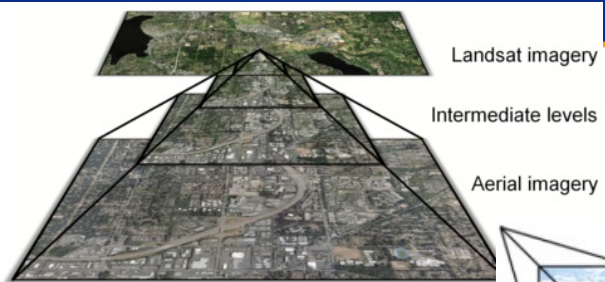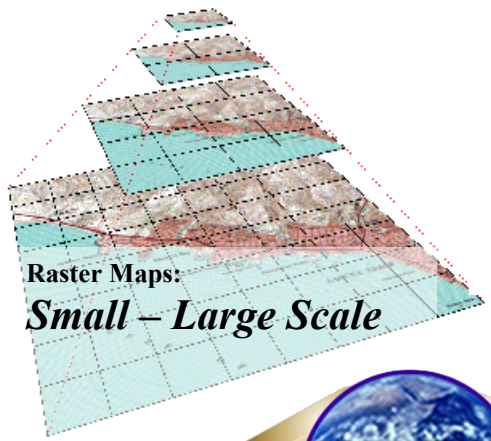# GeoPackage

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GeoPackage: Raster Maps, Images, and Feature Data in One File

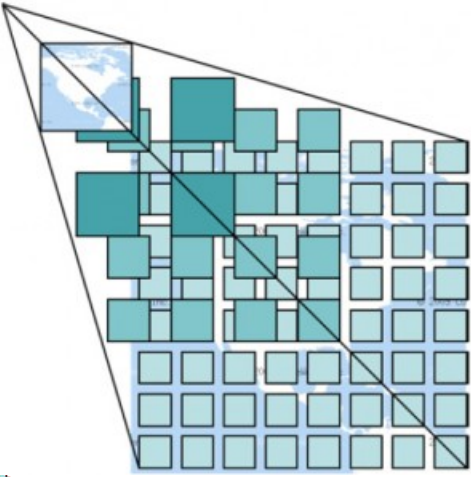Landsat imagery

Intermediate levels

Aerial imagery

Imagery
Low – High Resolution

Raster Maps:
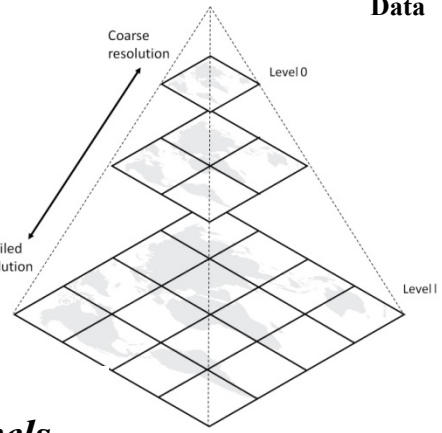*Small – Large Scale*

Feature Data

Tile Pyramids
24 zoom levels

Coarse resolution — Level 0

Detailed resolution — Level I

Single File Sqlite Database
containing all data for direct-use on mobile platforms & handheld devices

Before GeoPackage

- Storage and exchange formats for geospatial data before GeoPackage had various challenges and shortcomings.

Many alternative package formats for many representations of data.

Vectors as XML typically generate large and complex files.

Shapefiles have various well-known legacy limitations (DBF, Geometry Types, etc.).

Raster formats typically only provide a single resolution.

Proprietary formats are closed and controlled by the format owner.

Slide by Compusult, OGC TC
Opening Plenary June 2017

3

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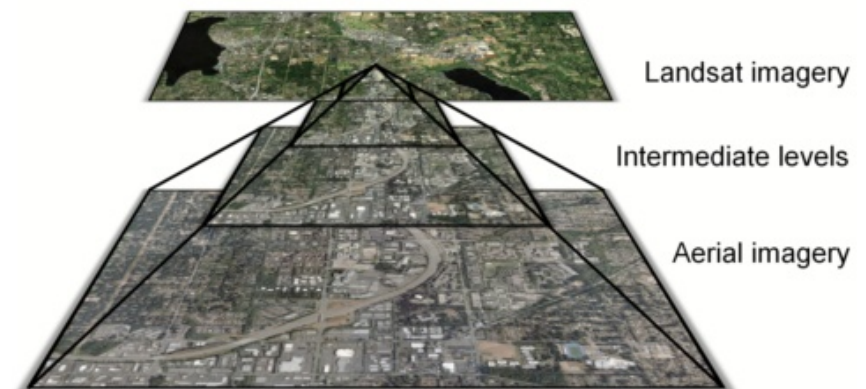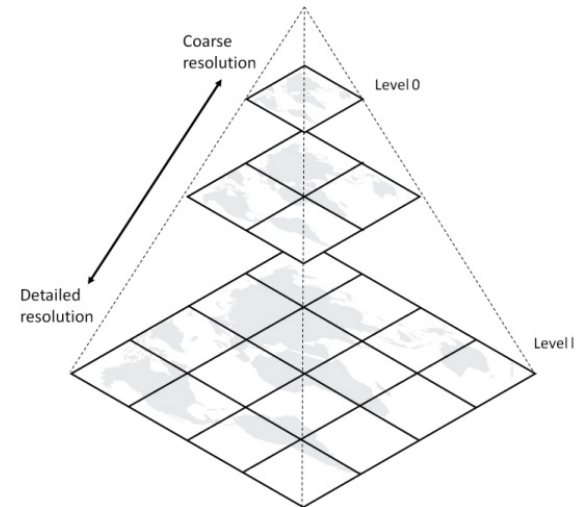
What is GeoPackage?

- An open format for geospatial information
  - Vector geospatial features
  - Raster tile matrix sets (pyramids) of imagery and raster maps at various scales
  - Attributes (non-spatial data)
  - Extensions
- An SQLite database schema
  - Table definitions
  - Integrity assertions
  - Format limitations
  - Content constraints

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Vector Data in GeoPackage

- Vector data support in GeoPackage follows the OGC Simple Features Specification
  - Point
  - LineString
  - Polygon
  - Collections of above
- Data is encoded using the Well Known Binary (WKB) format
- Geometries may have z (height or depth) or m (measure) coordinate values
- R-Tree indexing extension improves performance when querying vector data.

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Raster Tiles in GeoPackage

- GeoPackage supports raster data stored as tiles
- A tile pyramid contains data at multiple scales
- Tiles are either JPEG or PNG images
  – Extensions may allow other formats (not generally recommended for sake of interoperability)
- Tiles are individually addressed so retrieving data over a specific area has low cost
- Raster support is limited to tiles because of the simplicity and efficiency tiles allow on mobile devices.

St. John's GeoPackage
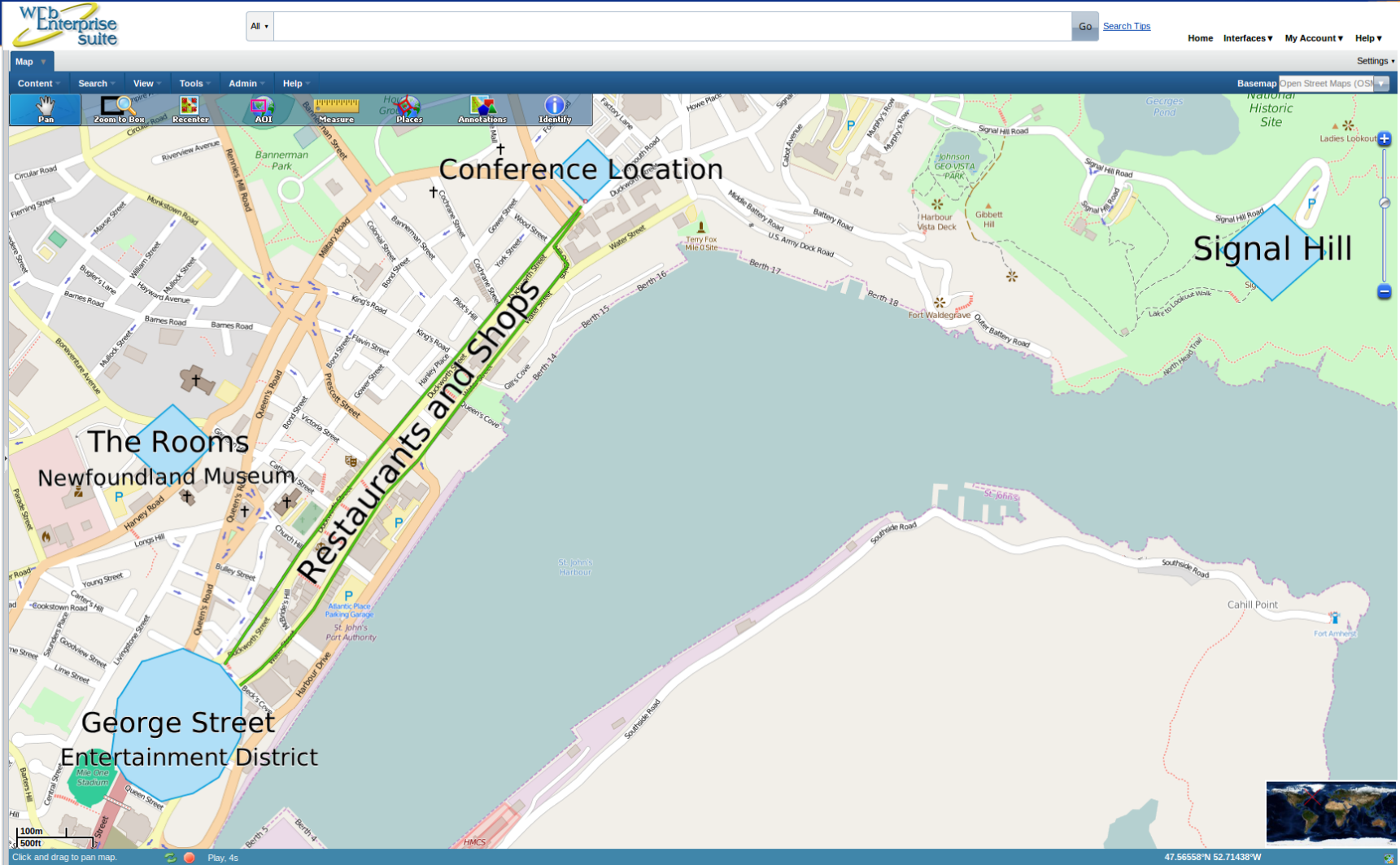
Points of Interest in the Local Area

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Benefits

- Supports sharing of raster and vector geospatial information in a single container

- Supports direct use
    - Avoids intermediate format translations (extract, transform, load)
    - SQLite is a true relational database with built-in indexing

- Platform independent, supporting multiple computing environments (hardware and operating system)
    - Local storage reduces power requirements and supports disconnected/intermittent/limited connectivity
    - Conserves storage space by allowing multiple applications to access the same data store
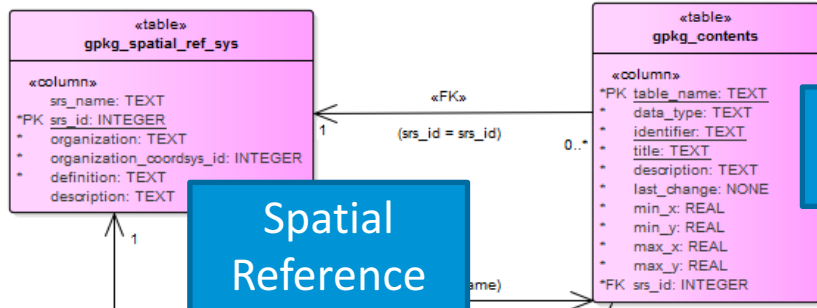
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Emerging Uses

- Mobile applications
- Data dissemination
  - Foundation GEOINT
  - Replacement to Shapefiles and other dated and/or proprietary formats
- Not the solution for everything
  - For simpler vector applications, GeoJSON may be plenty
  - In some enterprises an SQLite-based solution may be inappropriate

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geopackage.org

- **Go here first!**
- Web version of specification
- News, implementations, sample data, and FAQ
- Hyperlinks for participants (quickest way to portal, Wiki, etc.)
- Backed by github.com
  - https://github.com/opengeospatial/geopackage
  - AsciiDoc versions of the specification
  - Issue Tracker

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class GeoPackage

Boring Stuff

«table» gpkg_spatial_ref_sys

«column»
 srs_name: TEXT
*PK srs_id: INTEGER
 * organization: TEXT
 * organization_coordsys_id: INTEGER
 * definition: TEXT
 description: TEXT

«table» gpkg_contents

«column»
*PK table_name: TEXT
 * data_type: TEXT
 identifier: TEXT
 title: TEXT
 description: TEXT
 last_change: NONE
 * min_x: REAL
 * min_y: REAL
 * max_x: REAL
 * max_y: REAL
*FK srs_id: INTEGER

Contents

«FK»
(srs_id = srs_id)

Spatial Reference Systems

«FK»
(srs_id = srs_id)

e.g. "sample_feature_table"
data_type = features

«table» gpkg_geometry_columns

«column»
*pfK table_name: TEXT
*PK column_name: TEXT
 * geometry_type_name: TEXT
*FK srs_id: INTEGER
 * z: INTEGER
 * m: INTEGER
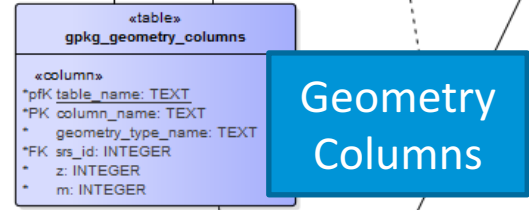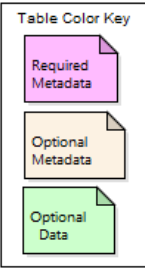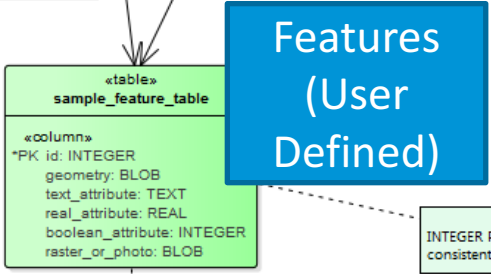
Geometry Columns

Features

table_name = feature table name,
e.g. "sample_feature_table"
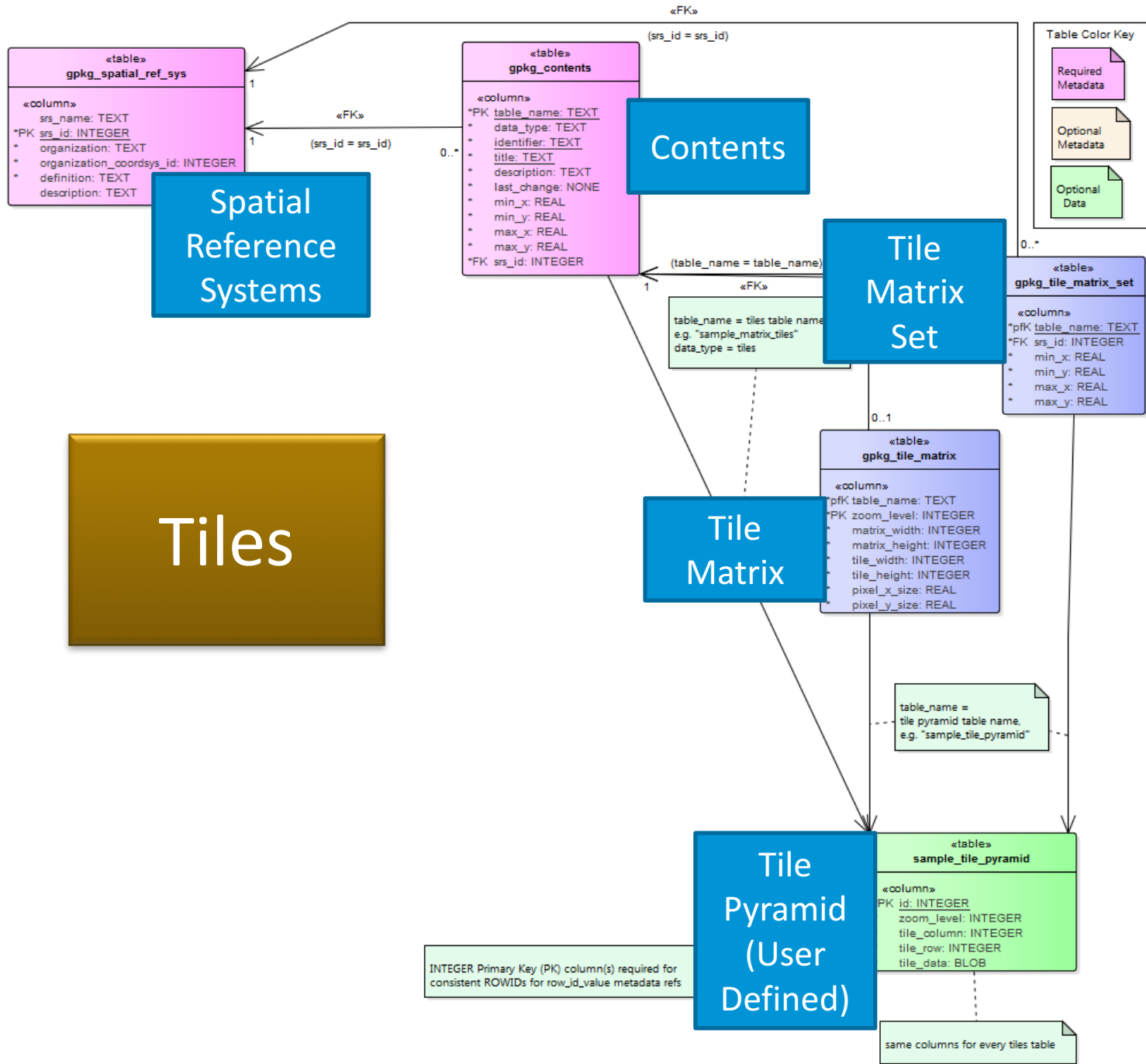column_name = geometry column name,
e.g. "geometry"

Features (User Defined)

«table» sample_feature_table

«column»
*PK id: INTEGER
 geometry: BLOB
 text_attribute: TEXT
 real_attribute: REAL
 boolean_attribute: INTEGER
 raster_or_photo: BLOB

INTEGER Primary Key (PK) column(s) required for consistent ROWIDs for row_id_value metadata refs

A feature type may have one geometry,
0..n rasters, and/or other attribute types

Table Color Key

Required Metadata

Optional Metadata

Optional Data

Brief History

- Foundations established prior to 2012
  - SQLite3 (sqlite.org) & SpatiaLite (https://www.gaia-gis.it/fossil/libspatialite/home)
  - MBTiles (https://github.com/mapbox/mbtiles-spec/blob/master/1.2/spec.md)
- 2012: Concept initiated by USACE's AGC/TEC and NGA at a hosted TEM with FOSS / commercial software developers
  - Started as Google Groups; moved to OGC due to need for standards development structure and potential IPR concerns
- Oct. 2012: Standards Working Group established
- 2013-present: OGC-sponsored testbeds, plugfests, etc.
- **Feb. 2014: Encoding Standard (1.0) adopted by OGC**
- Since then: specification maintenance
  - Adoption vote for v1.2.0 is currently under way

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Main Benefits of GeoPackage 1.2

- New "Attributes" section clears up major point of confusion in market
- Developed in conjunction with new Executable Test Suite (conformance)
- Lots of clean-up in requirements, prose, and abstract tests to improve clarity and readability
- All changes carefully vetted to ensure reverse compatibility – things should just work

- GeoPackage was designed for extensibility
  - Defined mechanism allows extensions in use to be discoverable (and automatically ignored if not supported)
  - May be developed by the SWG or from outside
  - *Some vendors consider this a key strength for the format*
- New OGC-approved extensions must have:
  - Clear Use Case
  - Sound technical approach that does not adversely affect the core
  - Commitment from critical mass of vendors (usually 3) to implement

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OGC-Adopted Extensions

- Non-linear geometry types (circles, etc.)
- RTree spatial indexes
- Web-P (a more efficient image format)
- Non-powers-of-2 scale sets (better for imagery)
- Metadata
- Schema
- WKT for Coordinate Reference Systems (new standard)
- *(3 were removed from 1.1.0 due to interoperability concerns)*

Emerging Extensions

Soon!

- Tiled Gridded Coverage (including elevation)
- Related Tables (including multimedia files)
- Feature Generalization
- Vector Tiles
- Styling/Symbology/Portrayal (requires more OGC coordination)
- Coordination with OWS Context SWG (context files inside and outside of GeoPackage)

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Thank You!

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