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OGC CDB GeoPackage Extension

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i. Abstract

This OGC CDB standard extension defines the requirements and provides CDB specific guidance on using GeoPackage containers in a CDB data store.

ii. Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, CDB, GeoPackage

iii. Preface

Background for this OGC Standard

The original requirement for this standard CDB extension was documented in OGC Change Request 545. This OGC change request was submitted based on work performed in OGC Testbed 13. The testbed activity and related change request captured a broad community requirement for being able to use GeoPackage containers in a CDB data store. At the same time, an additional requirement was identified to test and identify best practices for moving CDB vector files stored as Shapefiles into one or more GeoPackages.

In 2019, the CDB SWG executed the CDB Vector Data in GeoPackage Interoperability Experiment (IE). The participants in this IE tested transforming CDB Shapefile vector data into one or more GeoPackage(s) and storing the result in a CDB data store. GeoPackage Version 1.2 and CDB Version 1.1 and related Best Practices were the standards baseline used for this experiment. The IE built on the work described in the OGC CDB, Leveraging the GeoPackage Discussion Paper. A primary objective of the IE was to agree and document possible change requests and/or best practices for storing vector data in a CDB data using encodings and/or containers other than Shapefiles.

OGC Patent Declaration

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iv. Submitting organizations

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

Organization name(s)

v. Submitters

- Carl Reed & Associates

All questions regarding this submission should be directed to the editor or the submitters:

Name	**Affiliation**
Carl Reed *(editor)*	Carl Reed & Associates

Chapter 1. Scope

This OGC CDB Extension defines the behavior and requirements for encoding vector data in a GeoPackage container for use in a CDB data store. The requirements and related guidance are grounded in the existing CDB Core requirements and the GeoPackage core requirements for vector data. As such, any GeoPackage that is to be referenced/used in a CDB data store must be 1.) compliant with the CDB core requirements for vector data and 2.) compliant with the GeoPackage core requirements for encoding vector data. Please note that some of the core GeoPackage requirements are profiled in order to be consistent with the CDB core requirements as specified in Volume 1: OGC CDB Core Standard: Model and Physical Data Store Structure. Further, there are associated normative additions to the CDB Core to accommodate not just the use of GeoPackages but also other vector storage encodings/containers.

Chapter 2. Conformance

This standard defines [TBD] requirements / conformance classes.

The standardization targets of all conformance classes are "GeoPackages in CDB Data Store".

The main requirements class is:

```
Core. <<Add link to Annex A later>>
```

The Core specifies requirements that all GeoPackages that are to be stored in a CDB store that shall be implemented.

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site.

In order to conform to this OGC® interface standard, a software implementation shall choose to implement the conformance levels specified in Annex A (normative)

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

Chapter 3. References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

ISO / TC 211: ISO 19115-1:2014 Geographic information — Metadata — Part 1: Fundamentals (2014)

OGC: OGC 15-113r5, Volume 1: OGC CDB Core Standard: Model and Physical Data Store Structure (2017)

OGC: OGC 16-070r3, Volume 4: OGC CDB Best Practice use of Shapefiles for Vector Data Storage (2017)

OGC: OGC 12-128r15, OGC Geopackage Encoding Standard - with Corrigendum (2018)

Chapter 4. Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

For the purposes of this document, the following additional terms and definitions apply.

4.1. coordinate reference system

coordinate system that is related to the real world by a datum [ISO 19111]

4.2. coordinate system

set of mathematical rules for specifying how coordinates are to be assigned to points [ISO 19111]

4.3. dataset

collection of data, published or curated by a single agent, and available for access or download in one or more formats [DCAT]

NOTE	The use of 'collection' in the definition from [DCAT] is broader than the use of the term collection in this specification. See the definition of feature collection.

4.4. feature

abstraction of real world phenomena [ISO 19101-1:2014]

NOTE	If you are unfamiliar with the term 'feature', the explanations on Spatial Things, Features and Geometry in the W3C/OGC Spatial Data on the Web Best Practice document provide more detail.

4.5. feature collection; collection

a set of **features** from a **dataset**

NOTE	In this specification, 'collection' is used as a synonym for 'feature collection'. This is done to make the document easier to understand for those that are not geo-experts.

4.6. GeoPackage file

a platform-independent SQLite database file that contains GeoPackage data and metadata tables with specified definitions, integrity assertions, format limitations and content constraints.

4.7. tile

a geometric shape with known properties that is the result of the tiling (tessellation) of a plane. A tile consists of a single connected "piece" without "holes" or "lines" (topological disc).

4.8. Valid GeoPackage

A GeoPackage that contains features per clause Features and/or tiles per clause Tiles and row(s) in the gpkg_contents table with data_type column values of "features" and/or "tiles" describing the user data tables.

Chapter 5. Abbreviations

Chapter 6. Conventions

This sections provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

6.1. Identifiers

Identifiers

The normative provisions in this standard are denoted by the URI http://www.opengis.net/spec/cdb-vector-geopackage/1.0.

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

Chapter 7. Informative

This section provides information for understanding the role of using GeoPackage containers to encode vector data in a CDB data store. One key and overriding requirement to consider when implementing this CDB extension is that the structure if the content of the vector data in GeoPackage is also dictated by the core requirements in the CDB Standard. Examples would be for restrictions on the coordinate reference system (CRS) allowed and the size (extents) of the tiles.

7.1. What is a GeoPackage?

A GeoPackage is the SQLite container and the OGC GeoPackage Encoding Standard governs the rules and requirements of content stored in a GeoPackage container. The GeoPackage Standard defines the schema for a GeoPackage, including table definitions, integrity assertions, format limitations, and content constraints. The required and supported content of a GeoPackage is entirely defined in the standard.

7.2. What is CDB (or a CDB)?

CDB is an open standard defining physical, logical, and conceptual models for a single, “versionable,” virtual representation of the earth. CDB structured data stores provide for a geospatial content and model definition repository that is plug-and-play interoperable between database authoring workstations. Moreover, a CDB structured data store can be used as a common online (or runtime) repository from which various simulator client devices can simultaneously retrieve and modify, in real-time, relevant information to perform their respective runtime simulation tasks (OGC CDB Standard, 2018).

7.3. Why use GeoPackages in a CDB?

The geometries supported by the GeoPackage standard are consistent with the OGC Simple Feature Standard. A GeoPackage is capable of storing feature geometries as Points, LineStrings, Polygons, MultiPoints, MultiLineStrings, MultiPolygons, and GeomCollection. A strength of the GeoPackage is the portability and utility in non-traditional simulation environments, such as hand-held tactical devices. These strengths and the self describing nature of a GeoPackage created demand not just in the traditional modelling and simulation community but also other domains for having the ability to use GeoPackages in a CDB data store.

7.4. Identifed Use Cases

While considerable previous work focused on the process and requirements for transforming CDB structured vector Shapefiles into GeoPackages, the identified use cases are apropos when defining how to store and access any other vector/geometry content regardless of encoding or format. However, vector data encodings and containers developed outside a CDB data transformation process would also require definition of additional requirements. For example, a GeoJSON encoding of feature data would require a transformation to "break" the GeoJSON file into the appropriate tile and LoD structure in order to be consistent with the CDB data store and structure requirements. The same would be true of vector data provided as none CDB structured Shapefiles,

CityGML encodings, Oracle Spatial structured data, Esri GeoDataBase files and so on.

Both the OGC OGC CDB - Leveraging GeoPackage Discussion Paper and the OGC CDB Vector Data in GeoPackage Interoperability Experiment Engineering Report focused on a constrained set of well defined use cases related to the current CDB structure and how to best use GeoPackage for resolving each of the use cases. As such, dealing with non-CDB structured vector content was not addressed.

The four initial use cases identified in the OGC Discussion Paper are:

1. Replace each Shapefile with a GeoPackage: The easiest way to integrate a GeoPackage container into a CDB data store is to replace each Shapefile in a CDB data store with a GeoPackage.
2. Make each CDB tile a layer in a single GeoPackage: Constructing each vector tile within CDB as a table within a GeoPackage for a given CDB dataset is a straightforward approach to utilize GeoPackage capabilities and significantly reduce file counts in a CDB (note that in GeoPackage a table is known as a layer).
3. Store each CDB LOD as a layer in GeoPackage: Design approach #3 incorporates the lessons learn from experimentation with approach #2 to limit the number of tables within a GeoPackage and reduce the number of files in a CDB.
4. Store each CDB Geocell as a layer in GeoPackage: Design approach #4 extends design approach #3 to have a single GeoPackage per geotile of CDB. In this approach, the tables in the GeoPackage correspond to each data store of CDB (such as road networks, geospecific points, etc.).

In all cases, the experimentation focused on just vector data encoding as Shapefiles.

The research and tests performed and reported in the Discussion Paper were refined and provided the basis for the work done in the OGC GeoPackage in CDB Interoperability Experiment. In the interoperability experiment, Use Case 1 above was further refined into 4 options - each a possible approach for one to one conversions. All options were tested and reported on by the particpants. Many of the lessons learned, independent of the IE focus on Shapefiles already in a CDB, are germane to any process or workflow in which data are stored in a GeoPackage container that is to then be stored in a CDB data store.

Chapter 8. Requirements for Using GeoPackages in a CDB Data Store

This section defines the mandatory requirements for having GeoPackage containers in a structured CDB data store. Many of the requirements are by reference to specific requirements in both the GeoPackage and CDB standards. The referenced requirements are known as dependent requirments as they specifically reference requirements as specified in the CDB Core and GeoPackage Core standards documents.

8.1. Requirement CDB Core

The following requirement defines how vector data in a GeoPackage is to be structured based on requirements specified in the CDB Core document.

Requirement 1 Vector GeoPackage Geometry Type	http://www.opengis.net/spec/cdb/1.0/geopackage/cdb-core Any GeoPackage stored in a CDB data store shall adhere to the following CDB Core requirements List of requirements.

Use the following table for Requirements Classes.

Requirements Class	
http://www.opengis.net/spec/CDB/1.1/req/req-class-a	
Target type	Token
Dependency	Requirement 64: http://www.opengis.net/spec/cdb/1.1/core/vector-dataset-limit
Requirement 1	http://www.opengis.net/spec/ABCD/m.n/req/req-class-a/req-name-1 requirement description

8.1.1. Requirement 3

Paragraph - intro text for the requirement.

Requirement 3 Vector GeoPackage Geometry Type	http://www.opengis.net/spec/cdb/1.0/geopackage/vector-geom-rule All instances of the feature *SHALL* be of the same Geometry type. While the GeoPackage model supports encoding of 8 different types that can be stored in the same GeoPackage, the CDB standard requires a maximum of one geometry type for point features, a maximum of one geometry type for lineal features and a maximum of one geometry type for polygon features for each tile (for a maximum of 3 feature geometry types per tile).

Annex A: Conformance Class Abstract Test Suite (Normative)

NOTE	Ensure that there is a conformance class for each requirements class and a test for each requirement (identified by requirement name and number)

A.1. Conformance Class A

A.1.1. Requirement 1

Test id:	/conf/conf-class-a/req-name-1
Requirement:	/req/req-class-a/req-name-1
Test purpose:	Verify that…
Test method:	Inspect…

A.1.2. Requirement 2

Annex B: Conformance Class Abstract Test Suite (Normative)

NOTE	Ensure that there is a conformance class for each requirements class and a test for each requirement (identified by requirement name and number)

B.1. Conformance Class A

B.1.1. Requirement 1

Test id:	/conf/conf-class-a/req-name-1
Requirement:	/req/req-class-a/req-name-1
Test purpose:	Verify that…
Test method:	Inspect…

B.1.2. Requirement 2

Annex C: Revision History

Date	Release	Editor	Primary clauses modified	Description
2016-04-28	0.1	G. Editor	all	initial version

Annex D: Bibliography

NOTE

Example Bibliography (Delete this note).

The TC has approved Springer LNCS as the official document citation type.

Springer LNCS is widely used in technical and computer science journals and other publications

- For citations in the text please use square brackets and consecutive numbers: [1], [2], [3]

– Actual References:

[n] Journal: Author Surname, A.: Title. Publication Title. Volume number, Issue number, Pages Used (Year Published)

[n] Web: Author Surname, A.: Title, http://Website-Url

[1] OGC: OGC Testbed 12 Annex B: Architecture. (2015).