Building Basemaps:
MapCaches and VectorTiles

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What are Basemaps for

- Basemaps provide an optimal background and orientation for displaying your data on top

- Should be
  - Fast
  - Nice cartography
Areas where you use Basemap

- ArcGIS Desktop
- ArcGIS Pro
- ArcGIS Runtime
- JavaScript API
- ArcGIS Maps for Office
- WebMaps
- :
  ➔ Everywhere
Types of Basemaps

- Raster based/Map Caches
  - Cached MapServices (Server, Online/Portal)
  - Tilepackages

- Vector based
  - TileService (Online/Portal)
  - VectorTilePackages
Basemaps: Raster Tiles/Map Caches
Raster Tile Basemaps

- Created for years with ArcGIS Desktop and ArcGIS Server
- Hosted Services on ArcGIS Online and Portal for ArcGIS
- Option to choose StorageFormat of Rastertiles
  - PNG
  - JPEG
  - MIXED
- And Storage on Disk
  - Exploded
  - Compact
Settings for Map Cache

Service Editor

Connection: map.geoportal.at,6443 (admin - siteadmin)  Service Name: Allgemein_Orthofoto

Caching

- Draw this map service: Dynamically from the data
- Using files from a cache

Cache Settings

Tiling Scheme: An existing cached map/image service

Levels of Detail

Choose the minimum and maximum scales for this tiled map/image service. All levels between the minimum and maximum scale levels will be cached.

Minimum scale level: 0  Maximum scale level: 14
Scale: 1:10,000,000  Scale: 1:11,000

Estimated Cache Size: 64 GB

Update cache automatically
Update cache manually

OK  Cancel
Advanced Settings for Map Cache

Service Editor

Advanced Settings

- Enter Scale
- Enter Pixel Size

Scales | Pixel Size | Disk Space |
-------|-----------|-----------|
1:10,000,000 | 2,045,839,025 | 0.01 MB |
1:15,000,000 | 1,572,319,133 | 0.01 MB |
1:20,000,000 | 1,059,177,231 | 0.01 MB |
1:25,000,000 | 539,586,363 | 0.00 MB |
1:30,000,000 | 423,955,168 | 0.00 MB |
1:35,000,000 | 330,641,875 | 0.00 MB |
1:40,000,000 | 254,089,063 | 0.00 MB |
1:45,000,000 | 195,175,764 | 0.00 MB |
1:50,000,000 | 156,093,300 | 0.00 MB |

Minimum cached scale: 1:10,000,000
Maximum cached scale: 1:11,000
Cache directory: D:\\<username>\<local>\\mapcache
Area of interest to cache: Full extent of the map
Tile Format: METHOD
Compression: AS
Create tiles on demand

Advanced Cache Settings

- Tile Origin in map units:
  - X: 55223000
  - Y: 5001000

- Dots per inch (DPI):
  - 95

- Tile Height & Width:
  - 256 x 256

- Storage Format:
  - COMPACT

- Allow clients to cache tiles locally
- Allow clients to export cache tiles

Unit export limit: 100000 Tiles

OK | Cancel
Vector Tiles - Overview

- Why vector tiles?
- Vector tiles in ArcGIS
- ArcGIS vector tile basemaps
- Overview of creating vector tiles
- Authoring a map for vector tiles
- Consuming and styling vector tiles
- Common questions
Web and mobile mapping over the last 10+ years

- Typically vector content (points, lines, polygons)
- Displayed on top of basemaps
- Since ~2005, basemaps have usually been raster tiles

- Dynamic updates of the map consist of two things:
  - Updating overlay content as drawn in client
  - Changing the basemap

- Paradigm is changing
Raster tiles for high dpi devices

Example from Google Maps
Why vector tiles?

Raster is **Faster**, but Vector is **Corrector**

– Joseph Berry
Why vector tiles?

• GPUs have changed the landscape
  - On your devices (OpenGL ES)
  - In your browser (WebGL)
  - On your desktop (DirectX, OpenGL)
  - Even in virtualized systems (vGPU)

• Vector data can remain vector, draw at native resolution

• Raster data still best served as raster in most circumstances
Advantages of vector tiles

• **Display quality**
  - Best possible resolution for Retina 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

Labels rotate and flip
Vector tiles in ArcGIS

- Tiles produced in ArcGIS Pro 1.2+
  - Use the Mapbox vector tile spec
    - Which uses Google protocol buffers
    - Styling converted to Mapbox gl style spec
- Tiles produced in ArcGIS Pro 1.4+
  - Extended Spec with support of any CRS
- More aggressive overzoom
  - Builds on generalization work done in past ArcGIS releases
  - Support for traditional tiling also exists
Vector tile format

- Vector tiles are stored using protocol buffers
  - Compact binary format for transferring data
  - Data is organized into layers of geometry with key/value pairs of attributes

- A style file defines
  - The layer order
  - Definition query for each symbol layer
  - Symbol information for each symbol layer
  - Pro maps are converted to this model
    - Is a downgrade in some cases
## Tile Creation Process

<table>
<thead>
<tr>
<th>Esri Streetmap</th>
<th>Raster Tiles</th>
<th>Vector Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Earth</td>
<td>Earth</td>
</tr>
<tr>
<td>Volume</td>
<td>~ 20 TB</td>
<td>~13 GB</td>
</tr>
<tr>
<td>Duration</td>
<td>Weeks</td>
<td>~ 8 hours</td>
</tr>
<tr>
<td>Processing</td>
<td>Serverfarm with X Cores</td>
<td>Desktop machine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BasemapAT</th>
<th>Raster Tiles</th>
<th>Vector Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>City of Vienna (~ 400 km²)</td>
<td>City of Vienna (~ 400 km²)</td>
</tr>
<tr>
<td>Volume</td>
<td>325 MB</td>
<td>84 MB (*)</td>
</tr>
<tr>
<td>Duration</td>
<td>12 minutes</td>
<td>3 minutes (*)</td>
</tr>
<tr>
<td>Processing on same hardware</td>
<td>6 Cores</td>
<td>1 Core</td>
</tr>
</tbody>
</table>

(*) Visualization not yet optimized for Vector Tiles
Vector tile basemaps

• Available on ArcGIS.com since November 2015 – since Dec. 2016 in Production
• Street (with and w/o relief), Topo, Night, Navigation, Dark Canvas, Light Canvas, Hybrid
Vector basemap blogs
ArcGIS vector tiles – consumption

- **Tile consumption**
  - ArcGIS JavaScript 3.15-3.17 and 4.0/4.1 APIs
    - Uses the mapbox-gl-js library
    - Need a WebGL capable browser (e.g. IE11+, Chrome, Firefox)
  - ArcGIS JavaScript 3.18+ and 4.2+
    - Own implemented library to support other Tiling Schemas and Coordinate Systems
    - WebGL capable browser needed (e.g. IE11+, Chrome, Firefox)
  - ArcGIS Runtime 100.0+
    - Ground up implementation - OpenGL ES2 and DirectX (depends on platform)
  - ArcGIS Pro 1.3+
    - Will share Runtime implementation
  - ArcGIS Pro 2.0+
    - Printing/Export of Map with vector tiles implemented
Using vector tiles in your applications

• Multiple ways to use vector tiles:
  - A) Use Esri provided vector tiles / styles
  - B) Style Esri vector tiles for your own use
    - Change colors
    - Drop layers
    - Match the needs of your application
  - C) Create your own vector tiles from your own data
Authoring vector tiles
Authoring maps

• Only feature layers with simple, unique value, graduated, or class breaks symbology supported
• Maps should be re-authored for vector tiles
  - Limit number of layers
  - Limit duplication of content
• Several improvements have been made in ArcGIS Pro to assist with this
  - Scale dependent capabilities added to symbology
  - Alternate symbols added to symbology
  - Scale based sizing added to symbology
  - Improvement to scale logic
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
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 and creating vector tiles in ArcGIS Pro

Demo
Using and styling vector tiles
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 - GitHub
  - Vector Basemap Style Editor - GitHub
Styling vector tiles

Demo

Vector Basemap Style Editor
Accesing VectorTile Styles Demo
Common Questions
Q: Why would I need to create raster tiles anymore?

A: Consider consuming clients and map requirements before committing to vector tiles. At this time, it’s not an answer for everything. Vector tiles will never be a solution for most raster datasets.
Q: Can my data be extracted from vector tiles?

A: Think of vector tiles as generalized graphic derivations of your data. In many cases features are cut at tile boundaries, overlapped at tile boundaries, or are dissolved for optimal draw. Only a minimum number of attributes needed for feature draw are stored. It’s not raw data.
Q: Can I show popups for vector tiles?

A: Not at this time, we have this on the roadmap for our client implementations of vector tiles (JavaScript API, ArcGIS Runtime, ArcGIS Pro)
Q: Can I create vector tiles for any map projection?

A: Only Web Mercator (Auxiliary Sphere) supported for the initial releases (ArcGIS Pro 1.2 and 1.3). From ArcGIS Pro 1.4+ vector tiles can be created in any projection and used with the JavaScript API version 3.18+, ArcGIS Runtime 100+, and ArcGIS Pro 1.4+
Q: Can I project vector tiles on the fly?

A: ArcGIS Pro supports this with a much improved implementation at version 1.4. We do not expect to add this to other clients.
Q: Should I re-author my maps for vector tiles?

A: Yes, start by reading the help topic titled Author a map for vector tile creation
Q: Will ArcMap support vector tiles?

A: It is unlikely that ArcMap will ever support viewing vector tiles. Creation of vector tiles will not be implemented in ArcMap.
Q: Can I do server side vector tile creation?

A: Not at this time, we have this on our roadmap for Portal / ArcGIS Online including support for incremental updates.
Q: Vector tiles don’t draw correctly in my browser, is this a bug?

A: You’re likely experiencing a problem with WebGL support in your browser. Ensure you have the latest driver for your video card from the driver manufacturer. Do not rely on Windows Update on Windows machines for video drivers.
Q: Can I use any font for vector tiles?

A: From a technical standpoint any TrueType or OpenType font can be processed into the vector tile font format. However, font licenses vary widely and you should ensure you’re licensed for such use.
Q: Can Esri clients view non-Esri tiles conforming to the spec?

A: This is our goal. There are examples of this in the JavaScript API.

Example: Mapillary
Q: Does the print service support vector tiles?

A: Vector tiles can be printed in ArcGIS Pro. The print service does not support vector tiles at this time. We have development plans to support vector tiles in the print service at a future release. Newer releases of the JavaScript API send a raster rendering of vector tiles through to the print service until print service support is added.
Questions?
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Download the Esri Events app and go to DevSummit

Select the session you attended

Scroll down to the “Feedback” section

Complete Answers, add a Comment, and Select “Submit”
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