Transformation of EI - OI data for INSPIRE

Methodology

- Define some strategy

  - Theme EL

    - Meeting n° 1 : information

      - => decision: launch small test to gain experience

    - Meeting n° 2: test launching

    - Meeting n° 3: learnings from the test

  - Theme OI

    - Meeting n° 1 : information

High level choices, e.g. INSPIRE options

Methodology

- Which data for INSPIRE?

  - IGN has several (internal) products

  - IGN delivers many derived external products

    - Grid size

    - CRS

    - Radiometry (e.g. colour, B&W)

- Coordination required with other producers

  - Marine office (coastal areas)

  - ELF (European coverage)

  - => IGN has not decided yet which products to transform for INSPIRE

very limited progress

Technical choices

Delivery

- There are 2 technical solutions for download services for coverage data
  - Predefined data sets
  - Direct access (WCS)

- But WCS is not (yet) included in the INSPIRE Implementing Rule for download services

- There are currently no WCS on the IGNF GeoPortal infrastructure and no possibility to add new services until 2017
  - => Short term : use of predefined data sets

Delivery

- Short term : use of predefined data sets

=> duplicate data volume

- Decision:
  - Transformation for EL
    - DTM : short term (2016)
  - Transformation for OI
    - Later (when WCS is ready)

Elevation is ELF theme, limited volume of data

Deadline is 2020, huge volume of data

- Potential request for change (Thematic Cluster)
  - For Lidar point clouds, the INSPIRE format (GML) is not efficient
  - Allow more efficient formats, such as .las or .laz

Data model

- INSPIRE offers 3 possibilities:

  - Grid

  - Vector

  - TIN

- IGN choice : grid

  - Our main product(s)

  - Mandated by INSPIRE

  - Other IGN products (Lidar point clouds)

    - to be considered later … or not at all ?

Horizontal Coordinate Reference System
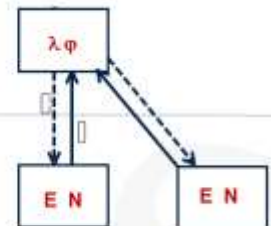
- INSPIRE offers several possibilities

    - Geographic coordinates

    - Projected coordinates

        - LAEA

        - Lambert conform

        - TMzn   Recommendation for regional data

- IGN decision: geographic coordinates

    - As for vector data (AD, AU, GN, TN, HY BU)

    - Pivot CRS

Geographic coordinates λ φ

Projected coordinates E N

Vertical Coordinate Reference System

- INSPIRE :

  – requires EVRS and recommends EVRF 2007 on continental Europe

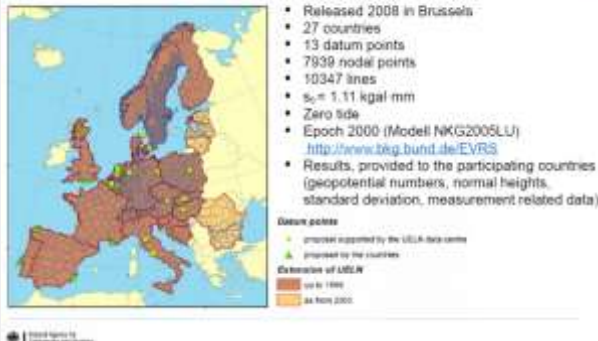 – Allows any gravity based heights outside EVRS scope

- IGN

  – Use of EVRS on continental Europe

  – Keep national systems elsewhere

    - **Corsica**

    - **Over sea departments**

Vertical Coordinate Reference System

European Vertical Reference Frame 2007 - EVRF2007

- Released 2008 in Brussels
- 27 countries
- 13 datum points
- 7939 nodal points
- 10347 lines
- s_0 = 1.11 kgal mm
- Zero tide
- Epoch 2000 (Modell NKG2005LU)
  http://www.bkg.bund.de/EVRS
- Results, provided to the participating countries (geopotential numbers, normal heights, standard deviation, measurement related data)

• EVRF issue

– IGN has computed transformation from national system to EVRF 2000

– But EVRF 2000 is deprecated in EPSG

– IGN can't compute transformation between national system to EVRF 2007

• no point was measured in France (no big issue)

• BKG (in charge of EVRF 2007) has not yet sent relevant information to IGN F

– IGN F will use deprecated EVRF 2000

• A priori, not an issue for GIS (may nevertheless read data)

Geographic grid system

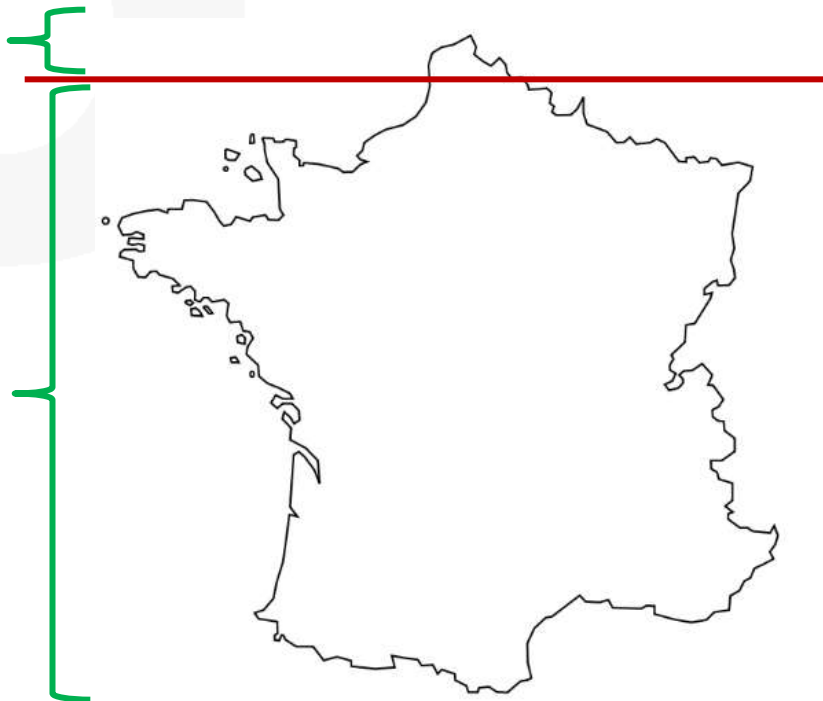- For INSPIRE themes EL et OI, a specific grid
  - Grid_ETRS89_GRS80zn_res
  - Zn : zone number
  - Res: grid size (angle unit)

Zone	Latitude	Factor
1	0°–50°	1
2	50°–70°	2
3	70°–75°	3
4	75°–80°	4
5	80°–90°	6

Zone 2

50°

Zone 1

IGN decision: whole France considered in one zone
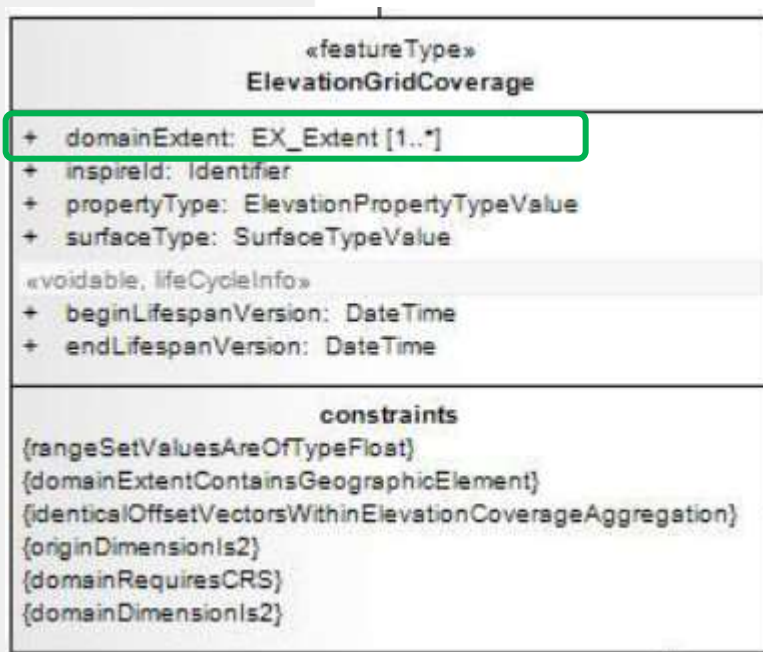
Transformation test

Source data

- Theme EL
  - RGE ALTI
  - Grid size : 5 m and 1 m
  - Horizontal CRS: RGF93 (ETRS89) – Lambert-93
  - Vertical CRS: IGN 69
  - Some tiles
  - Format ASC

```
ncols         51
nrows         51
xllcorner     914900.00
yllcorner     6449900.00
cellsize      200.00
NODATA_value  -9999
238 235 238 244 241 235 229 223 218 218 217 216 216 215
218 225 230 233 232 226 220 218 217 217 216 215 214 213
209 215 221 223 225 219 218 216 216 216 215 214 213 211
209 207 215 217 219 218 215 214 214 214 214 213 212 210
209 209 211 216 216 215 213 213 213 213 212 212 209 209
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213 213 212 212 212 212 211 212 215 214 212 209 209 209
```
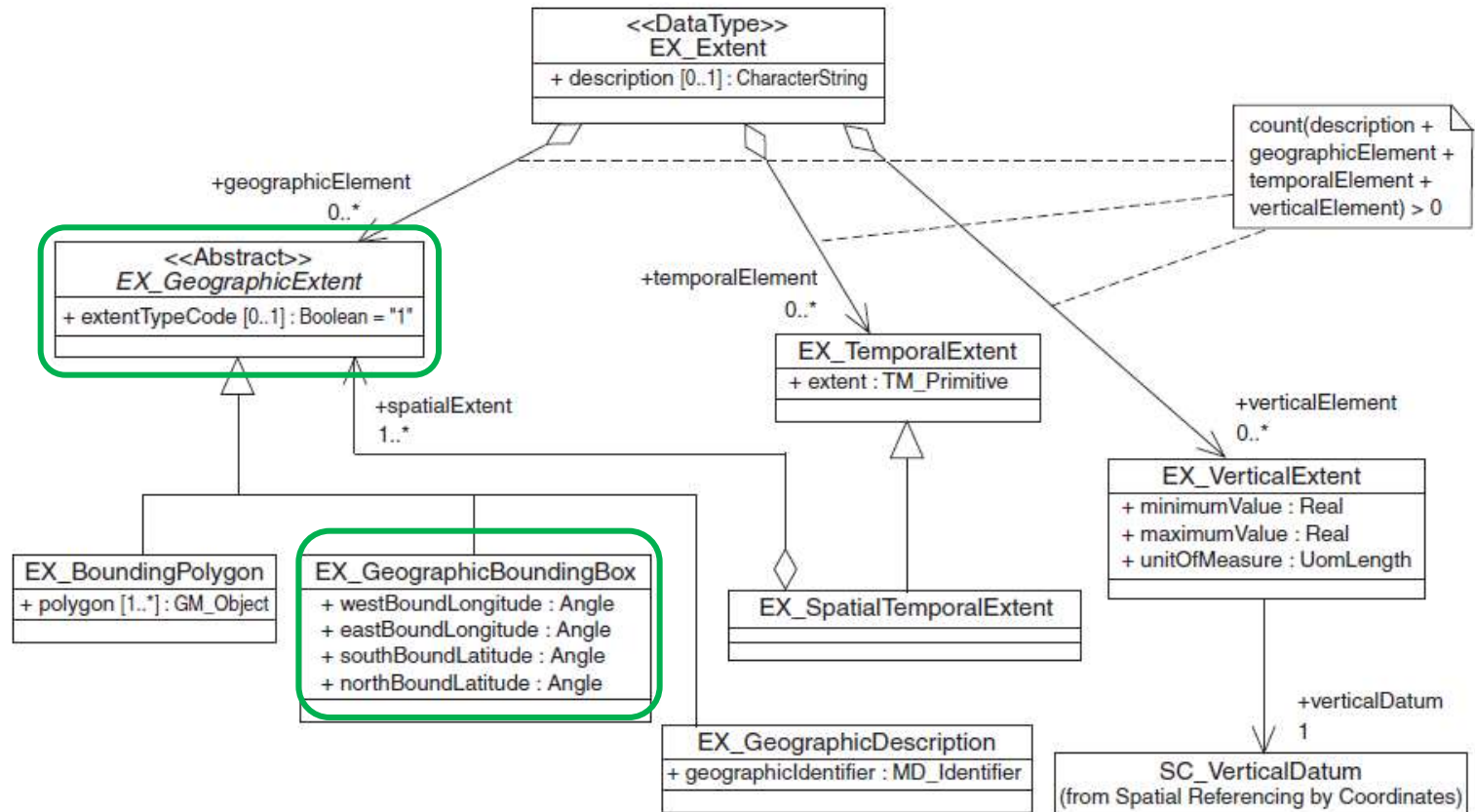
domainExtend

«featureType»
ElevationGridCoverage

+ domainExtent: EX_Extent [1..*]
+ inspireId: Identifier
+ propertyType: ElevationPropertyTypeValue
+ surfaceType: SurfaceTypeValue

«voidable, lifeCycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime

constraints
{rangeSetValuesAreOfTypeFloat}
{domainExtentContainsGeographicElement}
{identicalOffsetVectorsWithinElevationCoverageAggregation}
{originDimensionIs2}
{domainRequiresCRS}
{domainDimensionIs2}

- Main decision : a coverage is a tile 1000 x 1000

- Advantage: handlable data volume (4 Mo)

- Drawback: many tiles
  – Grid size 5 m => around 25 000 tiles
  – Grid size = 1 m => around 500 000 tiles

domainExtend

domainExtend

```
- <el-cov:domainExtent>
  - <gmd:EX_Extent>
    - <gmd:description>
        <gco:CharacterString>maximum geographic extent of data</gco:CharacterString>
      </gmd:description>
    - <gmd:geographicElement>
      - <gmd:EX_GeographicBoundingBox>
        - <gmd:extentTypeCode>
            <gco:Boolean>true</gco:Boolean>
          </gmd:extentTypeCode>
        - <gmd:westBoundLongitude>
            <gco:Decimal>6.6250000</gco:Decimal>
          </gmd:westBoundLongitude>
        - <gmd:eastBoundLongitude>
            <gco:Decimal>45.8333330</gco:Decimal>
          </gmd:eastBoundLongitude>
        - <gmd:southBoundLatitude>
            <gco:Decimal>6.6666667</gco:Decimal>
          </gmd:southBoundLatitude>
        - <gmd:northBoundLatitude>
            <gco:Decimal>45.8749997</gco:Decimal>
          </gmd:northBoundLatitude>
        </gmd:EX_GeographicBoundingBox>
      </gmd:geographicElement>
    </gmd:EX_Extent>
  </el-cov:domainExtent>
```
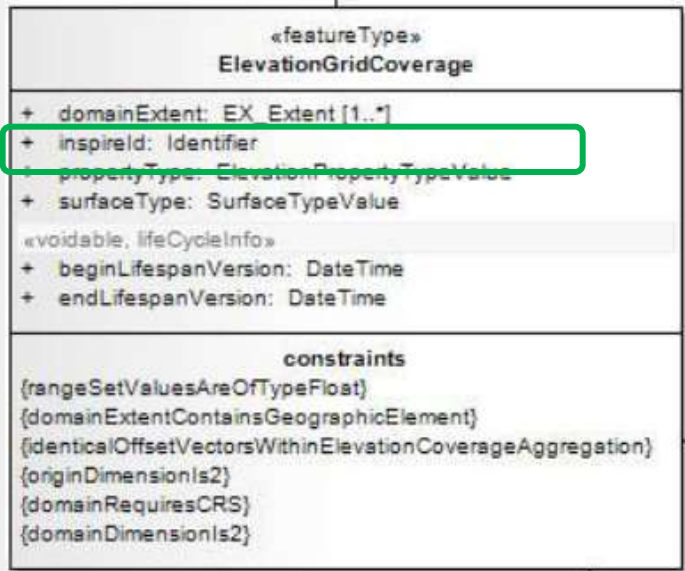
domainExtend provided as BoundingBox in default CRS

inspireIdentifier

«featureType»
ElevationGridCoverage

+ domainExtent: EX_Extent [1..*]
+ inspireId: Identifier
+ propertyType: ElevationPropertyTypeValue
+ surfaceType: SurfaceTypeValue

«voidable, lifeCycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime

constraints
{rangeSetValuesAreOfTypeFloat}
{domainExtentContainsGeographicElement}
{identicalOffsetVectorsWithinElevationCoverageAggregation}
{originDimensionIs2}
{domainRequiresCRS}
{domainDimensionIs2}

- Namespace:
  - FR_IGNF_RGEAlti_Elevation

- localId
  - EL_ETRS89_EVRF200_150MS_XXXX_YYYY
    - 150MS: grid size
    - XXXX = E [(180 + Lon)x (3600/150]
    - YYYY = E [(90+ Lat) x (3600/150)]
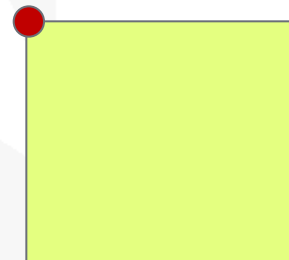
inspireIdentifier

??
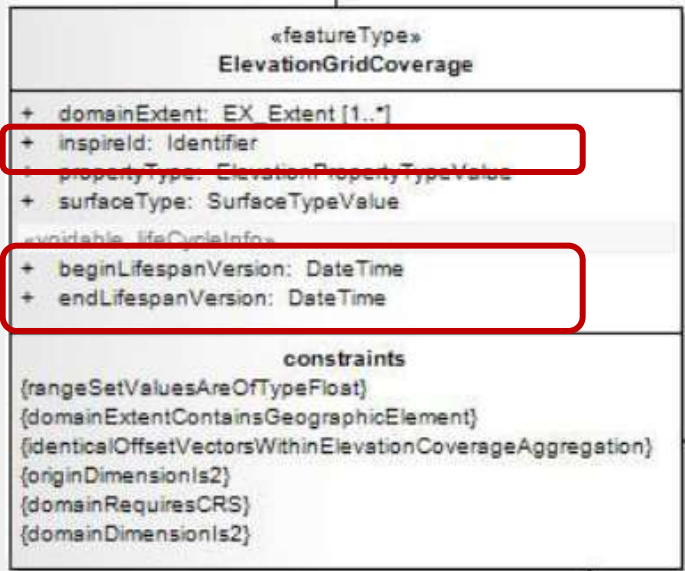
- INSPIRE requires persistent identifiers

- What to do when update on source data (RGE ALTI)?
  - Use temporal attributes (versioning)?
  - Include data (year) to the localId? (new identifier) ?

- Likely, second option

domainSet

- The half pixel issue
  - Georeferencement is present in
    - GML Cov : RectifiedGridCoverage has coverageFunction that documents:
      - Ground coordinates of origin point
      - Ground grid size(s) and directions
    - GeoTif :
      - Similar to GML Cov
      - Options Pixel Is Point or Pixel Is Area
    - => need to supply consistent information to users

  - IGN used Pixel Is Area because taken into account by (old) tools

  - Decision for INSPIRE: use option Pixel Is Point (considered as better)

  - To be checked carefully during transformation (Pixel Is area being default option of GDAL)

domainSet

```xml
- <gml:domainSet>
    - <gml:RectifiedGrid gml:id="EL-ETRS89-EVRF2000-150MS_4475_3255.grid" dimension="2">
            <!-- Note: même grille que celle du document GML de test OI_75-2008-2335-48840-ETRS89. -->
        - <gml:limits>
            - <gml:GridEnvelope>
                    <gml:low>0 0</gml:low>
                    <gml:high>1000 1000</gml:high>
                </gml:GridEnvelope>
            </gml:limits>
            <gml:axisLabels>Lat Long</gml:axisLabels>
        - <gml:origin>
            - <gml:Point gml:id="EL-ETRS89-EVRF2000-150MS_4475_3255.origin" srsName="urn:ogc:def:crs:EPSG::4258">
                    <gml:pos>6.6250000 45.8749997</gml:pos>
                </gml:Point>
            </gml:origin>
                <!--pas d'offset d'apres les specifications du projet INSPIRE-EL PixelIsPoint-->
            <gml:offsetVector srsName="urn:ogc:def:crs:EPSG::4258">0 0</gml:offsetVector>
            <gml:offsetVector srsName="urn:ogc:def:crs:EPSG::4258">0 0</gml:offsetVector>
        </gml:RectifiedGrid>
    </gml:domainSet>
```

rangeSet

```
- <gml:rangeSet>
   - <gml:File>
      <gml:rangeParameters xlink:role="image/tiff" xlink:arcrole="fileReference" xlink:href="EL-ETRS89-EVRF2000-150MS_4475_3255.tif"/>
         <!-- exemple de fichier en GeoTIFF, à instancier en BIL ou ASCII GRD si nécessaire. -->
      <gml:fileReference>EL-ETRS89-EVRF2000-150MS_4475_3255.tif</gml:fileReference>
      <gml:fileStructure>Record Interleaved</gml:fileStructure>
      <gml:mimeType>image/tiff</gml:mimeType>
   </gml:File>
</gml:rangeSet>
```

External file

Image format

For rangeSet, only the parameters necessary to access the associated image file of EL values

rangeType

- *rangeType enables clear description of main charcteristics of the Elevation Coverage*

    DataRecord::field

    "It holds the instance describing the elevation attribute of the coverage (i.e. the elevation property)".

    Quantity::definition attribute (optional)

    Property name : height / depth . Must be consistent with PropertyType

    Quantity::description attribute (optional)

    Property description

    Quantity::constraint attribute (optional)

    Number of meaningful figures after comma

    Quantity::nilValues attribute

    Identification of values dedicated for missing data

    Quantity::uom attribute

    Unit of measure. Mandatory

rangeType

```xml
- <gmlcov:rangeType>
    - <swe:DataRecord>
        - <swe:field name="height">
                <!-- Proposition d ela définition existe, sinon registre INSPIRE ou IGN -->
            - <swe:Quantity referenceFrame="http://www.opengis.net/def/crs/EPSG/0/5730"
                definition="http://opengis.net/def/property/OGC/0/Height">
                <swe:description>Height above mean sea level</swe:description>
                <swe:description>Description of Elevation (Digital Terrain Model) - RGE Alti - IGNF</swe:description>
                - <swe:nilValues>
                    - <swe:NilValues>
                        <swe:nilValue reason="http://www.opengis.net/def/nil/OGC/0/VoidAreaValue">-99999</swe:nilValue>
                            <!-- si cette ressource OGC existe, sinon, référencer une ressource INSPIRE ou IGN -->
                    </swe:NilValues>
                </swe:nilValues>
                <swe:uom code="m"/>
                - <swe:constraint>
                    - <swe:AllowedValues>
                        <swe:interval>-9000.00 +9000.00</swe:interval>
                            <!-- exemple de tenative d'identification de l'intervalle de valeurs autorisées, ici valeurs en float - GeoTIFF -->
                        <swe:significantFigures>2</swe:significantFigures>
                    </swe:AllowedValues>
                </swe:constraint>
            </swe:Quantity>
        </swe:field>
    </swe:DataRecord>
</gmlcov:rangeType>
```

Add vertical CRS to UoM?

Coverage Function

«union»
CoverageFunction

+ ruleDefinition: CharacterString
+ ruleReference: URI
+ gridFunction: GridFunction

«dataType»
GridFunction

+ sequenceRule: CV_SequenceRule [0..1]
+ startPoint: Integer [0..*] {ordered}

Quadrilateral Grid::CV_SequenceRule

+ type: CV_SequenceType = linear
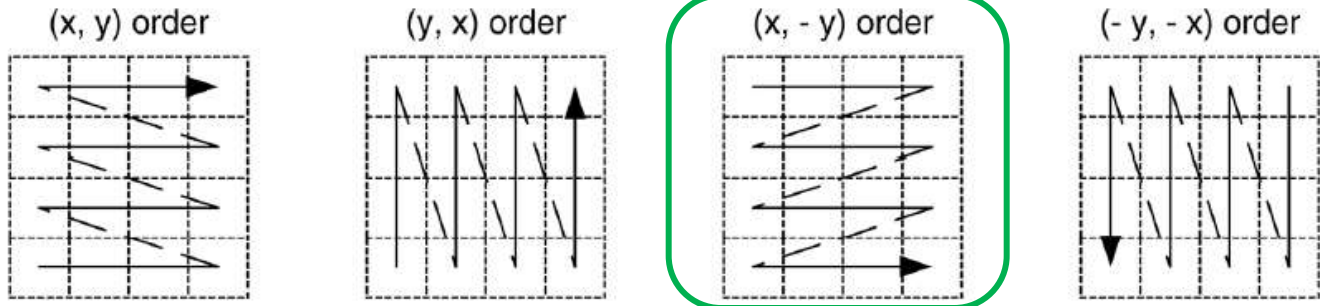+ scanDirection: Sequence<CharacterString>

«codelist»
Quadrilateral Grid::
CV_SequenceType

+ linear
+ boustrophedonic
+ CantorDiagonal
+ spiral
+ Morton
+ Hilbert

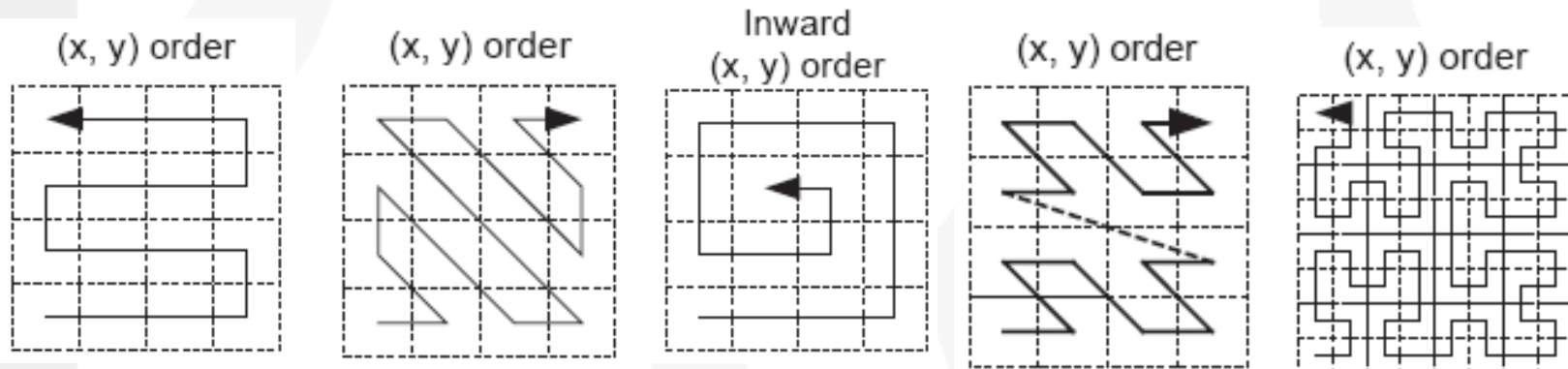For grids, there is a standardised way to associate domainSe to rangeSet

This Coverage Function is generally integrated in the encoding of the image representing the range set

Coverage Function (ISO)

| (x, y) order | (y, x) order | (x, - y) order | (- y, - x) order |

Linear (with various scanDirection)

| (x, y) order | (x, y) order | Inward (x, y) order | (x, y) order | (x, y) order |

boutrosphedonic   Cantor-Diagonal   Spiral   Morton   Hilbert

coverageFunction (GML Cov)

```
- <gml:coverageFunction>
    - <gml:GridFunction>
        <gml:sequenceRule axisOrder=" +1 +2 ">Linear</gml:sequenceRule>
        <gml:startPoint>0 0</gml:startPoint>
      </gml:GridFunction>
  </gml:coverageFunction>
```
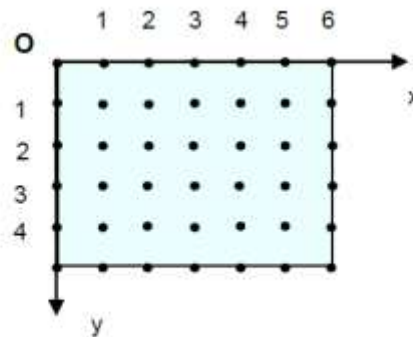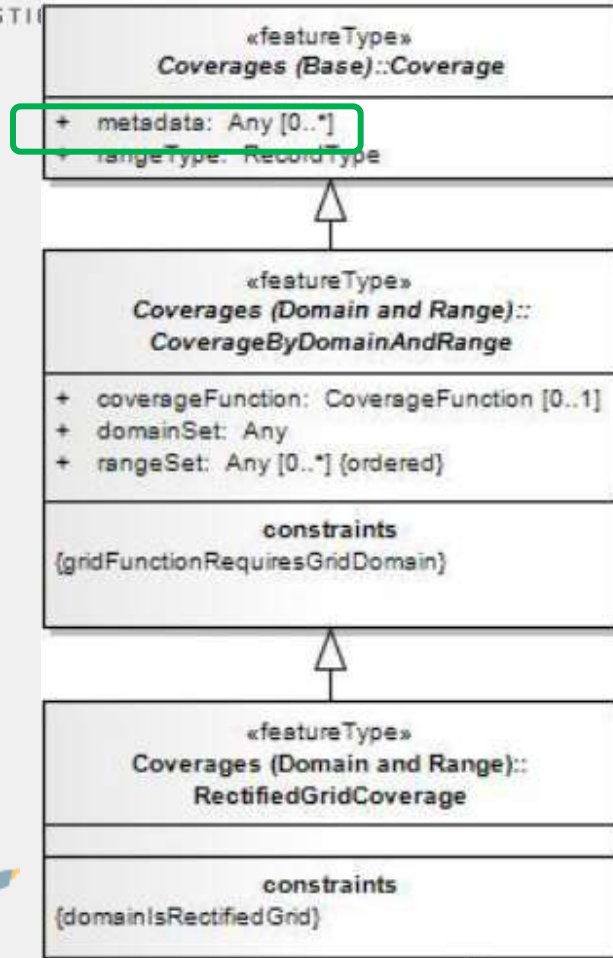

Figure 19 – Recommended grid coordinate system

metadata

INSPIRE alllows metadata:
- At feature type level (ElevationCoverage)
- At data set level

Second option is recommended.

metadata

```
238 235 238 244
218 225 230 233
209 215 221 223
209 207 215 217
209 209 211 216
```

1	2	2	2
1	1	2	2
1	1	1	2
1	1	1	2

1 : Lidar
2: automatic correlation
….

In IGN :
- Elevation data
- Source mask

- Metadata will be at data set level
- Reference to the source mask (e.g. from genealogy)
- possible only if interpolation method (when resampling during CRS transformation) is "nearest neighbour"
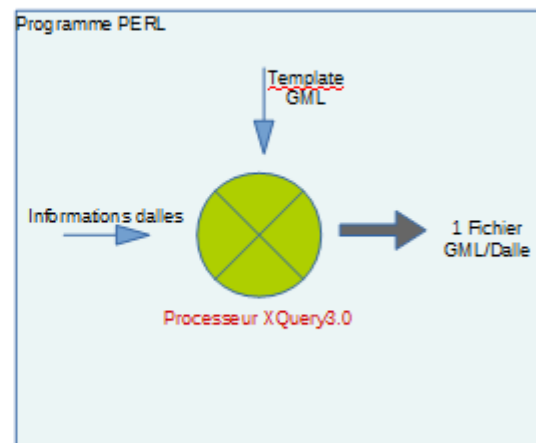
Transformation tools

- Changing CRS: GDAL

- GML Coverage

- Document de référence :
  - INSPIRE_DataSpecification_EL_v3.0.pdf
- Processeur xquery 3.0
  - ZORBA (Licence Apache)
  - alternative: xsl...
- Utilisation d'un template GML (simple extension du XML aux données géographiques).

- Applicatif

Results

DEPT 74 – ETRS89/EVRF2000