

# DATA CUBES & FRIENDS: THE COVERAGE DATA AND SERVICE MODEL IN ISO, OGC AND INSPIRE

*Peter Baumann*

Jacobs University | rasdaman GmbH, Germany, [pbaumann@constructor.university](mailto:pbaumann@constructor.university)

## ABSTRACT

We present the current status of ISO standardization work on coverages which serve to model spatio-temporal – generally: multi-dimensional – physical fields. The corresponding data structures defined in a uniform concept include discrete and continuous grids (“raster / pixel / voxel data”), point clouds, and general meshes.

To achieve this, ISO has modernized, corrected, and enhanced outdated 19123:2005 and replaced by a suite of standards consisting of 19123-1 (the abstract coverage data model), 19123-2 (an interoperable concretization of these concepts), and 19123-3 (an abstract coverage processing model).

*Index Terms*— Standards, datacubes, coverages, ISO, OGC, INSPIRE

## 1. INTRODUCTION

Earth-observing sensors, such as satellites and drones, play a critical role in today’s intelligence information mix. However, the huge volume of data obtained is not commensurate with evaluation capabilities; in fact, manifold opportunities for operative insight are missed due to the Big Data problem: too big, too fast, too diverse to analyse.

Looking at the problem from the common Big Data definition perspective we find that four Vs – Volume, Velocity, Variety, and Veracity – are decreasingly well understood in this sequence. In particular, Veracity, also termed “fit for purpose”, remains a big concern. On the one hand, this concerns the server side which should provide data fit for various purposes. On the other hand, the client should be able to express when data are fit for its particular purpose.

Such challenges have prompted the term Analysis-Ready Data (ARD) **Error! Reference source not found.** which requires data to be offered not upstream sensor-centric, but downstream application-centric. Research on ARD meantime is under way from various perspectives, such as metadata-centric CARD4L and its ongoing evolution.

Coming back to Volume, obviously in Earth sciences generally gridded data, such as satellite imagery and weather/climate data, contribute the biggest volume and hence require particular attention. Meantime the Earth datacube paradigm, which provides an integrated and homogenized view built from the zillions of individual files of a particular topic or phenomenon observer, such as a sensor, is an accepted cornerstone towards ARD as it significantly simplifies handling through the client when offered through appropriate services. Pioneered by rasdaman, spatio-temporal – more generally: multi-dimensional data services – many time have been shown to benefit from the datacube concept meanwhile.

## 2. COVERAGE STANDARDIZATION

For the purpose of standardization, the challenge is attacked from a more general perspective, honoring that the physical concept behind the data acquired in general represents *fields* as defined in physics, i.e., a physical quantity that has a value for each point in space and time (and possibly along further dimensions, such as spectral frequency). The concept for representing field data is named *coverages*. Standardization of OGC, ISO, W3C, INSPIRE, etc. uniformly rely on the notion of coverages for defining data interchange, extraction, processing, and analytics.

The main coverage standard, from which all others derive, is ISO 19123 (identical to OGC Abstract Topic 6). Unfortunately, this standard is very outdated as it originally has been written more than 20 years back. Just as an example, a raster in ISO 19123:2005 (i.e., the edition finally published in 2005, although before over several years) is defined as “usually rectangular pattern of parallel scanning lines forming or corresponding to the display on a cathode ray tube”.

Therefore, a complete revision and modernization has been undertaken, leading to a suite of standard addressing abstract versus implementation level and data versus processing level, thereby also obtaining a clear separation of concerns. For example, in the past many implementation have claimed to be conformant with 19123 and therefore interoperable whereas 19123:2005 mostly remains on an abstract level without concrete interoperability guidance.

### 3. THE 19123-X COVERAGE SUITE

The result of this several-years endeavor which included manifold stakeholder consultations and discussions is the 19123-x coverage standards suite. Figure 1 illustrates the roadmap along work was organized. The top line in the matrix represents the abstract, conceptual level which serves to define terminology semantics without implementation considerations; the latter are captured in the bottom line.

	Geometry/data model	Function/processing model
abstract	19123-1 Coverage Fundamentals = OGC AT6	19123-3 Coverage Processing Fundamentals = OGC WCPS
concrete	19123-2 Coverage Implementation Schema = OGC CIS	19123-4 Coverage Services = OGC WCS & OAPI-Coverages ?

Figure 1 – Schematic overview of the ISO 19123-x coverage standards suite

Vertically, the matrix differentiates data and processing. The left column addresses data. 19123-1 establishes the conceptual, abstract coverage data model whereas 19123-2 defines a concrete, interoperable coverage data model which is based on the OGC Coverage Implementation Schema (CIS) where, for example, various data encodings are defined in addition.

In the right column, 19123-3 establishes a processing model operating on the semantic level of the 19123-1 coverages. Technically, it represents a domain-specific language to express operations on and between coverages. Again, this model is abstract and can be used to describe coverage services in an unambiguous manner; examples for such service descriptions through 19123-3 are presented in the Annex of the standard.

The 19123-4 field is a placeholder for possible future work, there is no such specification yet.

### 4. STATUS

At the time of this writing, the status of the revised 19123-1 is as follows:

- 19123-1 has successfully passed Draft International Standard (DIS) ballot and is out for Final Draft International Standard (FDIS) ballot; at this stage, only editorial changes are allowed any longer so that the concepts as such can be considered stable. At IGARSS 2023 time the ballot will be closed and final adoption will be concluded.
- 19123-3 has been submitted in parallel and is at the same stage.

- 19123-4 remains for potential addressing in the future, depending on the thrust stakeholder groups agree upon.

Altogether, the revision of outdated 19123:2005 has yielded several critical advantages impacting both client and server implementers, enhances general interoperability, and guides further research. In detail, the following work has been accomplished:

- 19123-1 covers relevant approaches to represent physical fields: discrete and continuous grids, point clouds, and general meshes.
- The text has been simplified for better understanding.
- Errors have been corrected.
- Operations have been moved into ISO 19123-3.
- The concept of discrete and continuous coverages has been simplified and generalized; among others, it allows coverages which are discrete along some axes and continuous along other domain. As a side effect, this reworking has greatly simplified the structure of the document.
- Import of concepts has been adjusted to use the current version of the respective standards, including the necessary conceptual adjustments; among others, this concerns all coordinate-related definitions taken from ISO 19111 and interpolation taken from ISO 19107.

For political reasons an approximate version of the outdated 19123:2005 had to be kept as Annex E.

### 5. SUMMARY AND OUTLOOK

OGC already has announced that it will consider 19123-1 and 19123-3 for adoption as new Abstract Topics. Notably, the European INSPIRE coverage service definition relies on the OGC Coverage Implementation Schema (CIS), from which 19123-2 is derived, and the Web Coverage Processing Service (WCPS), which is a concretization of 19123-1.

Following successful establishing of the 19123-x suite structure a next step will be to update 19123-2 to incorporate OGC CIS 1.1 which adds a General Grid Coverage which unifies, enhances, and greatly simplifies grid coverage handling.

### ACKNOWLEDGEMENT

This work is in part co-funded by EU CENTURION, EU StandICT, and NATO SPS.