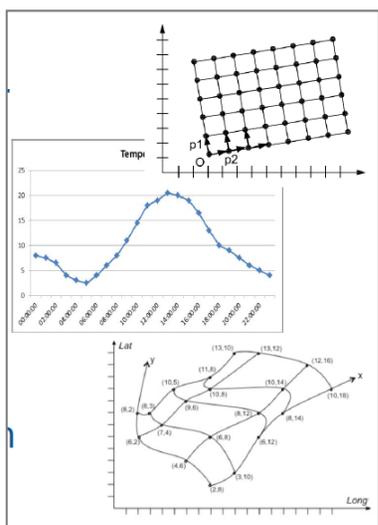# INSPIRE coverages and WCS

Basic concepts & Overview of relevant implementation issues

**INSPIRE Thematic Cluster on
Elevation, Orthoimagery, Reference systems and Geographical grids**

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Introduction / Coverages in INSPIRE

- **Coverage:**

  Describe characteristics of real-world phenomena that vary over space and/or time (temperature, elevation, land cover, imagery...)

- **Contains** sets of values, associated to a spatial and/or temporal domain

- **Used in several INSPIRE themes**:

  AC-MF, OF, ER, EL, NZ, OI, LU, LC

- **Elevation & Orthoimagery**

  Data shall be provided using (mainly) the raster data spatial representation type – Coverages.

Introduction / Coverages in INSPIRE

- **INSPIRE** reuses the concept of coverage from ISO 19123

  spatial object that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal domain [Adapted from ISO 19123]

- **Main components**

  - **Domain Set**

  - **Range Set**

  - **Coverage Function**

  - **Range Type**

Introduction / Coverages in INSPIRE
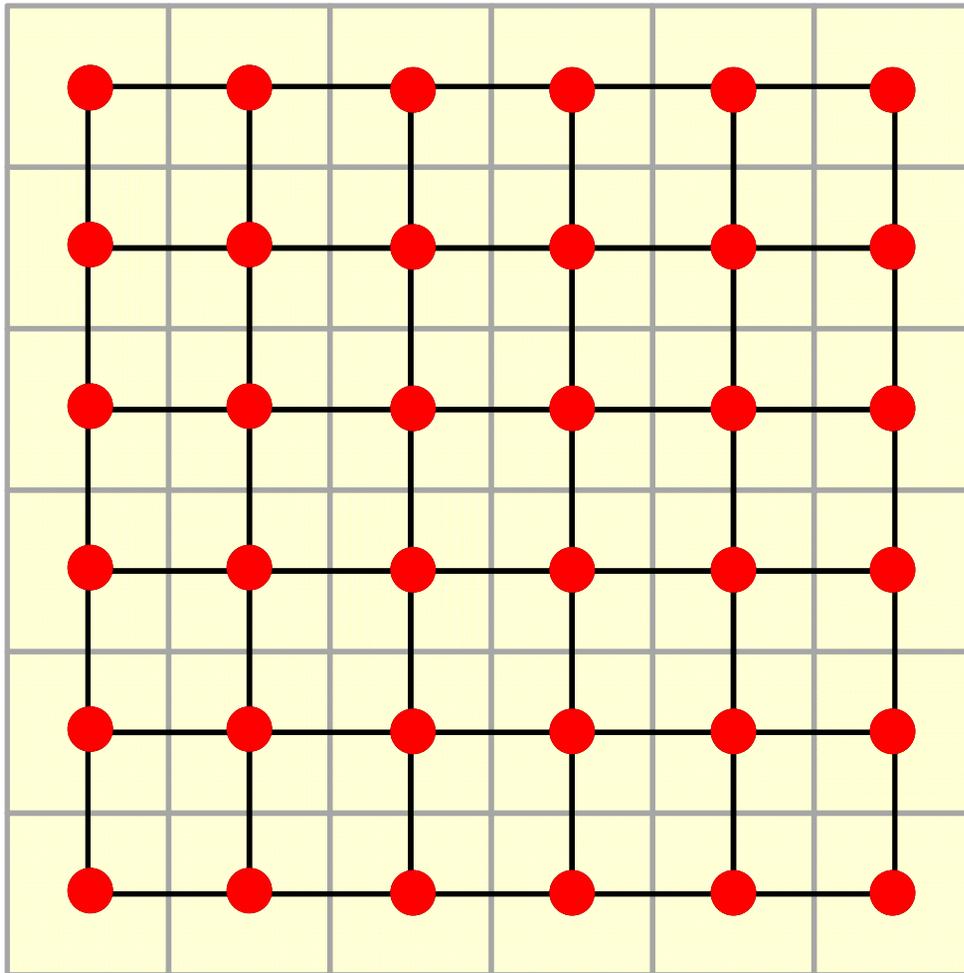
Main components:

- **Domain Set**: Spatial domain of the coverage – Locations (points / grids)

- **Range Set**: The values of the phenomenon

- **Coverage Function**: Defines the correspondence between the domain and the range of the coverage, e.g. the rules assigning the phenomenon values to the grid

- **Range Type**: Describes the characteristics of the range values (type of phenomenon)

Encoding of INSPIRE Coverages (EL)

- **Coverage, except Range Set**
  - OGC GML Application Schema for Coverages [OGC 09-146r2]

- **Coverage Range Set**
  - **OPTION 1: Multipart representation**
    - 1st Part: GML Part (gmlcov:RectifiedGridCoverage)
    - 2nd Part: Range Set encoded using a well-known binary format (embedded in 1st Part) – TIFF / GeoTIFF (*)

  - **OPTION 2: External file encoding**
    - 1st Part: GML Part (gmlcov:RectifiedGridCoverage)
    - 2nd Part: Range Set, encoded using an external well-known binary format (gml:File) – TIFF / GeoTIFF (*)

  - **OPTION 3: Inline encoding**
    - Range Set is encoded within the XML inline (DataBlock)

(*) Alternatively, the BAG format for Hydrographic bathymetry data

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Activities in TC #3 focused on coverages

- **Main Thematic Cluster activities in the scope** - EuroGeographics:

  - *Workshop about Transformation of Coverage-Based Data Themes and WCS – Barcelona(ICGC venues), 29-30 September 2015*

    https://themes.jrc.ec.europa.eu/pages/view/45690/workshop-about-transformation-of-coverage-based-data-themes-and-wcs-barcelona-29-30-september-2015

  - *Follow-up Webinar on Coverage Data and Services, 18 January 2016*

- **Results**: List of open issues about INSPIRE coverage data and WCS implementation.

- Presented in the MIG-T Meeting – 20 April 2016, Ispra.

List of open issues

Implementation of INSPIRE coverages and WCS

Evolution of standardization from GMLCOV to CIS v1.1

- **CIS v1.1** to be nearly adopted by OGC.

- It will become the ISO 19123-2 standard.

- OGC WCS will be treated in a new dedicated ISO standard.

- Any possible **changes in the INSPIRE TGs derived from the adoption of CIS v1.1 would not encourage implementers to transform their data quickly** / according the roadmap.

- **More information about CIS v1.1 in the 2nd Session of this workshop**

How to implement the concepts of mosaicking (OI) and coverage aggregation (EL & OI)

«featureType»
OrthoimageCoverage

+ inspireId: Identifier
+ domainExtent: EX_Extent [1..*]
+ interpolationType: InterpolationMethodValue = nearestneighbor

«voidable»
+ footprint: GM_MultiSurface
+ name: CharacterString [0..1]
+ phenomenonTime: TM_Period [0..1]

«voidable, lifeCycleInfo»
+ beginLifespanVersion: TM_Position
+ endLifespanVersion: TM_Position [0..1]

constraints
{domainDimensionIs2}
{originDimensionIs2}
{domainRequiresCRS}
{domainExtentContainsGeographicElement}
{rangeSetValuesAreOfTypeInteger}
{identicalOffsetVectorsWithinOrthoImageAggregation}
{acquisitionTimeRequired}

+mosaicElement
«voidable»

0..*

«featureType»
MosaicElement

+ inspireId: Identifier [0..1]
+ geometry: GM_MultiSurface
+ phenomenonTime: TM_Period

Topic / Issue to be discussed in the 2nd Session

«featureType»
Aggregated...

«voidable»
+ imageSourceReference: CharacterString [0..1]

+contributingOrthoimageCoverage
0..*

«dataType»
OrthoimageAggregation

+ contributingFootprint: GM_MultiSurface

«codeList»
InterpolationMethodValue

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How to deal with huge volume of coverage data

Case 1 - Delivery through Predefined data sets

- Most data providers consider each **tile / map sheet as a coverage** - general trend among NMCAs.

- The coverage over a certain territory is split in several pieces, for both organizational and efficiency purposes.

- To be **implemented using the concept of tiling**.

- **Are there better solutions?** E.g. using multiple rangeSets instead of tiling? - Open discussion in TC #3:

  https://themes.jrc.ec.europa.eu/discussion/view/50412/how-to-implement-tiling-model-mosaic-elements-coverages-and-coverage-aggregations-in-gmlcov-files

- Tiling approach may have a direct impact on efficiency of delivery.

Topic / Issue to be discussed in the 2nd Session

How to deal with huge volume of coverage data

Case 2 - Delivery through WCS

- A coverage is the natural response of a WCS to a data request (GetCoverage operation).

- However, some **possible efficiency issues** has been reported when using such kind of services:

  - *WCS implementations build the final output of the GetCoverage request first totally in the RAM of the server before sending it out to the client, e.g. MapServer / GeoServer [Jukka Rahkonen].*

- How to solve them?

Topic / Issue to be discussed in the 2nd Session

Redundancies between INSPIRE coverages and GMLCOV components / INSPIRE extensions

- INSPIRE models based on coverages partially extends the standard way of modelling and implementing OGC coverages.

- Such **INSPIRE extensions** corresponds to thematic needs identified by TWGs.

- **Danger**: They are ignored by WCS interface.

- **Agreement**: Minimize INSPIRE extensions as possible - Need to examine them case-by-case.

- Worth to take this into account in the new implementation standards.

Topic / Issue to be discussed in the 2nd Session

Redundancies between INSPIRE coverages and GMLCOV components / INSPIRE extensions

- **EXAMPLE - Identification of coverage extent –**

  There are 2 attributes to deal with it:

  - **boundedBy** (GML): Optional / Approximate / Does not allow identification of discontinuous spatial extents.

  - **domainExtent** (INSPIRE extension): It supports the identification of discontinuous spatial extents (needed e.g. when coverage aggregations are identified) / Not recognized by WCS.

- Largely discussed in TC #3:

  https://themes.jrc.ec.europa.eu/discussion/view/12901/domainextent-vs-gmlboundedby-el-oi-coverages-encoding

Purpose of the metadata hook

- **Coverages may have metadata at different levels**:

    - Data set level (xml metadata file of the data set) – For discovery purposes (CSW).

    - Image file (header) – Required by specific format.

    - Coverage level (**optional metadata hook**, as proposed in GMLCOV).

- **Guidelines about the purpose and content of the metadata hook are needed**.

Topic / Issue to be discussed in the 2nd Session

What is the state-of-play of WCS servers and client applications?

- **Open source solutions** (e.g. MapServer, GeoServer, etc.) **might not be scalable enough**.

- It would be highly desirable to have:

    - **Independent advice from MIWP-7b**

    - **List of available software solutions.**

Are there validation tools?

- Any XML validator can be used.

- For this purpose, the appropriate schemas have to be included within the schemaLocation element, in the header of the GML file (e.g. gmlcovAll.xsd).

- However, clients don't always accept schemas, even if validated.

- **Additional information about available validation tools would be extremely useful**:
  - List of aspects to be validated.
  - Tools available in the market for validating the GMLCOV Files.

Is there interest for a common pan-European grid for sharing coverage data?

- Adopting a common grid is the only way to avoid interoperability problems and misalignments between coverages from different data providers.

- Non-standardized rasters pose a major problem for utilising COPERNICUS and other free / open data.

- Sharing coverage data using grids based in TMzn projections (different zones), is not a good solution to achieve interoperability.

- The 'Zoned Geographic Grid' (based on geodetic coordinates / DTED structure) recommended by INSPIRE for EL and OI, seems not the best solution.

- **More information about this topic in the 2nd Session of this workshop: "*Challenges of INSPIRE & Copernicus*"**
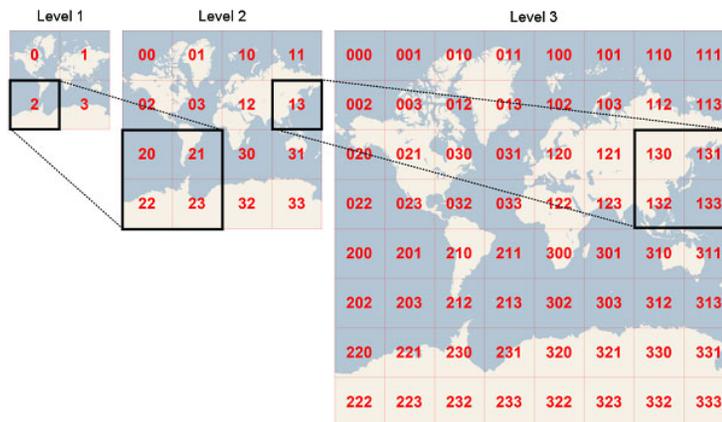
Is there interest for a common pan-European grid for sharing coverage data?

- **3 emerging proposals** trying to find a solution:
  - **Nested Grid**, Web Mercator projection, based on the OGC WMTS standard.
  - **Equi7 Grid**, multiple projection based system.
  - **OGC DGGS** (Discrete Global Grid Systems).
- Open discussion in TC #3:

  https://themes.jrc.ec.europa.eu/discussion/view/10935/usability-of-the-zoned-geographic-grid-grid-etrs89-grs80

- **This issue may deserve a dedicated workshop** to examine all proposals.

Is there interest for a common pan-European grid for sharing coverage data?

- **Nested Grid**, Web Mercator projection, based on the OGC WMTS standard – Poles cannot be represented / Considerable data volumes.

- https://themes.jrc.ec.europa.eu/file/view/76196/2015-11-29-a-nested-grid-for-inspire-ortoimagesdocx
- https://themes.jrc.ec.europa.eu/file/view/76508/a-nested-grid-for-inspire-ortoimages-introductory-pptx

Is there interest for a common pan-European grid for sharing coverage data?

- **Equi7 Grid**, multiple projection based system - Apt for Earth Observation data over land masses / Problems at projection boundaries / Not widely used.

- https://themes.jrc.ec.europa.eu/file/download/60853
- https://themes.jrc.ec.europa.eu/file/download/61118

Is there interest for a common pan-European grid for sharing coverage data?

- **OGC DGGS** (Discrete Global Grid Systems).

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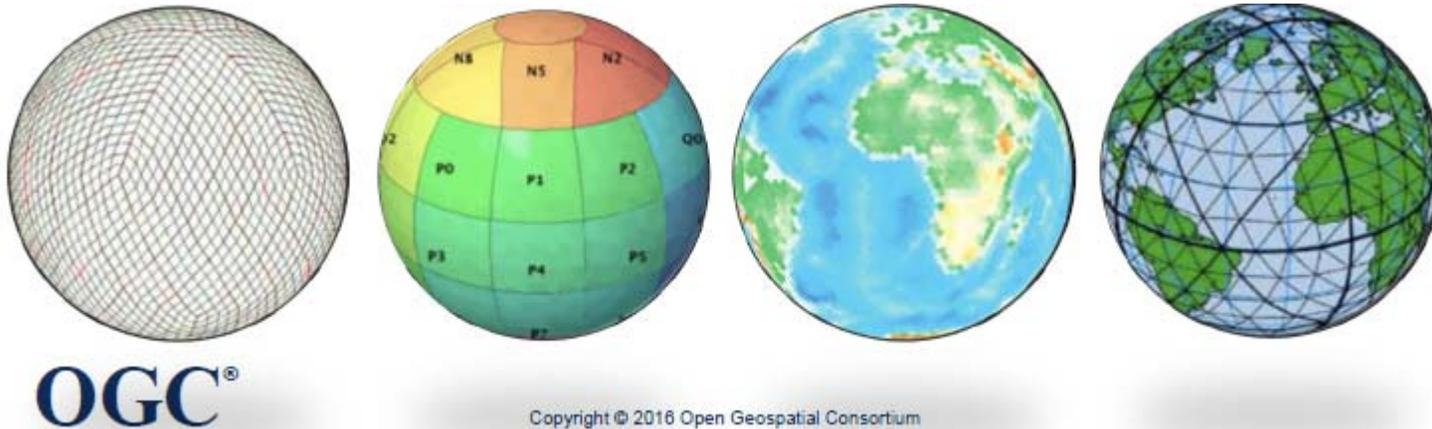
- http://www.opengeospatial.org/projects/groups/dggsswg
- http://congrexprojects.com/custom/16M05/bids/ALL/EH_1440_02_Strobl.pdf

Conclusions

- Many data providers (especially NMCAs) do not have previous experience with coverage data and services (WCS).

- Neither at implementation nor at exploiting level.

- They have questions and some issues that may prevent a successful implementation in time.

- To be considered for drafting the *Technical Guidelines for providing INSPIRE coverage data using WCS* (MIG-T MIWP-7b - Task 2).