data
  - Single SOC for Map / Image Service
- **Generation can consumes lots of resources**
  - nCPU x Time = Weeks
- **Most flexible**
  - Any CRS
  - Any Data (imagery or vector)
  - Any Client

Vector Tiles

- **Small footprint**
  - 13 GB for whole world
  - Hosted tile layer
- **Generation consumes less resources**
  - CPU x Time = hours
- **Getting more flexible**
  - Any supported CRS*
  - Vectors, no imagery
  - Modern browsers with WebGL
  - Pro v 1.3
Questions?
Please Take Our Survey on the **Esri Events App**!

1. **Download the Esri Events app and find your event**
2. **Select the session you attended**
3. **Scroll down to find the survey**
4. **Complete Answers and Select “Submit”**
Print Your Certificate of Attendance
Print stations located in the 140 Concourse

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30 PM – 6:30 PM</td>
<td>10:45 AM – 5:15 PM</td>
</tr>
<tr>
<td>GIS Solutions Expo, Hall B</td>
<td>GIS Solutions Expo, Hall B</td>
</tr>
<tr>
<td>5:15 PM – 6:30 PM</td>
<td>6:30 PM – 9:30 PM</td>
</tr>
<tr>
<td>Expo Social, Hall B</td>
<td>Networking Reception, Smithsonian National Air and Space Museum</td>
</tr>
</tbody>
</table>