Practicing INSPIRE coverages
Enhancing your raster and datacube assets!

INSPIRE Thematic Clusters #3 & #4
Elevation, Orthoimagery, Reference systems and Geographical grids
Observations & Measurements

Kathi Schleidt & Peter Baumann & Jordi Escriu
Practicing INSPIRE coverages
Workshop agenda

• Coverage overview
  ▪ Coverages data and services – General basic concepts
  ▪ OGC Coverage implementation standards evolution

• INSPIRE coverage data and services
  ▪ Coverage-based Data Models in INSPIRE
    – WCS view: Coverages as Features
    – SOS view: Coverages as Observation Results
  ▪ Issues in Provision by WCS

• A revised model for INSPIRE coverages

• Discussion & Wrap-up
Workshop agenda

• Coverage overview – By Peter Baumann
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- A revised model for INSPIRE coverages
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INSPIRE Coverages
Modelled at conceptual level

INSPIRE Data models
(Conceptual level)

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

Implementation standards
(Implementation level)

OGC 09-146r1
GML Coverage application
schema
INSPIRE Coverages
Modelled at conceptual level

INSPIRE Data models
(Conceptual level)

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

<<featureType>>
<Theme-specific coverage class 1>

... 

<<featureType>>
<Theme-specific coverage class N>

Implementation standards
(Implementation level)

OGC 09-146r1
GML Coverage application schema
INSPIRE Coverages
Modelled at conceptual level

INSPIRE Data models
(Conceptual level)

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

Implementation standards
(Implementation level)

OGC 09-146r1
GML Coverage application
schema

OGC 09-146r2
CIS 1.0
GML Application
Schema for
Coversages

<<featureType>>
<Theme-specific coverage class 1>

... 

<<featureType>>
<Theme-specific coverage class N>
INSPIRE Coverages
Modelled at conceptual level

INSPIRE Data models
(Conceptual level)

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

<<featureType>>
Theme-specific coverage class 1>

...  

<<featureType>>
Theme-specific coverage class N>

INSPIRE Themes

Implementation standards
(Implementation level)

OGC 09-146r1
GML Coverage application schema

OGC 09-146r2
CIS 1.0
GML Application Schema for Coverages

<<featureType>>
?
INSPIRE Coverages
Common seed model for all INSPIRE themes

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

abstract

CoverageByDomainAndRange

- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
  Domain constrained to CV_Grid (*)
INSPIRE Coverages
Common seed model for all INSPIRE themes

D2.10.2 v1.0
INSPIRE Data specifications –
Base Models –
Coverage types

<<featureType>>
CoverageByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
  Domain constrained to CV_Grid (*)

<<featureType>>
RectifiedGridCoverage
  Domain constrained to CV_RectifiedGrid (*)

Regular domain

Regular grids
INSPIRE Coverages
Common seed model for all INSPIRE themes

D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

<<featureType>>
CoverageByDomainAndRange

- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)

Domain constrained to CV_Grid (*)

<<featureType>>
RectifiedGridCoverage

Domain constrained to CV_RectifiedGrid (*)

<<featureType>>
ReferenceableGridCoverage

Domain constrained to CV_ReferenceableGrid (*)

Regular domain
Irregular domain

Regular gridsIrregular grids
Use of coverages in INSPIRE

INSPIRE Coverages

- WCS view: Coverages as Features
Use of coverages in INSPIRE

- WCS view: Coverages as Features
- SOS view: Coverages as Observation Results
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WCS view: Coverages as Features

INSPIRE FeatureTypes based on Coverage Classes

INSPIRE Coverages

EL, LC, GE, OI, SO, LU, NZ, EF, AC, MF, SD, ER, OF, MF, AC, EF
INSPIRE Coverages

- Regular grids:
  - Elevation (EL)
  - Land cover (LC)
  - Orthoimagery (OI)
  - Soil (SO)
  - Energy resources (ER)
  - Species distribution (SD)

Application schema deprecated.
WCS view: Coverages as Features

INSPIRE FeatureTypes based on Coverage Classes

- **Regular grids:**
  - Elevation (EL)
  - Land cover (LC)
  - Orthoimagery (OI)
  - Soil (SO)
  - Energy resources (ER).
  - Species distribution (SD) - Application schema deprecated.

- **Regular or Irregular grids:**
  - Natural risk zones (NZ)
  - Geology (GE).
WCS view: Coverages as Features

INSPIRE FeatureTypes based on Coverage Classes

- **Energy Resources:** RenewableAndWastePotentialCoverage
- **Natural Risk Zones:** ExposedElementCoverage, HazardCoverage, ObservedEventCoverage, RiskCoverage
- **Elevation:** ElevationGridCoverage
- **Land Cover:** LandCoverGridCoverage
- **Land Use:** ExistingLandUseGrid
- **Orthoimagery:** OrthoimageCoverage
- **Soil:** SoilThemeCoverage, SoilThemeDescriptiveCoverage
- **Geology (Hydrogeology):** HydrogeologicalSurface
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

---

**Coverage types**

*abstract*

- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to CV_Grid (*)

**RectifiedGridCoverage**
- Domain constrained to CV_RectifiedGrid (*)

**ReferenceableGridCoverage**
- Domain constrained to CV_ReferenceableGrid (*)

---

*Theme-specific coverage class>*

**HydroGeologicalSurface**
(to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
INSPIRE Data specifications – Base Models – Coverage types

**Abstract**

CoverageByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)

Domain constrained to CV_Grid (*)

**Regular grids**

RectifiedGridCoverage
- Domain constrained to CV_RectifiedGrid (*)

ReferenceableGridCoverage
- Domain constrained to CV_ReferenceableGrid (*)

**Theme-specific coverage class**

HydroGeologicalSurface (to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

Irregular grids

Regular domain

Irregular domain

CoveredByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
  Domain constrained to CV_Grid (*)

RectifiedGridCoverage
- Domain constrained to CV_RectifiedGrid (*)

ReferenceableGridCoverage
- Domain constrained to CV_ReferenceableGrid (*)

HydroGeologicalSurface (to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007

Irregular grids

(NZ)

(EL)

(GE)

(SD)

(ER)

(LC)

(OI)

(SO)

(LU)
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

<<featureType>>
<Theme-specific coverage class>
Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

<<featureType>>
<Theme-specific coverage class>
Domain constrained to class CV_RectifiedGrid (*)

<<featureType>>
abstract
CoverageByDomainAndRange
• domainSet (any type)
• rangeSet (any type)
• rangeType (RecordType type)
• metadata (any type)
Domain constrained to CV_Grid (*)

<<featureType>>
RectifiedGridCoverage
Domain constrained to CV_RectifiedGrid (*)

<<featureType>>
ReferenceableGridCoverage
Domain constrained to CV_ReferenceableGrid (*)

<<featureType>>
ElevationGridCoverage
(to define the piezometric state of Ground Water Bodies)
• surfaceRectifiedGrid (type RectifiedGridCoverage), or
• surfaceReferenceableGrid (type ReferenceableGridCoverage), or
• surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

**Coverage types**
- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to CV_Grid (*)

**Regular domain**
- **RectifiedGridCoverage**
  - Domain constrained to CV_RectifiedGrid (*)

**Irregular domain**
- **ReferenceableGridCoverage**
  - Domain constrained to CV_ReferenceableGrid (*)

**LandCoverGridCoverage**
- Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

**HydroGeologicalSurface**
  - (to define the piezometric state of Ground Water Bodies)
  - surfaceRectifiedGrid (type RectifiedGridCoverage), or
  - surfaceReferenceableGrid (type ReferenceableGridCoverage), or
  - surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
INSPIRE Data specifications – Base Models – Coverage types

**Coverage types**

- **RectifiedGridCoverage**
  - Domain constrained to CV_RectifiedGrid (*)

- **ReferenceableGridCoverage**
  - Domain constrained to CV_ReferenceableGrid (*)

- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to CV_Grid (*)

- **OrthoimageCoverage**
  - (to define the piezometric state of Ground Water Bodies)
  - surfaceRectifiedGrid (type RectifiedGridCoverage), or
  - surfaceReferenceableGrid (type ReferenceableGridCoverage), or
  - surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
INSPIRE Data specifications – Base Models – Coverage types

**CoverageByDomainAndRange**
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)

Domain constrained to CV_Grid (*)

**RectifiedGridCoverage**
- Domain constrained to CV_RectifiedGrid (*)

**ReferenceableGridCoverage**
- Domain constrained to CV_ReferenceableGrid (*)

**SoilThemeCoverage**
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(* From ISO 19123:2007)
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

Abstract

CoverageByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
Domain constrained to CV_Grid (*)

Regular domain
RectifiedGridCoverage
Domain constrained to CV_RectifiedGrid (*)

Irregular domain
ReferenceableGridCoverage
Domain constrained to CV_ReferenceableGrid (*)

Theme-specific coverage class
Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

HydroGeologicalSurface
(to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

<<featureType>>
<Theme-specific coverage class>
Domain constrained to classes
CV_RectifiedGrid or CV_ReferenceableGrid (*)

<<featureType>>
<Theme-specific coverage class>
Domain constrained to class
CV_RectifiedGrid (*)

abstract

<<featureType>>
CoverageByDomainAndRange
• domainSet (any type)
• rangeSet (any type)
• rangeType (RecordType type)
• metadata (any type)
Domain constrained to CV_Grid (*)

<<featureType>>
RectifiedGridCoverage
Domain constrained to
CV_RectifiedGrid (*)

<<featureType>>
ReferenceableGridCoverage
Domain constrained to
CV_ReferenceableGrid (*)

<<dataType>>
ExistingLandUseGrid
(to define the piezometric state of Ground Water Bodies)
• surfaceRectifiedGrid (type RectifiedGridCoverage), or
• surfaceReferenceableGrid (type ReferenceableGridCoverage), or
• surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
INSPIRE Data specifications – Base Models – Coverage types

**Coverage types**

- **RectifiedGridCoverage**
  - Domain constrained to **CV_RectifiedGrid** (*)

- **ReferenceableGridCoverage**
  - Domain constrained to **CV_ReferenceableGrid** (*)

**Abstract**

- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to **CV_Grid** (*)

**Theme-specific coverage class**

- **RenewableAndWastePotentialCoverage**
  - Domain constrained to class **CV_RectifiedGrid** (*)

**HydroGeologicalSurface**

(to define the piezometric state of Ground Water Bodies)

- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
INSPIRE Data specifications – Base Models – Coverage types

D2.10.2 v1.0

**Abstract**

CoverageByDomainAndRange

- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)

Domain constrained to CV_Grid (*)

**Regular domain**

RectifiedGridCoverage

Domain constrained to CV RectifiedGrid (*)

**Irregular domain**

ReferenceableGridCoverage

Domain constrained to CV ReferenceableGrid (*)

**Theme-specific coverage class**

HydroGeologicalSurface (to define the piezometric state of Ground Water Bodies)

- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007

Deprecated use of coverages Considered in TG SD rc2
INSPIRE Data specifications – Base Models – Coverage types

**Abstract**

- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to CV_Grid (*)

**Types**

- **RectifiedGridCoverage**
  - Domain constrained to CV_RectifiedGrid (*)

- **ReferenceableGridCoverage**
  - Domain constrained to CV_ReferenceableGrid (*)

**Theme-specific coverage classes**

- **ExposedElementCoverage**
  - Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

- **HydroGeologicalSurface**
  - (to define the piezometric state of Ground Water Bodies)
    - surfaceRectifiedGrid (type RectifiedGridCoverage), or
    - surfaceReferenceableGrid (type ReferenceableGridCoverage), or
    - surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0

INSPIRE Data specifications –
Base Models –
Coverage types

<<featureType>>
HazardCoverage
Domain constrained to classes
CV_RectifiedGrid or CV_ReferenceableGrid (*)

<<featureType>>
ReferenceableGridCoverage
Domain constrained to class
CV_ReferenceableGrid (*)

abstract

<<featureType>>
CoverageByDomainAndRange

- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)

Domain constrained to CV_Grid (*)

Regular domain

<<featureType>>
RectifiedGridCoverage
Domain constrained to
CV_RectifiedGrid (*)

Irregular domain

<<featureType>>
ReferenceableGridCoverage
Domain constrained to
CV_ReferenceableGrid (*)

<<featureType>>
HydroGeologicalSurface
(to define the piezometric state of Ground Water Bodies)

- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(* From ISO 19123:2007)
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

abstract

CoverageByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
Domain constrained to CV_Grid (*)

RectifiedGridCoverage
Domain constrained to CV_RectifiedGrid (*)

ReferenceableGridCoverage
Domain constrained to CV_ReferenceableGrid (*)

ObservedEventCoverage
Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

HydroGeologicalSurface
(to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0

INSPIRE Data specifications – Base Models – Coverage types

**Coverage types**

- **RiskCoverage**
  - Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

- **RectifiedGridCoverage**
  - Domain constrained to CV_RectifiedGrid (*)

- **ReferenceableGridCoverage**
  - Domain constrained to CV_ReferenceableGrid (*)

**Abstract**

- **CoverageByDomainAndRange**
  - domainSet (any type)
  - rangeSet (any type)
  - rangeType (RecordType type)
  - metadata (any type)
  - Domain constrained to CV_Grid (*)

**Theme-specific coverage class**

- **HydroGeologicalSurface**
  - (to define the piezometric state of Ground Water Bodies)
  - surfaceRectifiedGrid (type RectifiedGridCoverage), or
  - surfaceReferenceableGrid (type ReferenceableGridCoverage), or
  - surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
D2.10.2 v1.0
INSPIRE Data specifications – Base Models – Coverage types

**abstract**

CoverageByDomainAndRange
- domainSet (any type)
- rangeSet (any type)
- rangeType (RecordType type)
- metadata (any type)
  Domain constrained to CV_Grid (*)

**Regular domain**

RectifiedGridCoverage
- Domain constrained to CV_RectifiedGrid (*)

**Irregular domain**

ReferenceableGridCoverage
- Domain constrained to CV_ReferenceableGrid (*)

**Theme-specific coverage class**
- Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

**Theme-specific coverage class**
- Domain constrained to class CV_RectifiedGrid (*)

**Theme-specific coverage class**
- Domain constrained to classes CV_RectifiedGrid or CV_ReferenceableGrid (*)

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**DataType**

HydroGeologicalSurface
(to define the piezometric state of Ground Water Bodies)
- surfaceRectifiedGrid (type RectifiedGridCoverage), or
- surfaceReferenceableGrid (type ReferenceableGridCoverage), or
- surfacePointCollection (type PointObservationCollection)

(*) From ISO 19123:2007
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SOS view: Coverages as Observation Results

INSPIRE Coverages

- **Regular or irregular grids**
  - Environmental monitoring facilities (EF)
  - Atmospheric conditions (AC)
  - Meteorological geographic features (MF)
  - Oceanographic geographic features (OF)
  - Geology (GE)

- Provided as discrete observation coverages, i.e. gridded data specialized observation types applying the ISO 19156:2011 (O&M), following *INSPIRE D2.9 v3.0*
SOS view: Coverages as Observation Results
Coverage based models in the observational context

D2.9 v3.0
INSPIRE Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development

Based on ISO 19156:2011 Observations and Measurements standard (O&M in OGC)

Use of Gridded Data specialized observation types.
SOS view: Coverages as Observation Results
Coverage based models in the observational context
SOS view: Coverages as Observation Results
Coverage based models in the observational context

Diagram with nodes and edges:
- Observation
- Domain
- Range
- Process
- Property
- Coverage
- RangeType
- domainSet
- rangeSet
- result (xlink)

Edges:
- Domain to Observation
- Observation to DomainSet
- Observation to RangeSet
- Observation to RangeTyp
- Process to Observation
- Property to Observation
- ProcessUsed to Observation
- phenomenon to Observation
- +featureOfInterest to Observation

Labels:
- +domainSet
- +rangeSet
- +rangeType
- +result (xlink)
SOS view: Coverages as Observation Results
Coverage based models in the observational context
SOS view: Coverages as Observation Results
Coverage based models in the observational context
**SOS view: Coverages as Observation Results**

Coverage based models in the observational context

- **Observational Model** (GCM)
  - GridObservation: RectifiedGridCoverage or ReferencableGridCoverage
  - GridSeriesObservation: RectifiedGridCoverage or ReferencableGridCoverage
  - PointObservation: CV_DiscretePointCoverage
  - MultiPointObservation: MultiPointCoverage
  - ProfileObservation: RectifiedGridCoverage or ReferencableGridCoverage

- **Environmental Monitoring Facilities**: GCM-OM

- **Atmospheric Conditions & Meteorological Features**: GCM-OM

- **Oceanographic Features**: GCM-OM

- **Geology (Geophysics)**: RectifiedGridCoverage or ReferencableGridCoverage
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Issues in Provision by WCS

• **INSPIRE coverage extensions**
  - Additional information to OGC coverages shall be provided as Coverage Metadata (not extending the coverage class).

• **Identifier and scope issues**
  - What exactly is a dataset?
  - Do subsets require identifiers?

• **Coverage aggregation**

• **Orthoimage mosaic elements**
Issues in Provision by WCS

INSPIRE Coverage extensions

INSPIRE Orthoimagery
Issues in Provision by WCS

INSPIRE Coverage extensions

INSPIRE Orthoimagery Model
‘Orthoimage Coverage’ schema
Issues in Provision by WCS
INSPIRE Coverage extensions

Generic Conceptual Model
‘Coverage – Domain and range’ schema
Based on ISO 19123

INSPIRE Orthoimagery Model
‘Orthoimage Coverage’ schema
INSPIRE Coverage extensions

Existing model
INSPIRE Coverage extensions

Existing model

```
<featureType>
  OrthoimageCoverage
  + inspireId: Identifier
  + domainExtent: EX_Extent [1..*]
  + interpolationType: InterpolationMethod = 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}
{originDimensionsIs2}
{domainRequiresCRS}
{domainExtentContainsGeographicElement}
{rangeSetValuesAreOfTypeInteger}
{identicalOffsetVectorsWithinOrthoimageAggregation}
{acquisitionTimeRequired}

+ contributingOrthoimageCoverage 0..*
```

```
<featureType>
  MosaicElement
  + inspireId: Identifier [0..1]
  + geometry: GM_MultiSurface
  + phenomenonTime: TM_Period

<featureType>
  AggregatedMosaicElement

<featureType>
  SingleMosaicElement
  + imageSourceReference: CharacterString [0..1]

<featureType>
  OrthoimageAggregation
  + contributingFootprint: GM_MultiSurface

<codeList>
  InterpolationMethodValue
```
INSPIRE Coverage extensions

Existing model

```plaintext
<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}
  {rangeSetValuesAreOfType: Integer}
  {identicalOffsetVectorsWithinOrthoimageAggregation}
  {acquisitionTimeRequired}

+ contributingOrthoimageCoverage [0..*]
```

```plaintext
<featureType>
  MosaicElement
  + inspireId: Identifier [0..1]
  + geometry: GM_MultiSurface
  + phenomenonTime: TM_Period
  «voidable»

<featureType>
  AggregatedMosaicElement

<featureType>
  SingleMosaicElement

<dataType>
  OrthoimageAggregation
  + contributingFootprint: GM_MultiSurface

<codeList>
  InterpolationMethodValue
```
Issues in Provision by WCS Identifier and scope

- **What is the scope of the inspireId?**
  - INSPIRE: A complete coverage ingested in the WCS server.
  - OGC: A complete coverage, unique within the WCS server. (i.e. coverageId)

- **What exactly a dataset is?**
  - A predefined raster map-sheet? Not needed!
  - Just the coverage in the WCS server.

- **Do subsets require identifiers?**
  - Probably not!

- **How to map this into CIS 1.0 / CIS 1.1?**
  - gml:id / cis:coverageId
Issues in Provision by WCS
Coverage aggregation
Issues in Provision by WCS

Coverage aggregation

Construction of the aggregated orthoimage coverage (footprint in blue) from subsets of the contributing orthoimage coverages (contributing footprints in orange)
Construction of the aggregated orthoimage coverage (footprint in blue) from subsets of the contributing orthoimage coverages (contributing footprints in orange).
Issues in Provision by WCS

Coverage aggregation

Footprint and contributing footprint of an orthoimage referred by an aggregated orthoimage (respectively in blue and orange).
Issues in Provision by WCS
Coverage aggregation

Solution in CIS 1.1

- Feature
  - «Feature Type» AbstractCoverage
  - «Data Type» Metadata
    + any : any [0..*]
  - CoverageByPartitioning
    - «Feature Type» CoverageByDomainAndRange
      - «Data Type» DomainSet
        + value : any [0..*] (ordered)
      - «Data Type» RangeType
        + rangeSet
      - «Data Type» InterpolationRestriction
        + allowedInterpolation : anyURI [0..*]
  - CoverageByDomainAndRange
    - «Data Type» PositionValuePair
      + directPosition : DirectPosition
      + value : any
    - «Data Type» PartitionSet
      + partition : Partition [0..*]
      + value : any [0..*]
    - «Data Type» Partition
      + envelope : EnvelopeByAxis [0..1]
    - «Data Type» RangeSet
      + value : any 
    - «Feature Type» AbstractCoverage
      - «Data Type» RangeType
        + rangeSet
      - «Data Type» InterpolationRestriction
        + allowedInterpolation : anyURI [0..*]
      - «Data Type» Metadata
        + any : any [0..*]
      - rangeType
      + metadata 0..1
      + interpolationRestriction 0..1
      + rangeType
      + rangeSet

refined in the individual coverage types
structure of values is defined by RangeType, multiplicity defined by DomainSet
Issues in Provision by WCS
Coverage aggregation

• **Solution in OGC EO-WCS Application Profile.**

• It already addresses this concept.

• Interoperability of INSPIRE and other existing and implemented solutions is desirable.
Issues in Provision by WCS
Orthoimage mosaics

- Use of SingleMosaic-Element objects
Issues in Provision by WCS

Orthoimage mosaics

- Use of SingleMosaic-Element objects
Issues in Provision by WCS
Orthoimage mosaics

- Use of AggregatedMosaicElement objects
Issues in Provision by WCS

- **Coverage range options**
  - Non-numeric Range: how to provide categories (i.e. CORINE Land Cover values)
  - Multiple Range Components: profile measurements with depth together with measurement

- **Non-Spatial CRS** - pressure used for oceanographic depth & meteorological height
Workshop agenda

- **Coverage overview**
  - Coverages data and services – General basic concepts
  - OGC Coverage implementation standards evolution

- **INSPIRE coverage data and services**
  - Coverage-based Data Models in INSPIRE
    - WCS view: Coverages as Features
    - SOS view: Coverages as Observation Results
  - Issues in Provision by WCS

- A revised model for INSPIRE coverages

- Discussion & Wrap-up
A revised model for INSPIRE coverages
Coverage Metadata Model

```
class LandCover

  «featureType»
  Coverages (Domain and Range): RectifiedGridCoverage

  ::CoverageByDomainAndRange
    + coverageFunction: CoverageFunction [0..1]
    + domainSet: Any
    + rangeSet: Any [0..*] [ordered]
  ::Coverage
    + metadata: Any [0..*]
    + rangeType: RecordType

  constraints
  {domainIsRectifiedGrid}
  {grid points shall coincide with grid cell centres}
  ::CoverageByDomainAndRange
  {gridFunctionRequiresGridDomain}

// LandCoverRaster::LandCoverGridCoverage

  + inspireId: Identifier
  + extent: EX_Extent
  + name: CharacterString
  + nomenclatureDocumentation: LandCoverNomenclature
  «voidable, lifecycleInfo»
    + beginLifespanVersion: DateTime
    + endLifespanVersion: DateTime [0..1]
  «voidable»
    + validFrom: Date
    + validTo: Date

  constraints
  {rangeSetIsKindOfLandCoverClassValue}
```
A revised model for INSPIRE coverages

Coverage Metadata Model

class LandCoverExpanded

«featureType»
LandCoverRaster::LandCoverGridCoverage

+ inspireId: Identifier
+ extent: EX_Extent
+ name: CharacterString
+ nomenclatureDocumentation: LandCoverNomenclature

::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] {ordered}

::Coverage
  + metadata: Any [0..*]
  + rangeType: RecordType

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

«voidable»
  + validFrom: Date
  + validTo: Date

constraints
{rangeSetsIsKindOfLandCoverClassValue}
::RectifiedGridCoverage
{ domainsIsRectifiedGrid }
{ grid points shall coincide with grid cell centres }
::CoverageByDomainAndRange
{ gridFunctionRequiresGridDomain }
A revised model for INSPIRE coverages

Coverage Metadata Model

```plaintext
class LandCoverExpanded
  «featureType»
  LandCoverRaster::LandCoverGridCoverage

  + inspireId: Identifier
  + extent: EX_Extent
  + name: CharacterString
  + nomenclatureDocumentation: LandCoverNomenclature

  ::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] {ordered}

  ::Coverage
  + metadata: Any [0..*]
  + rangeType: RecordType

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

  «voidable»
  + validFrom: Date
  + validTo: Date

  constraints
  [rangeSetsKindOfLandCoverClassValue]

  ::RectifiedGridCoverage
  {domainIsRectifiedGrid}
  {grid points shall coincide with grid cell centres}

  ::CoverageByDomainAndRange
  {gridFunctionRequiresGridDomain}
```

class Coverage
  «featureType»
  Coverages (Domain and Range)::RectifiedGridCoverage

  ::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] {ordered}

  ::Coverage
  + metadata: Any [0..*]
  + rangeType: RecordType

  constraints
  [domainIsRectifiedGrid]
  {grid points shall coincide with grid cell centres}

  ::CoverageByDomainAndRange
  {gridFunction Requires GridDomain}
A revised model for INSPIRE coverages

Coverage Metadata Model

class LandCoverExpanded

```plaintext
+ inspireId: Identifier
+ extent: EX_Extent
+ name: CharacterString
+ nomenclatureDocumentation: LandCoverNomenclature
::CoverageByDomainAndRange
+ coverageFunction: CoverageFunction [0..1]
+ domainSet: Any
+ rangeSet: Any [0..*] {ordered}
::Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType
  «voidable, lifeCycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
  «voidable»
+ validFrom: Date
+ validTo: Date

constraints
{rangeSetsIsKindOfLandCoverClassValue}
::RectifiedGridCoverage
{domainsIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{gridFunctionRequiresGridDomain}
```

class Coverage

```plaintext
+ coverageFunction: CoverageFunction [0..1]
+ domainSet: Any
+ rangeSet: Any [0..*] {ordered}
::Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType

constraints
{domainsIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{gridFunctionRequiresGridDomain}
```
A revised model for INSPIRE coverages

Coverage Metadata Model

class LandCover

«featureType»
Coverages (Domain and Range):
RectifiedGridCoverage

::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] [ordered]
::Coverage
  + metadata: Any [0..*]
  + rangeType: RecordType

constraints
{domainIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{gridFunctionRequiresGridDomain}

class Coverage

«featureType»
Coverages (Domain and Range):
RectifiedGridCoverage

::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] [ordered]
::Coverage
  + metadata: Any [0..*]
  + rangeType: RecordType

constraints
{domainIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{gridFunctionRequiresGridDomain}
A revised model for INSPIRE coverages

Coverage Metadata Model

```
class Coverage

  «featureType»
  Coverages (Domain and Range)::
  RectifiedGridCoverage

  ::CoverageByDomainAndRange
  + coverageFunction: CoverageFunction [0..1]
  + domainSet: Any
  + rangeSet: Any [0..*] {ordered}

  ::Coverage
  + metadata: Any [0..*]
  + rangeType: RectifiedType

constraints
{domainsIsRectifiedGrid}
{grid points shall coincide with grid cell centres}
::CoverageByDomainAndRange
{ gridFunctionRequiresGridDomain }
```

class LandCoverMD

```
«featureType»
LandCoverGridCoverageMD

+ inspireId: Identifier
+ extent: EX_Extent
+ name: CharacterString
+ nomenclatureDocumentation: LandCoverNomenclature

«voidable, cycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
«voidable»
+ validFrom: Date
+ validTo: Date
```
A revised model for INSPIRE coverages
Example WCS services

- http://sandbox.datacove.eu:8080/rasdaman/ows?&SERVICE=WCS&VERSION=2.0.1&REQUEST=DescribeCoverage&COVERAGEID=FiLCCoverageBit&FORMAT=application/

- http://sandbox.datacove.eu:8080/rasdaman/ows?&SERVICE=WCS&VERSION=2.0.1&REQUEST=GetCoverage&COVERAGEID=FiLCCoverageBit

- http://sandbox.datacove.eu:8080/rasdaman/ows?&SERVICE=WCS&VERSION=2.0.1&REQUEST=GetCoverage&COVERAGEID=FiLCCoverageBit&subset=E(620000,620050)&subset=N(7220000,7220050)
<table>
<thead>
<tr>
<th>INSPIRE Conceptual data model</th>
<th>Mapping to OGC CIS v1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage element: type [cardinality]</td>
<td>CIS (gmlcov:) / GML element (gml:)</td>
</tr>
<tr>
<td>ElevationGridCoverage (type RectifiedGridCoverage as defined in D2.10.2 [18])</td>
<td>gmlcov:RectifiedGridCoverage</td>
</tr>
<tr>
<td>OrthoimageCoverage (type RectifiedGridCoverage as defined in D2.10.2 [18])</td>
<td>gmlcov:RectifiedGridCoverage</td>
</tr>
<tr>
<td>rangeSet: Any [0..*] (type duly constrained in each theme; represents each of the coverage values)</td>
<td>gmlcov:RectifiedGridCoverage.rangeSet [1] (type gml:RangeSet; represents the set of coverage values)</td>
</tr>
<tr>
<td>rangeType: RecordType [1]</td>
<td>gmlcov:RectifiedGridCoverage.rangeType [1] (type swe:DataRecord)</td>
</tr>
<tr>
<td>metadata: Any [0..*]</td>
<td>gmlcov:Coverage.metadata: Any [0..*]</td>
</tr>
</tbody>
</table>
# A revised model for INSPIRE coverages

## Mapping between INSPIRE EL & OI models & CIS

<table>
<thead>
<tr>
<th>INSPIRE Conceptual data model</th>
<th>Mapping to OGC CIS v1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coverage element: type [cardinality]</strong></td>
<td>CIS (gmlcov:) / GML element (gml:)</td>
</tr>
<tr>
<td><strong>&lt;&lt;stereotype&gt;&gt;</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Element type</strong></td>
<td></td>
</tr>
<tr>
<td><strong>inspireId: Identifier [1]</strong></td>
<td>gml:id property (To be further analysed)</td>
</tr>
<tr>
<td><strong>Property</strong></td>
<td></td>
</tr>
<tr>
<td><strong>domainExtent: EX_Extent [1..*]</strong></td>
<td>gml:boundedBy / gml:Envelope / gml:EnvelopeWithTimePeriod</td>
</tr>
<tr>
<td><strong>Property</strong></td>
<td></td>
</tr>
<tr>
<td><strong>beginLifespanVersion: DateTime [1]</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td><strong>&lt;&lt;voidable&gt;&gt;</strong></td>
<td></td>
</tr>
<tr>
<td><strong>endLifespanVersion: DateTime [0..1]</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td>**(Cardinality [1] in EL; [0..1] in OI) **</td>
<td></td>
</tr>
<tr>
<td><strong>&lt;&lt;voidable&gt;&gt;</strong></td>
<td></td>
</tr>
<tr>
<td><strong>contributingElevationGridCoverage [0..*]</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td><strong>Aggregation relationship</strong></td>
<td></td>
</tr>
<tr>
<td><strong>contributingOrthoimageCoverage [0..*]</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td><strong>Aggregation relationship</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ElevationGridCoverageAggregation</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td><strong>Association class</strong></td>
<td></td>
</tr>
<tr>
<td><strong>OrthoimageAggregation</strong></td>
<td>Not matched (INSPIRE Extension).</td>
</tr>
<tr>
<td><strong>Association class</strong></td>
<td></td>
</tr>
</tbody>
</table>
A revised model for INSPIRE coverages

Some conclusions & suggestions

- Wide use of coverages in INSPIRE.
- Suggested but appropriate for clarity:
  - Revise consistency of INSPIRE conceptual models (UML) and TGs to CIS.
  - Cross-theme harmonization.
  - Verify alignment of seed model for INSPIRE Coverages (D1.10.2) to OGC CIS.
- Necessary to update the INSPIRE coverage schemas to standard CIS.
- Take into account present and future implementation:
  - CIS 1.0 (OGC 09-146r2) and CIS 1.1 (OGC 09-146r6).
- Consider a INSPIRE extension as Coverage Metadata elements.
- Avoid modelling of complex concepts (aggregations, OI mosaics):
  - Treat them in coverage metadata, or;
  - Move them to an extended / optional schema, but using standardized mechanisms (OGC CIS 1.1 or EO-WCS profile);
Workshop agenda

- **Coverage overview**
  - **Coverages data and services** – General basic concepts
  - **OGC Coverage implementation standards evolution**

- **INSPIRE coverage data and services**
  - **Coverage-based Data Models in INSPIRE**
    - WCS view: Coverages as Features
    - SOS view: Coverages as Observation Results
  - **Issues in Provision by WCS**

- **A revised model for INSPIRE coverages**

- **Discussion & Wrap-up**
Thanks for your attention!

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