

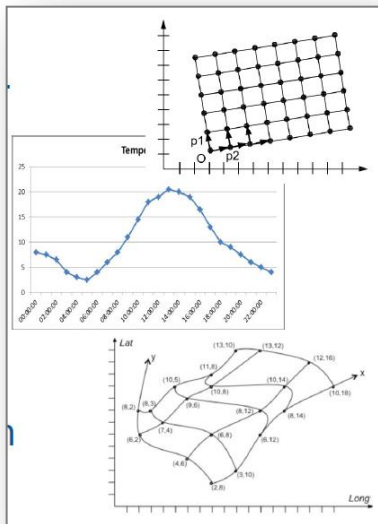
Practicing INSPIRE coverages

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**
 - **Coverages data and services** – General basic concepts
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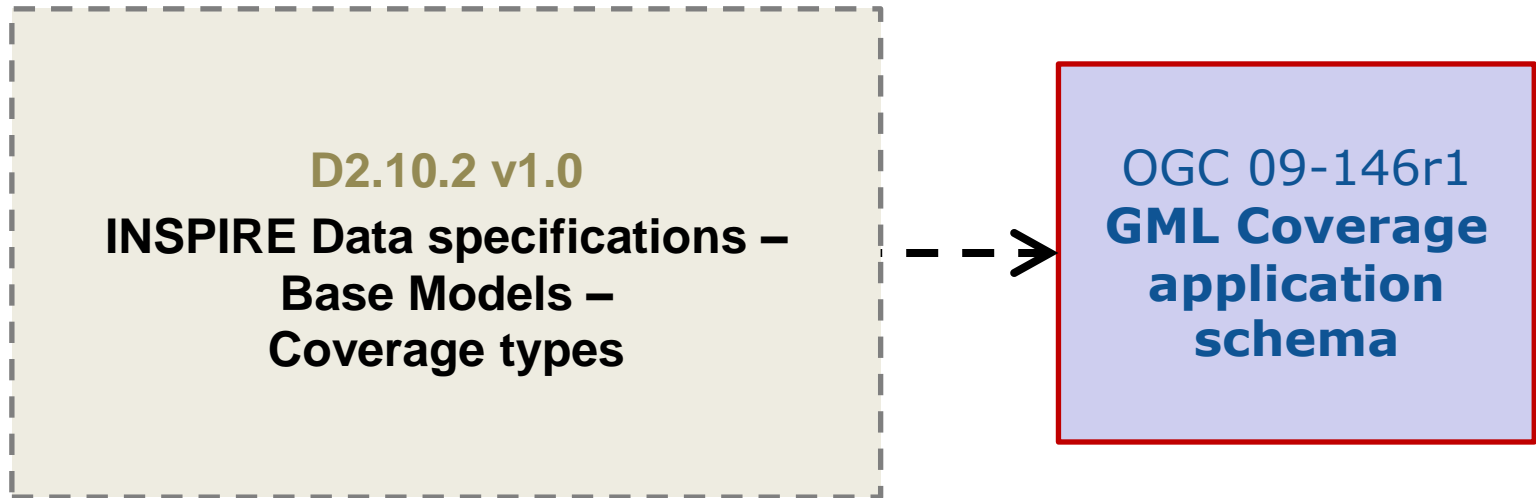
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INSPIRE Coverages

Modelled at conceptual level

**INSPIRE Data models
(Conceptual level)**

**Implementation standards
(Implementation level)**

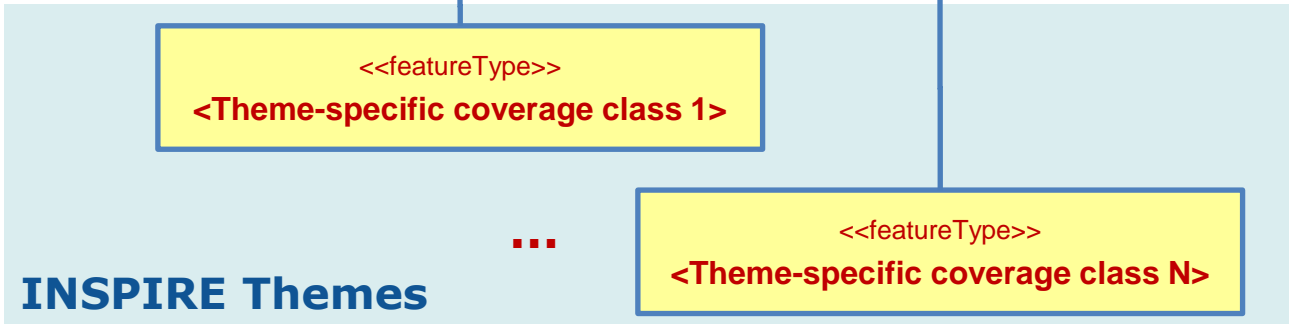
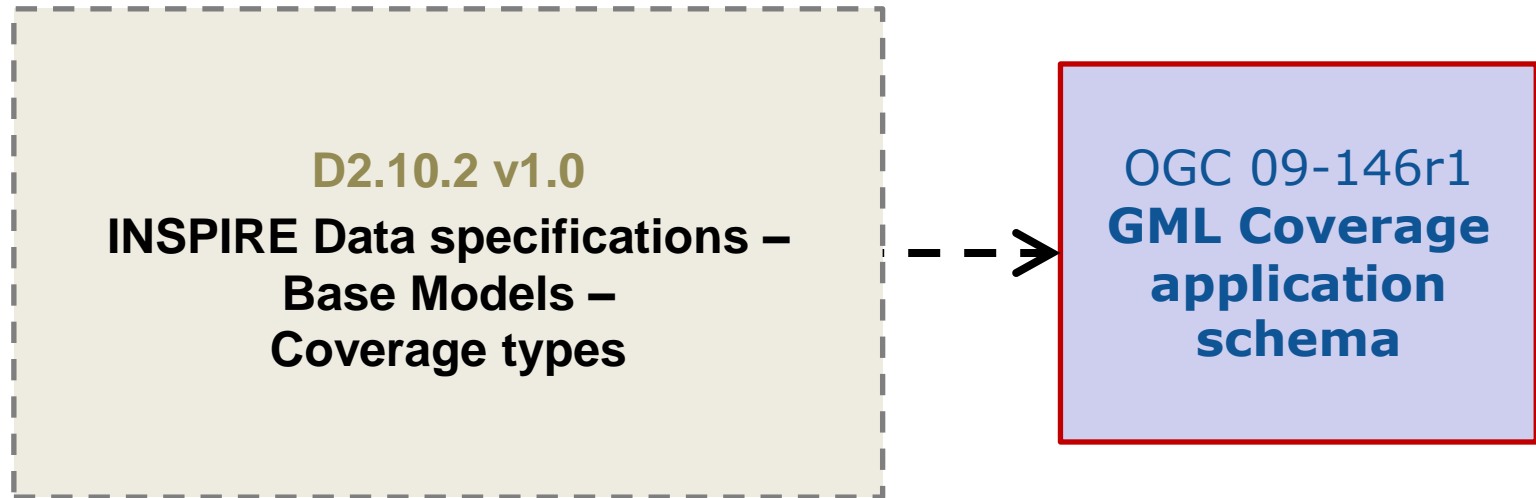


INSPIRE Coverages

Modelled at conceptual level

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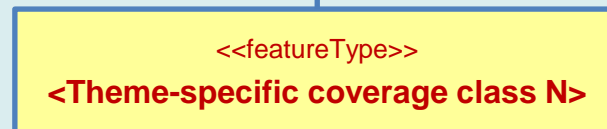
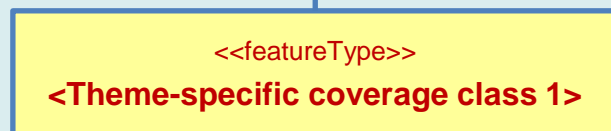
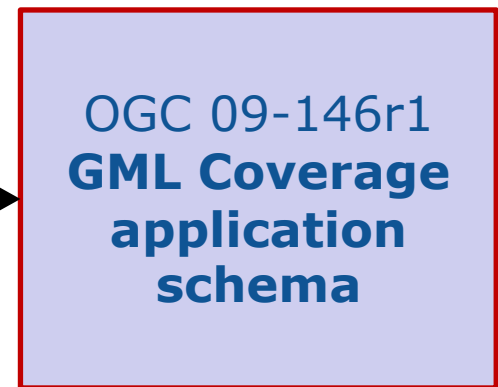
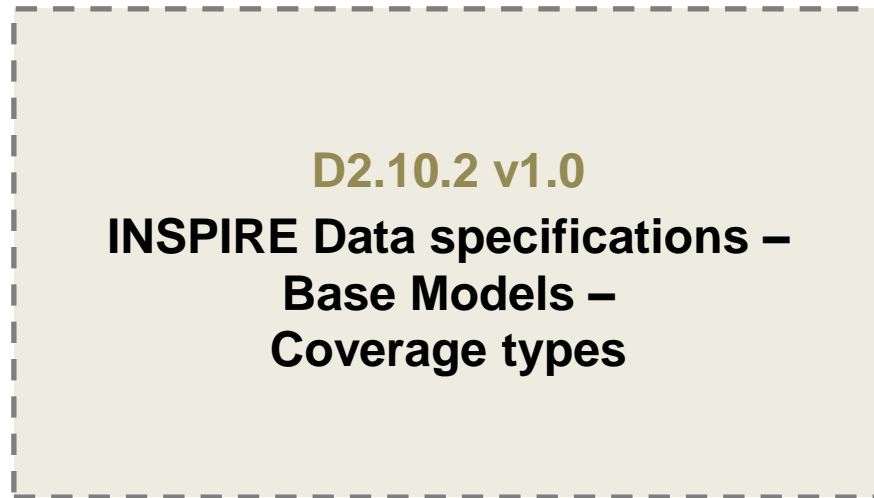


INSPIRE Coverages

Modelled at conceptual level

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INSPIRE Themes

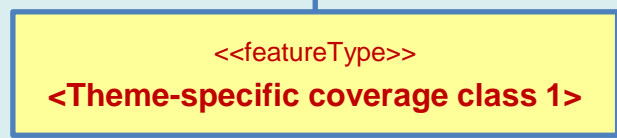
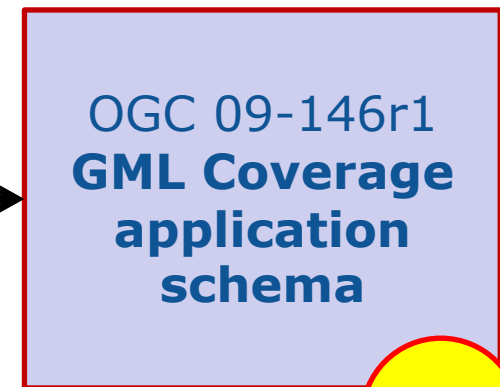
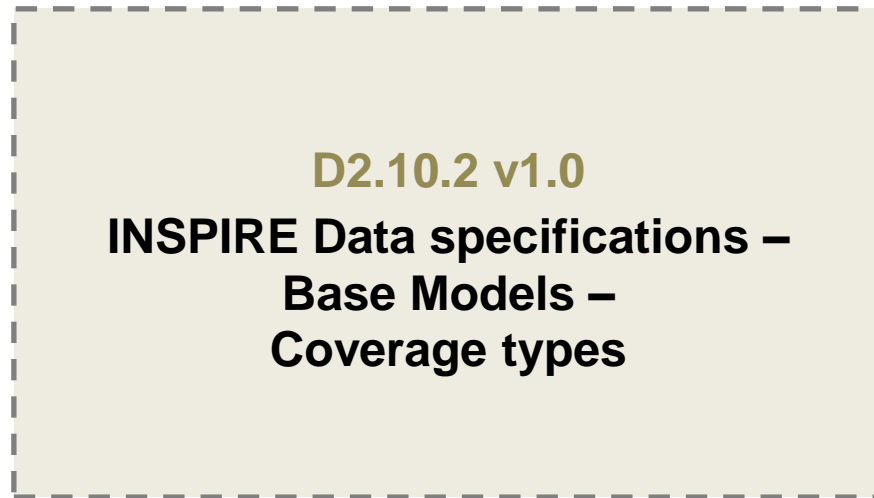


INSPIRE Coverages

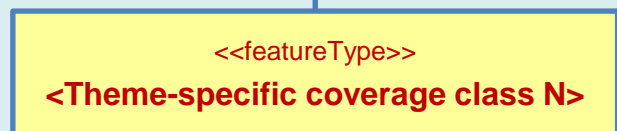
Modelled at conceptual level

**INSPIRE Data models
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**Implementation standards
(Implementation level)**



...



INSPIRE Themes

INSPIRE Coverages

Common seed model for all INSPIRE themes

D2.10.2 v1.0

INSPIRE Data specifications –
Base Models –
Coverage types

abstract

<<featureType>>

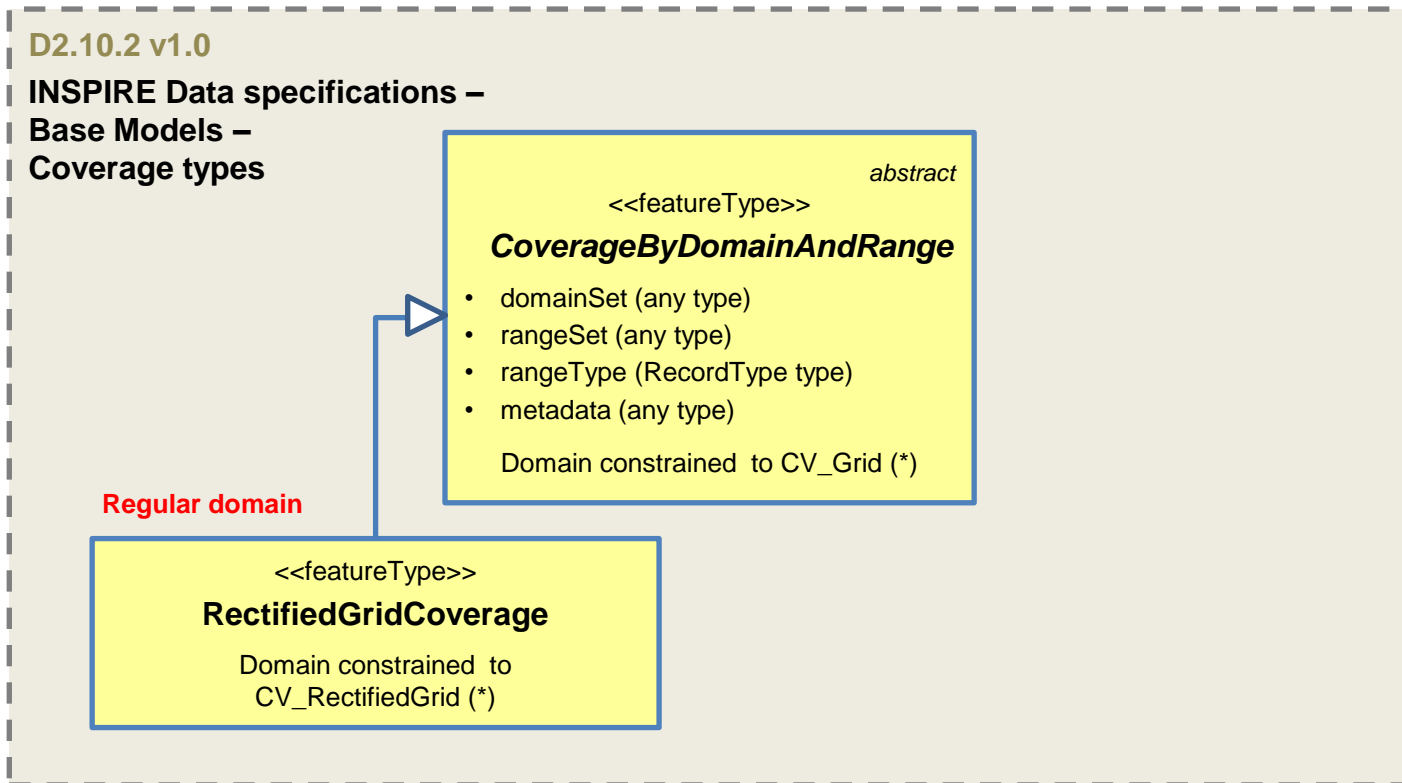
CoverageByDomainAndRange

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

Domain constrained to CV_Grid (*)

INSPIRE Coverages

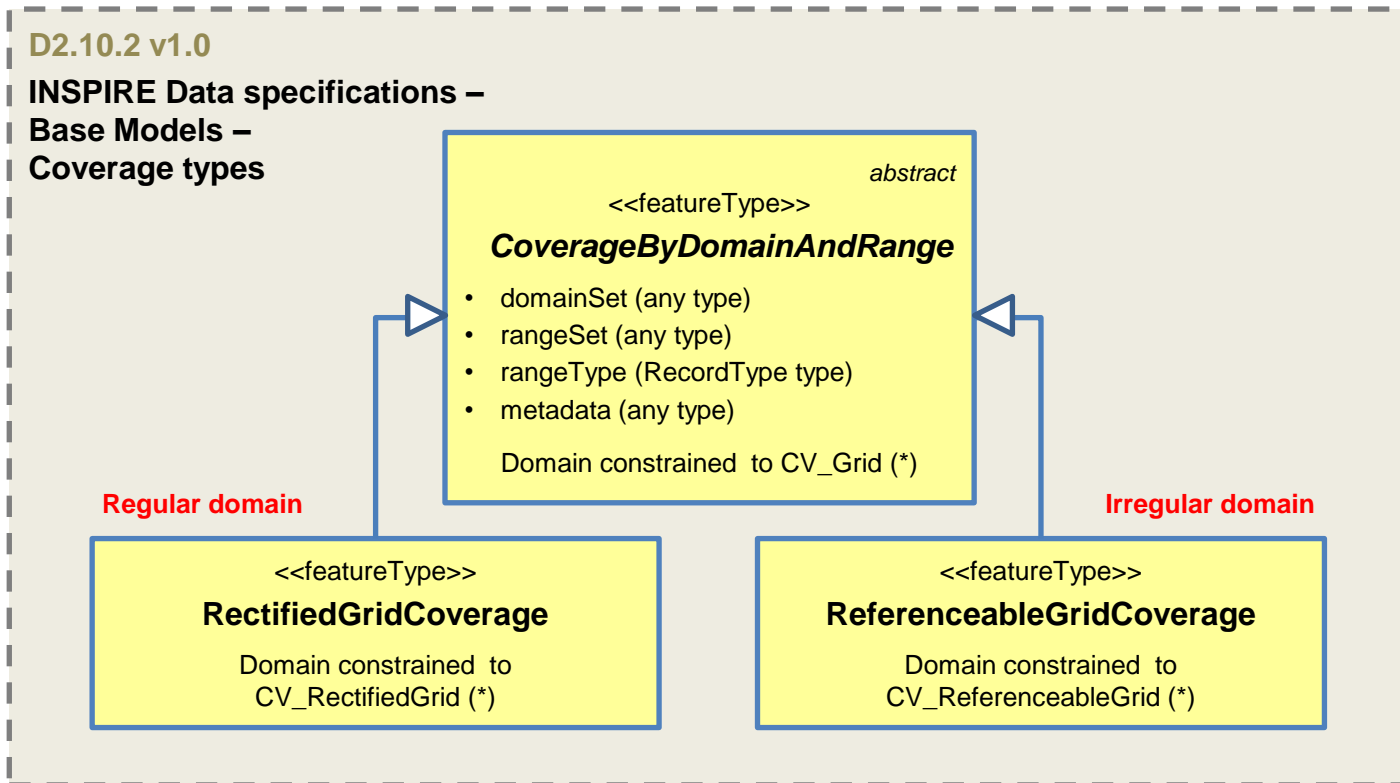
Common seed model for all INSPIRE themes



Regular grids

INSPIRE Coverages

Common seed model for all INSPIRE themes



Regular grids

Irregular grids

Use of coverages in INSPIRE



- **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



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.

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:

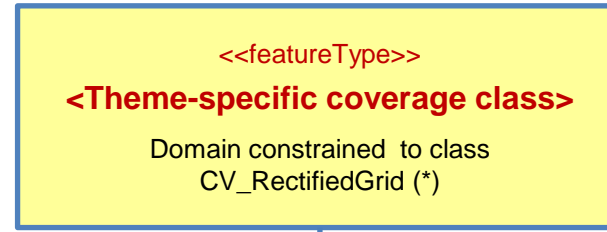
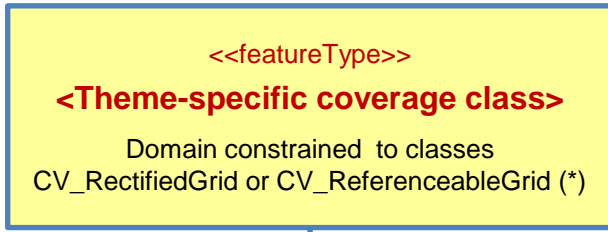
- Natural risk zones (NZ)
- Geology (GE).

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

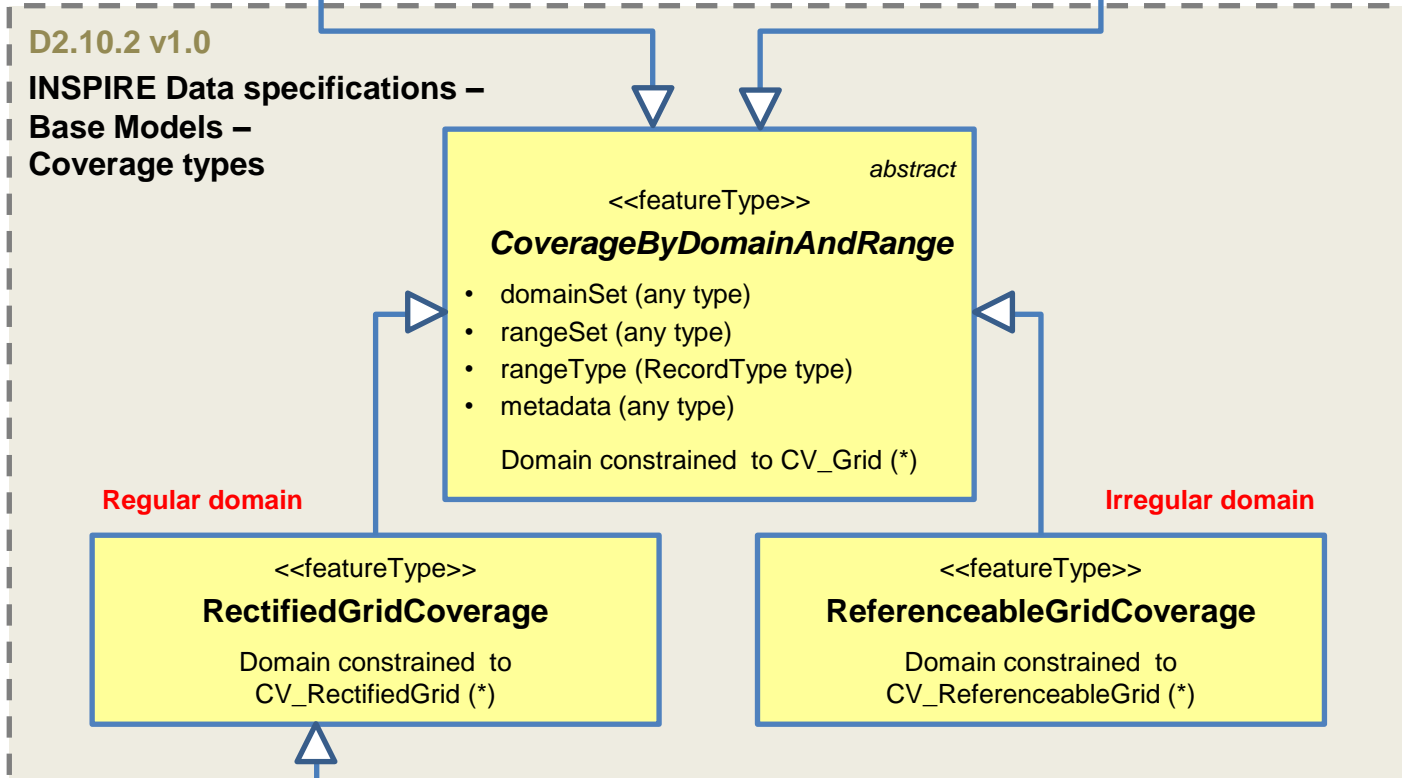
NZ



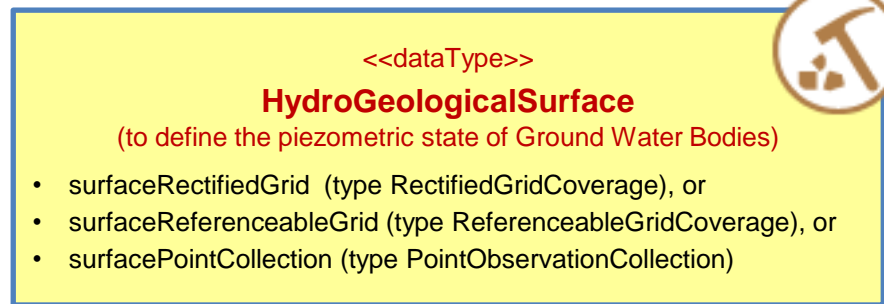
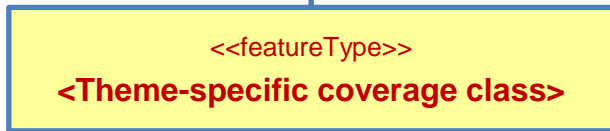
SD



ER



EL



GE

LC



OI



SO

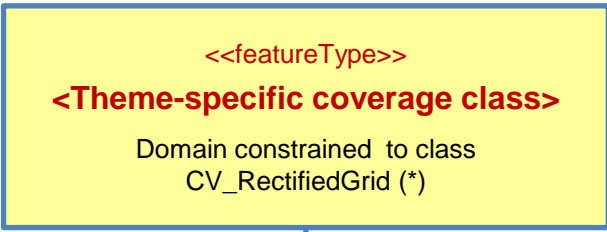
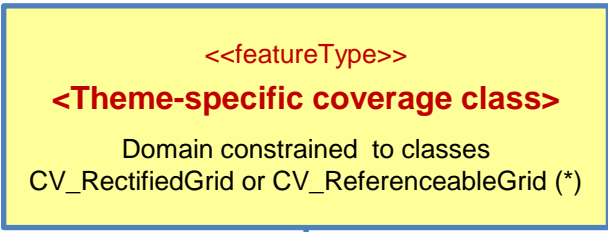


LU



(*) From ISO 19123:2007

NZ



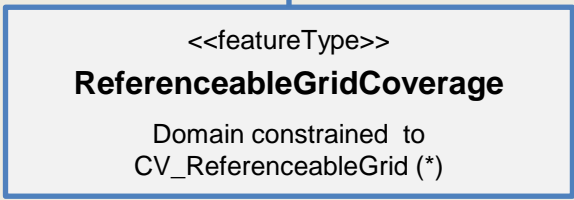
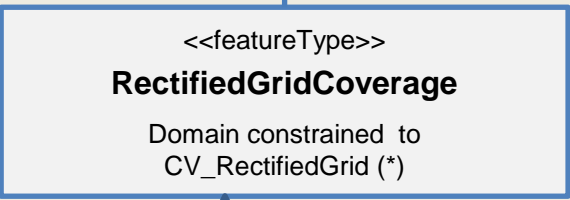
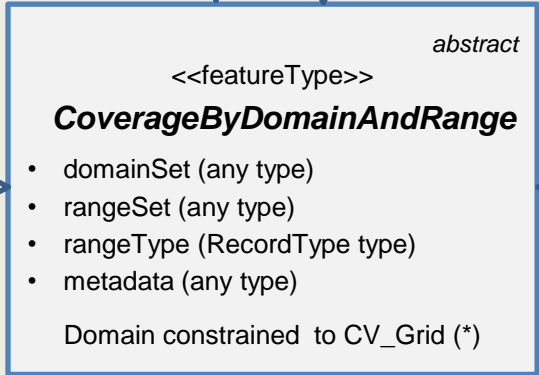
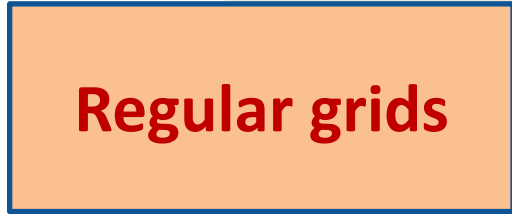
SD



ER

D2.10.2 v1.0

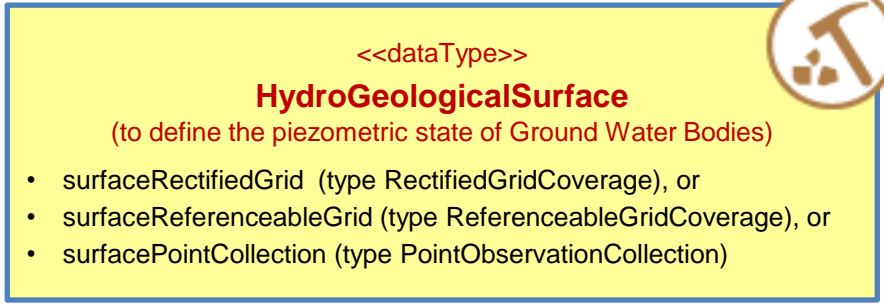
INSPIRE Data specifications –
 Base Models –
 Coverage types



Regular domain

Irregular domain

EL



GE

LC



OI



SO

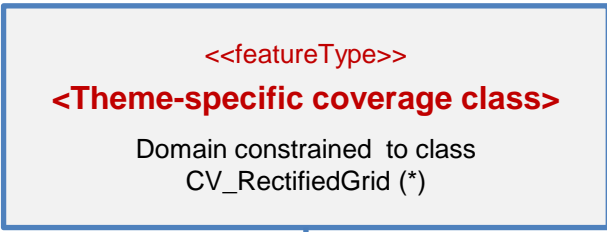
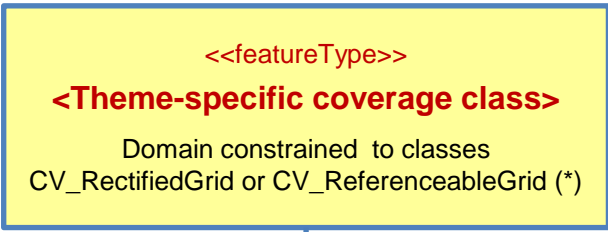


LU



(*) From ISO 19123:2007

NZ



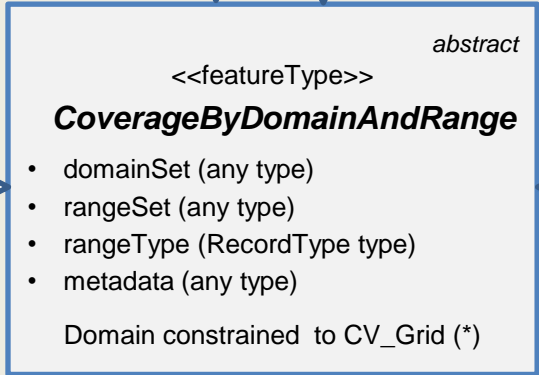
SD



ER

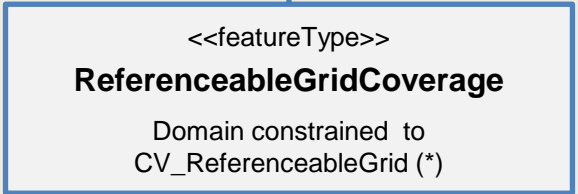
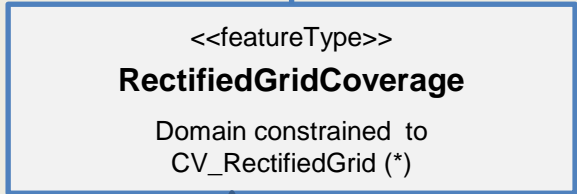
D2.10.2 v1.0

INSPIRE Data specifications –
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Coverage types

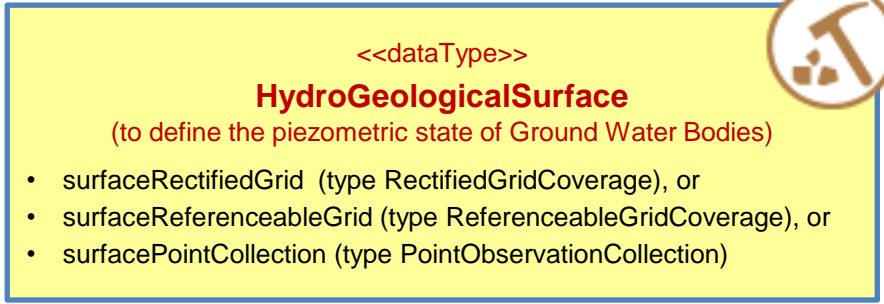
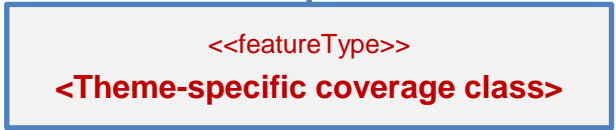


Regular domain

Irregular domain



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GE

LC



OI



SO

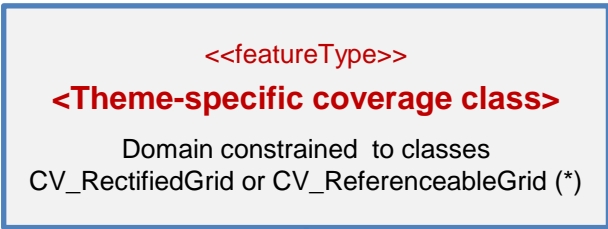


LU

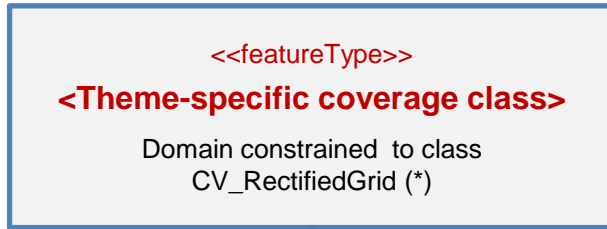


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NZ



SD

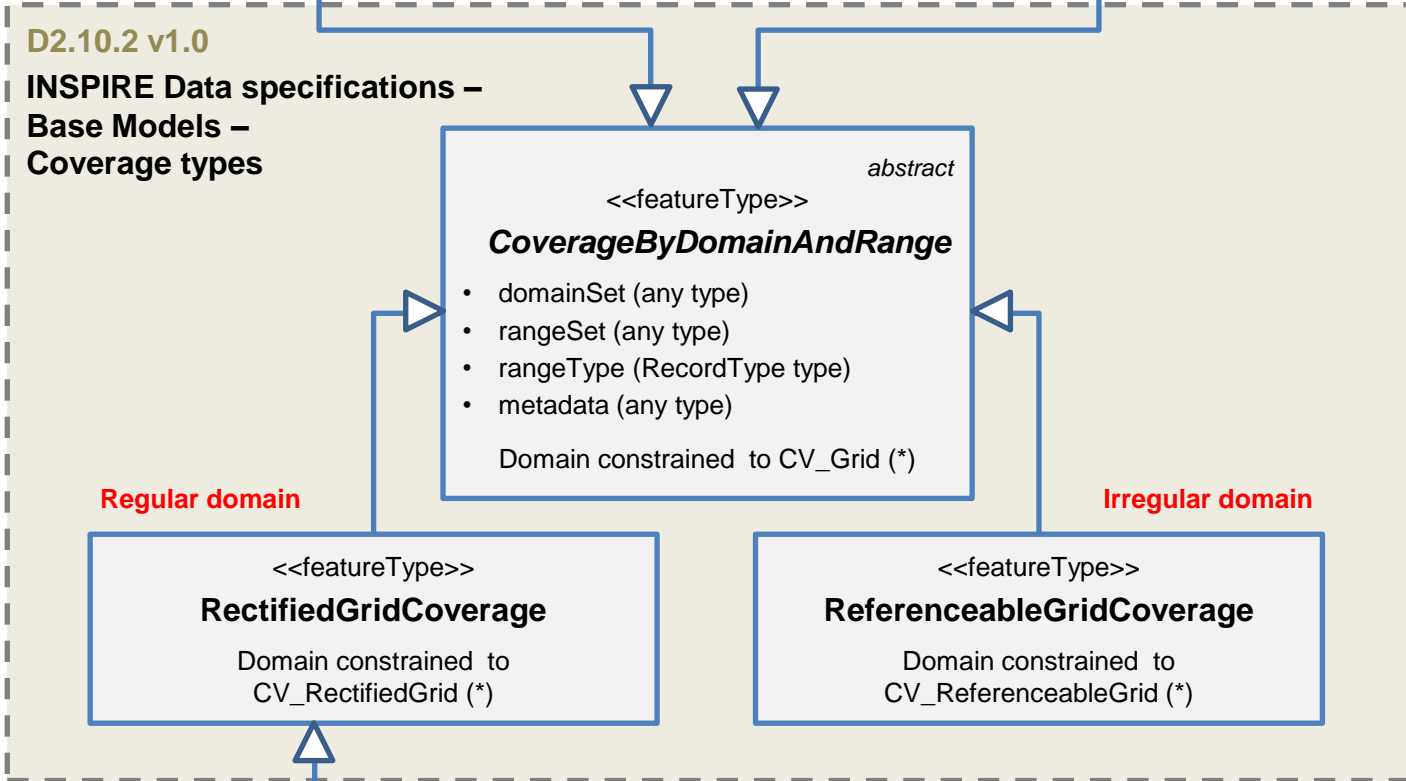


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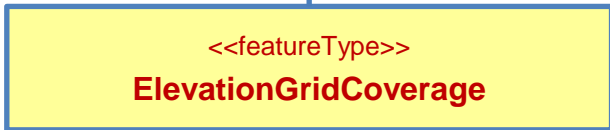


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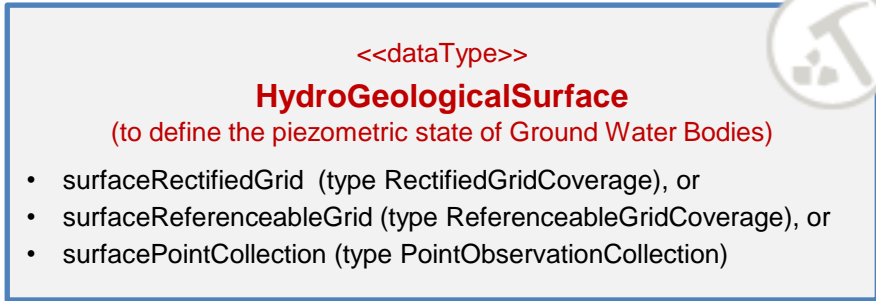
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EL



GE



LC



OI



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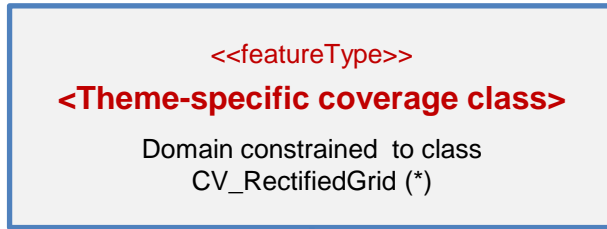
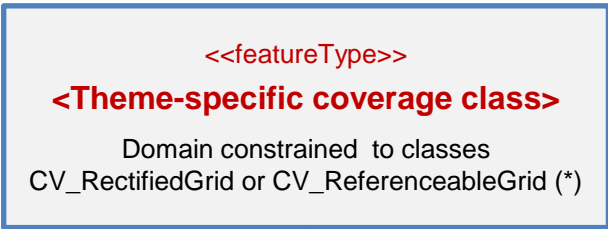


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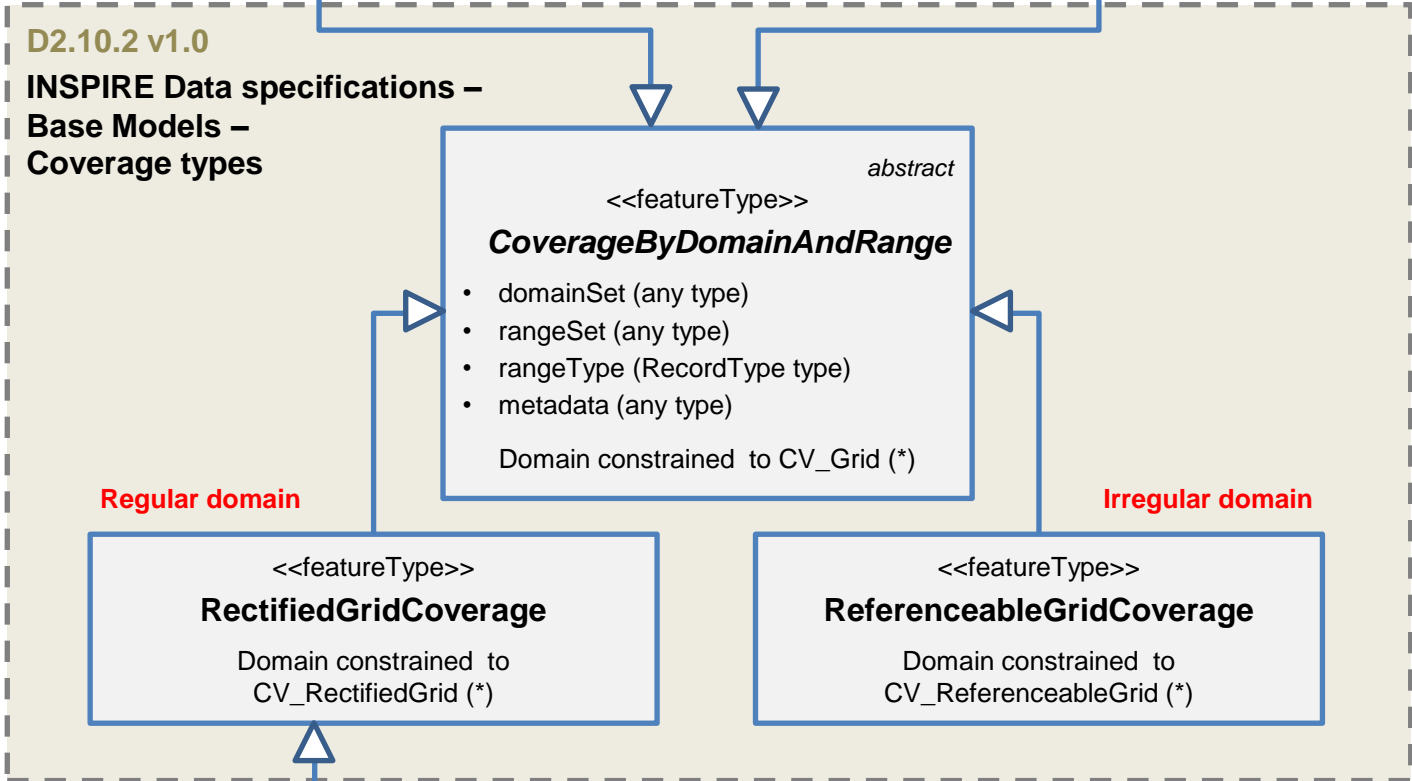
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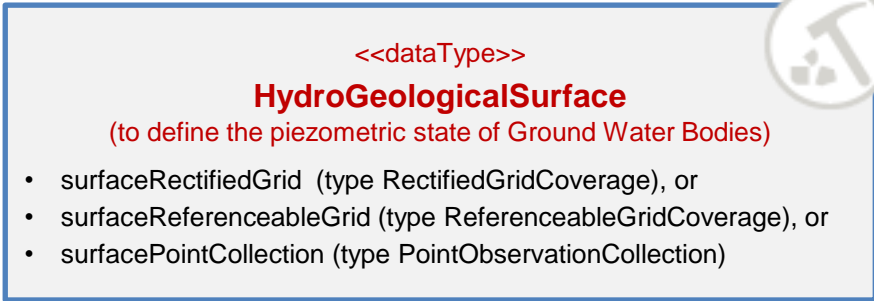
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EL



GE

LC



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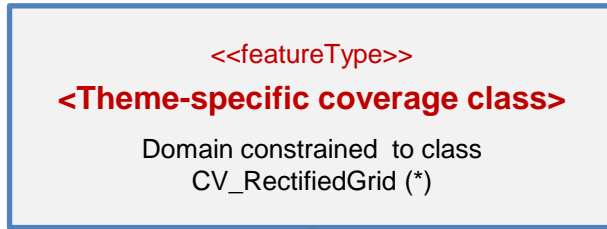
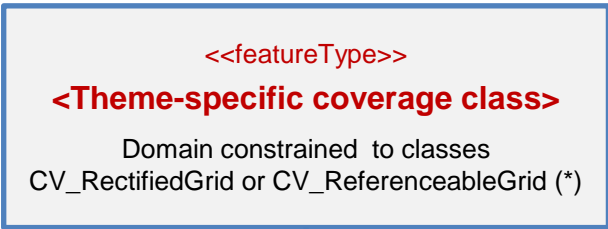


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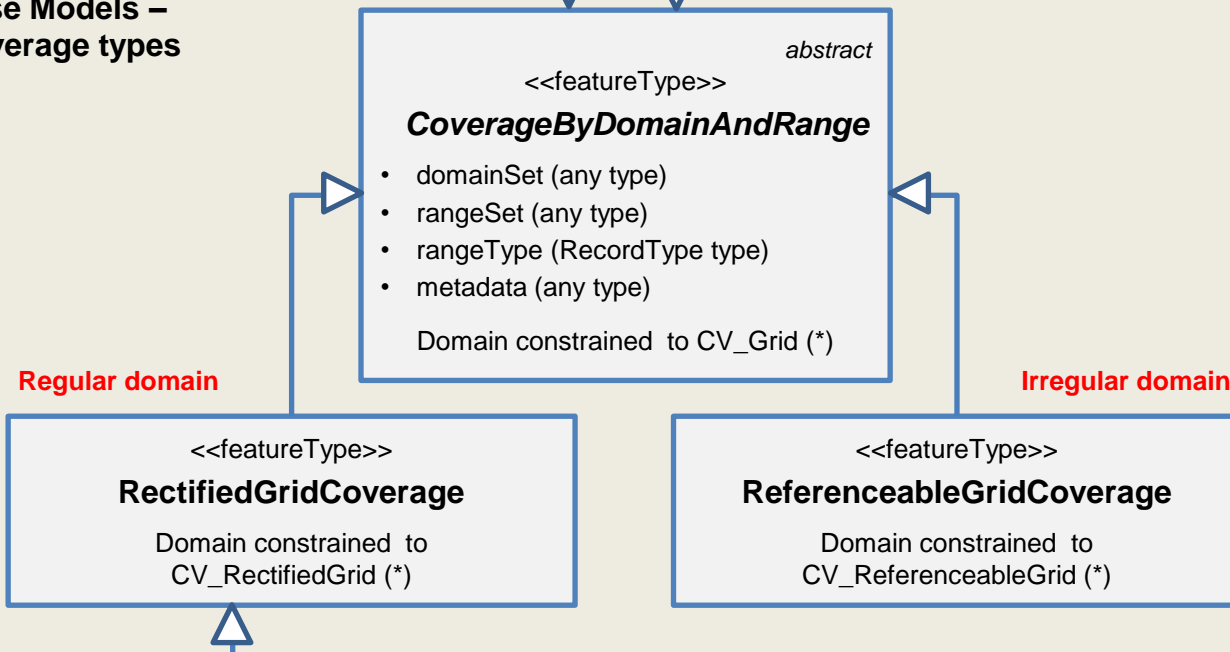
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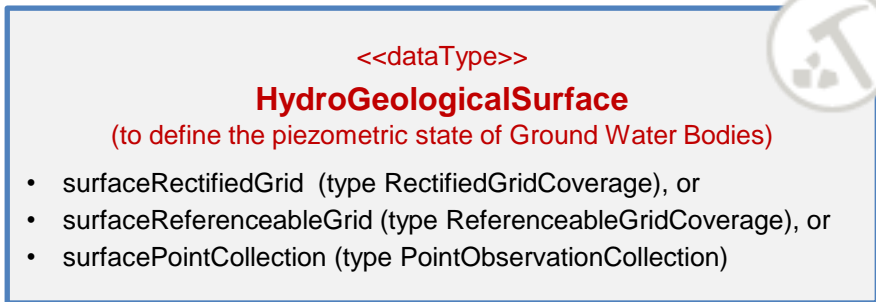
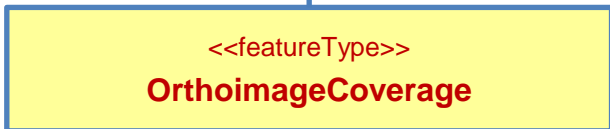
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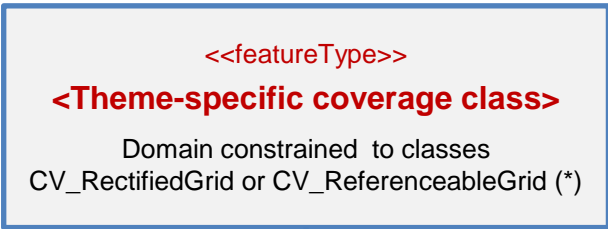


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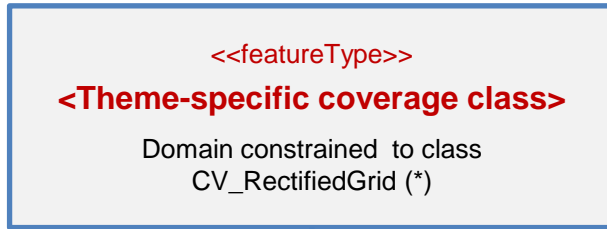


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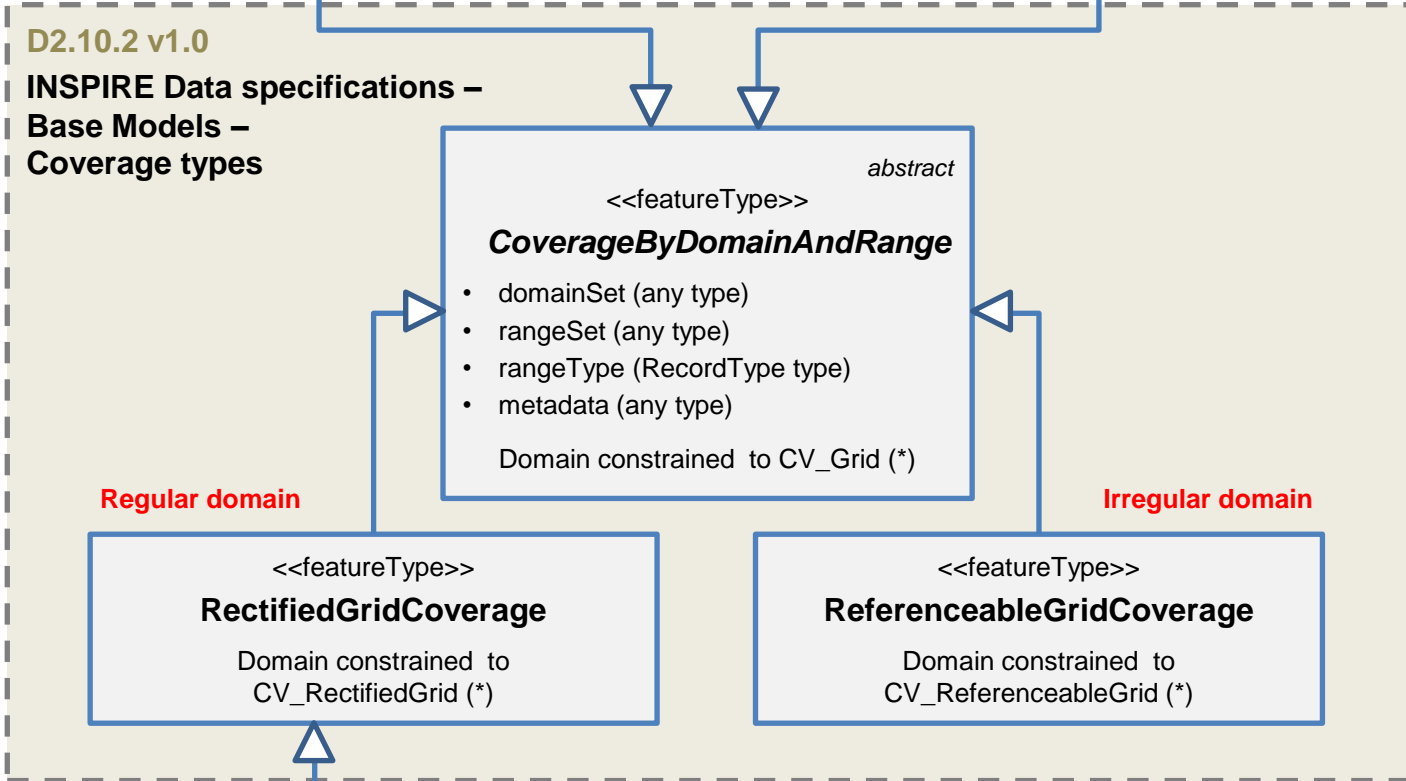


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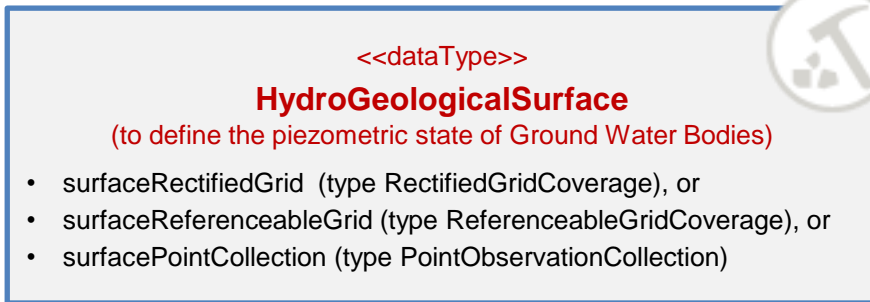
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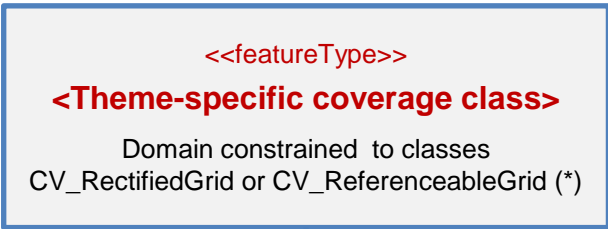


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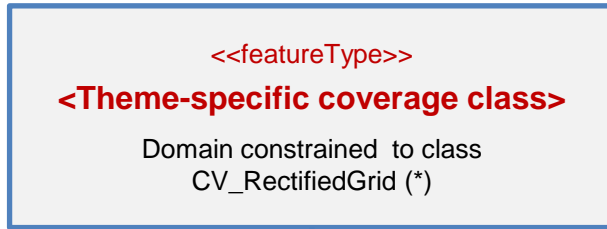


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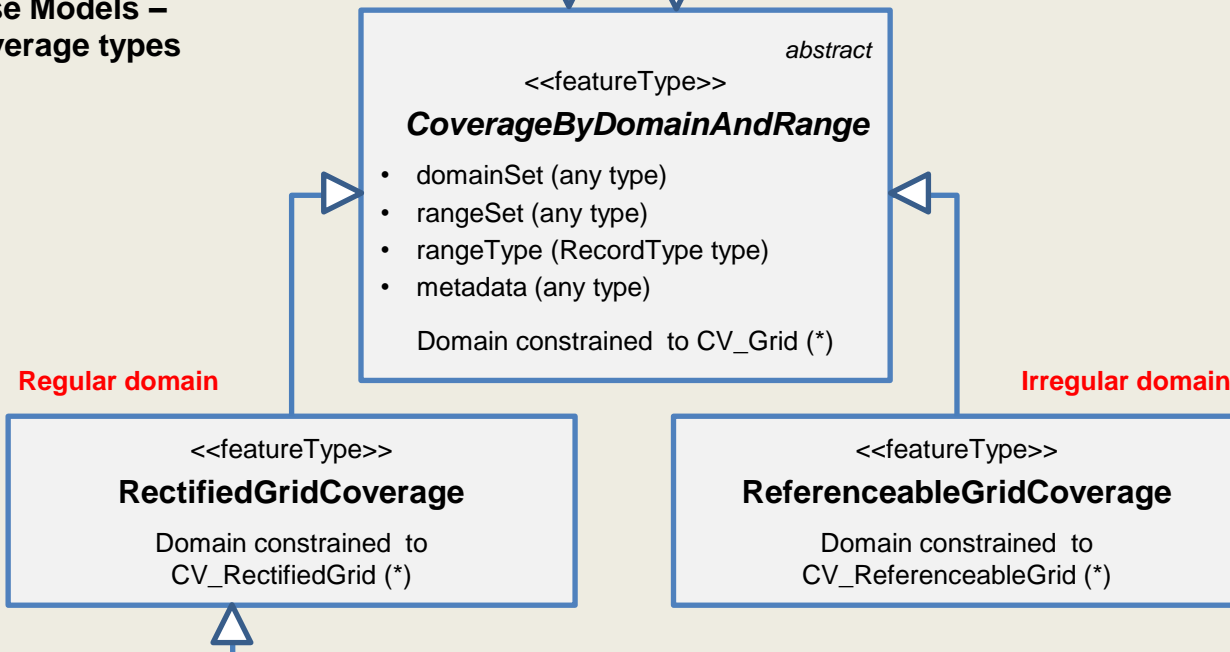


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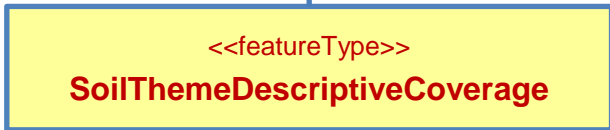


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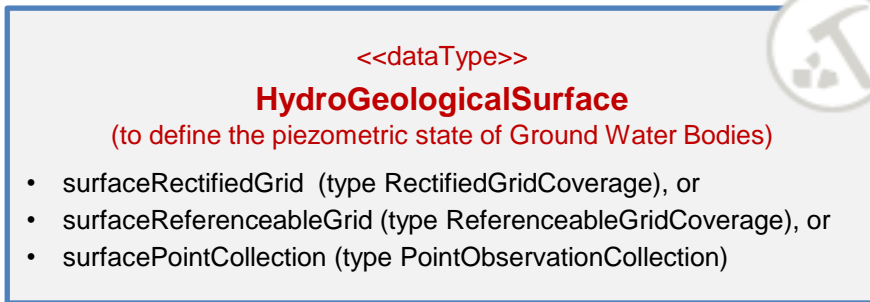
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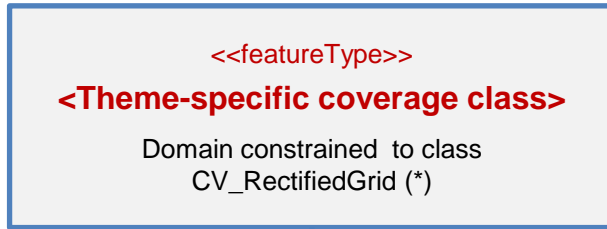
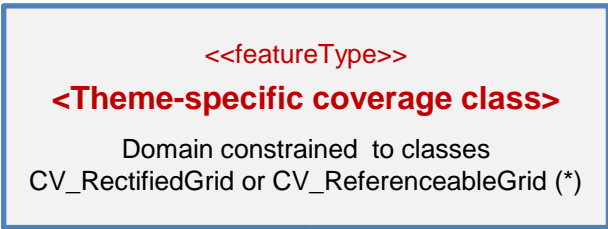


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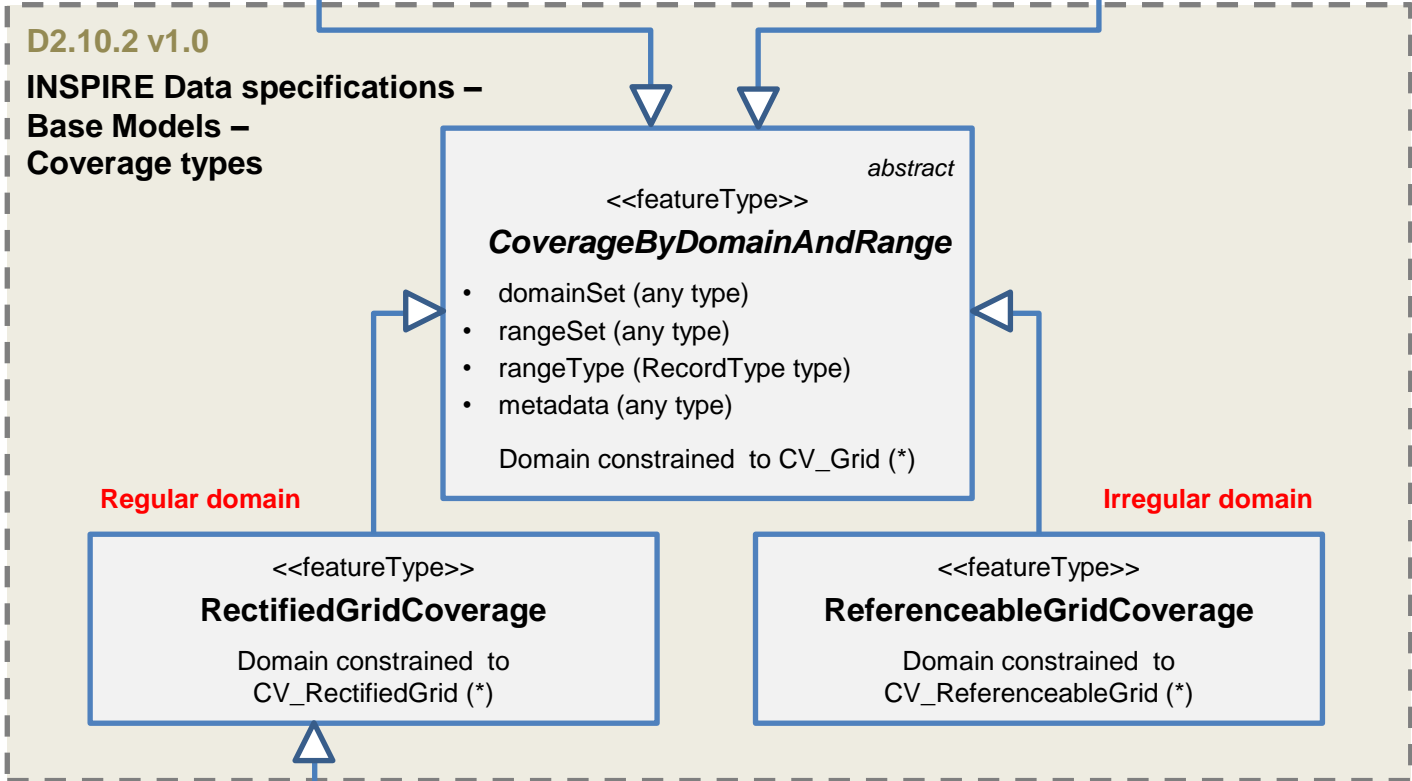
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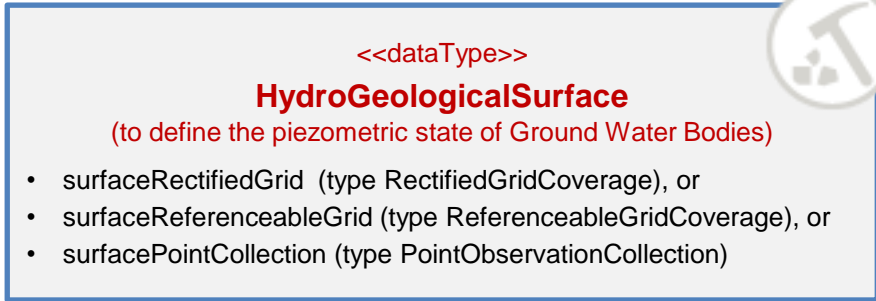
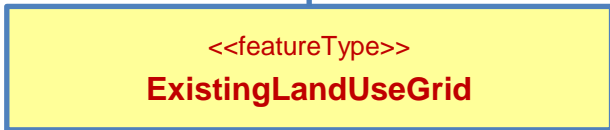
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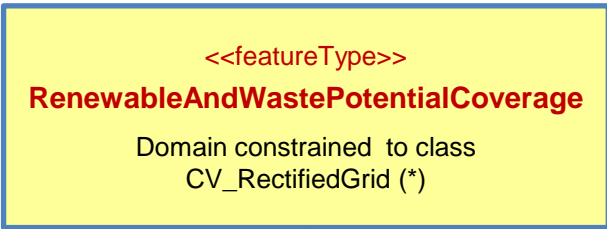
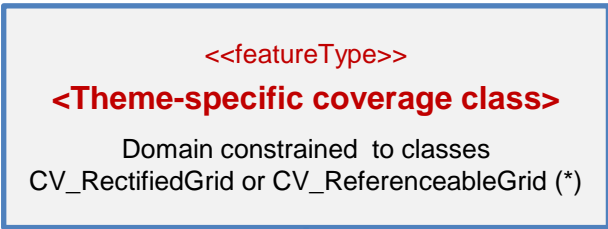


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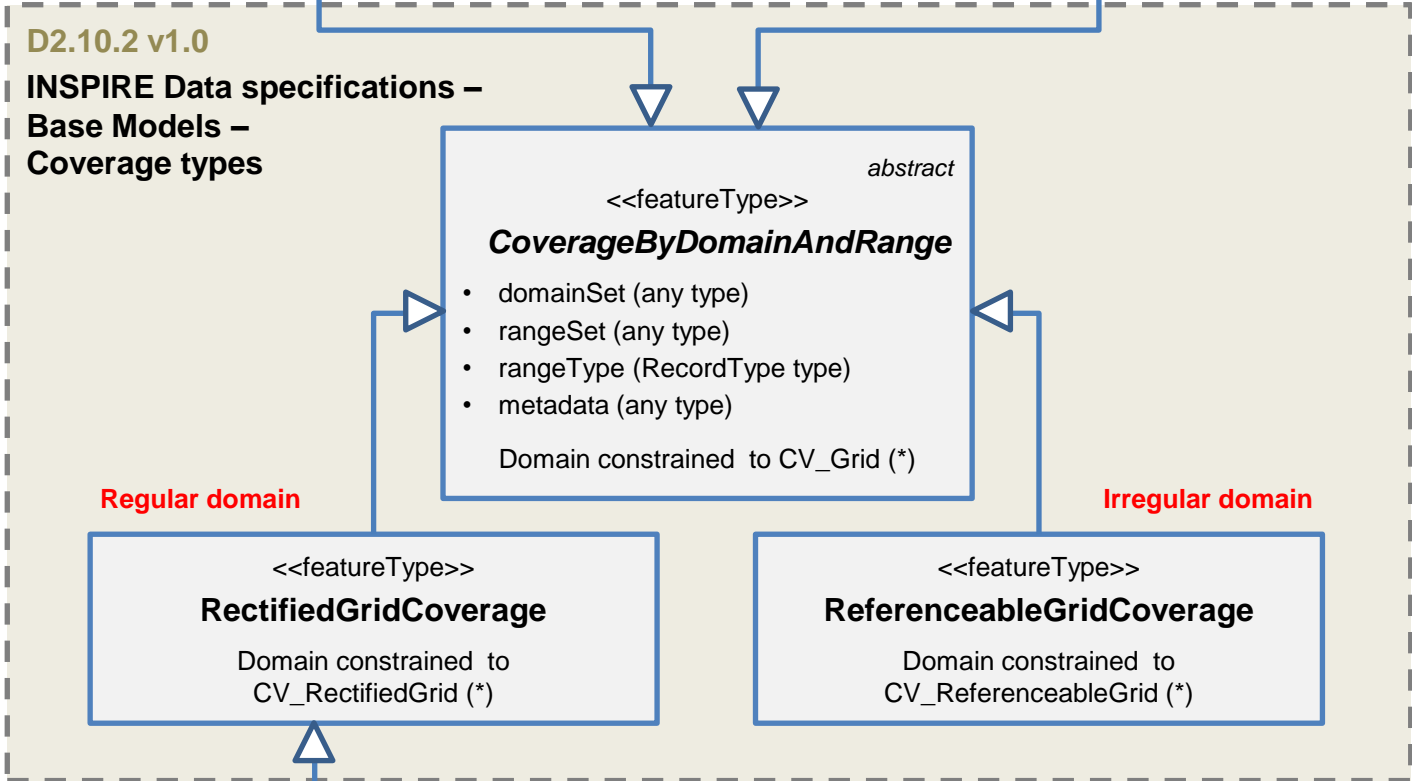
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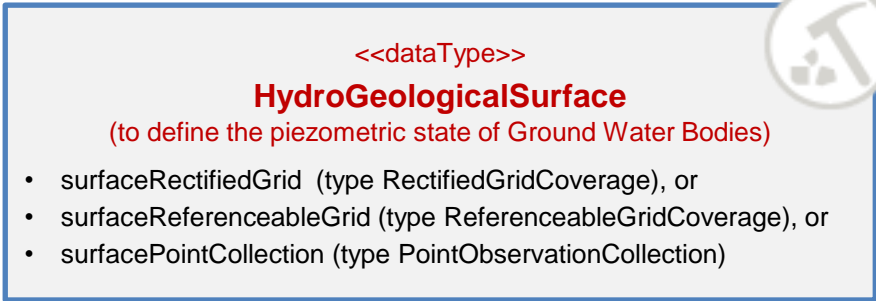
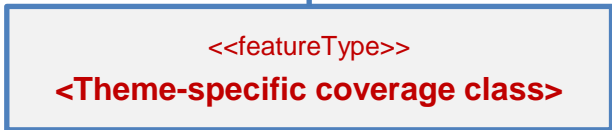
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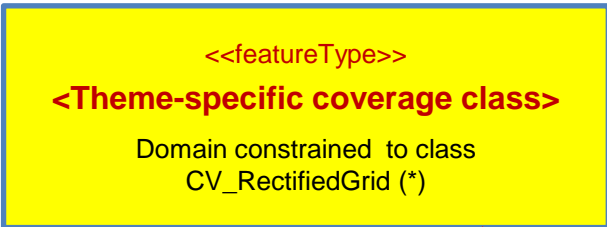
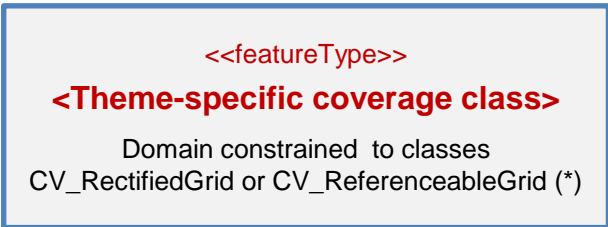


LU



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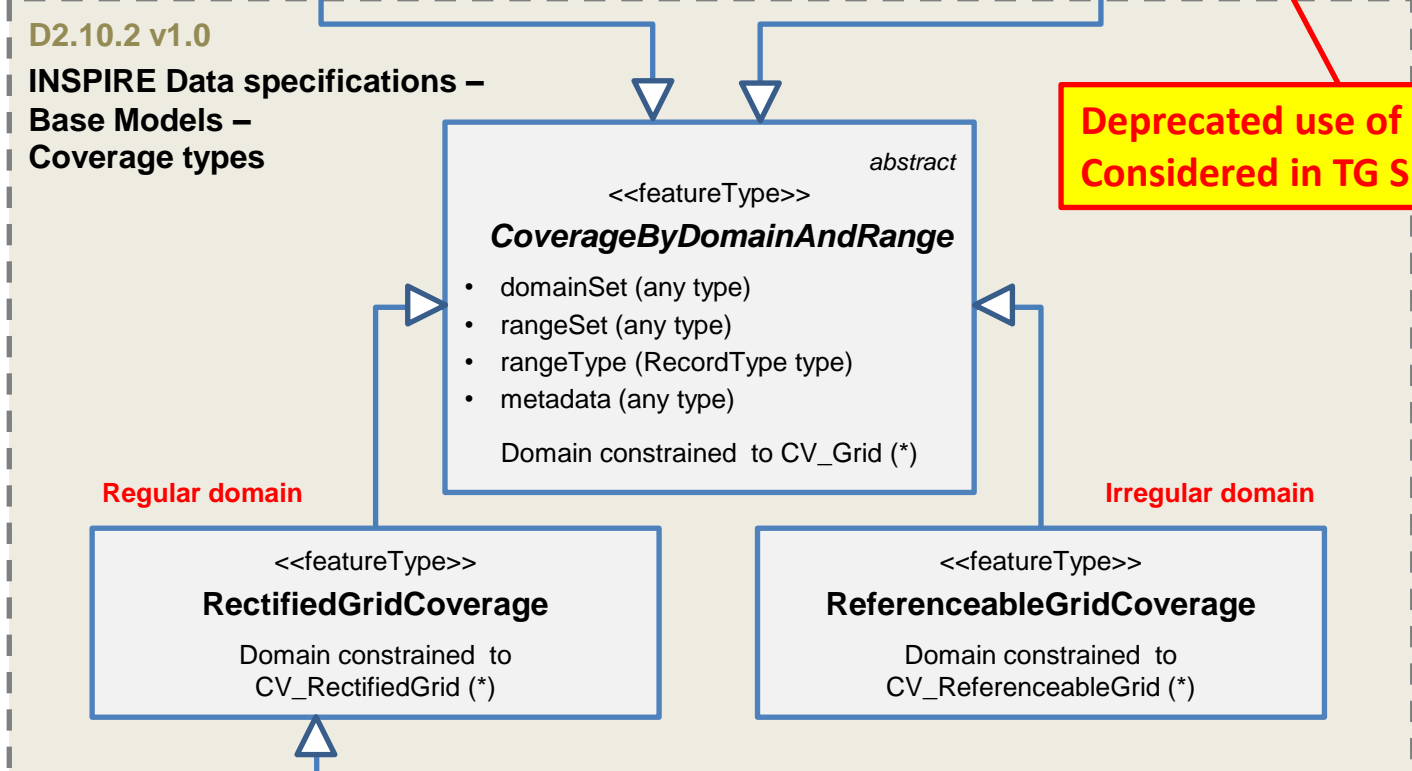
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SD



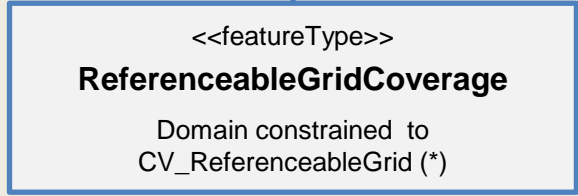
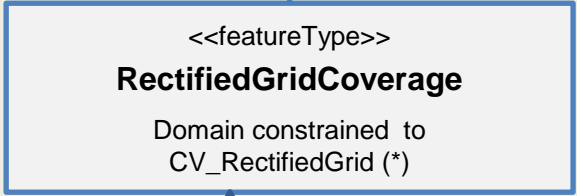
ER



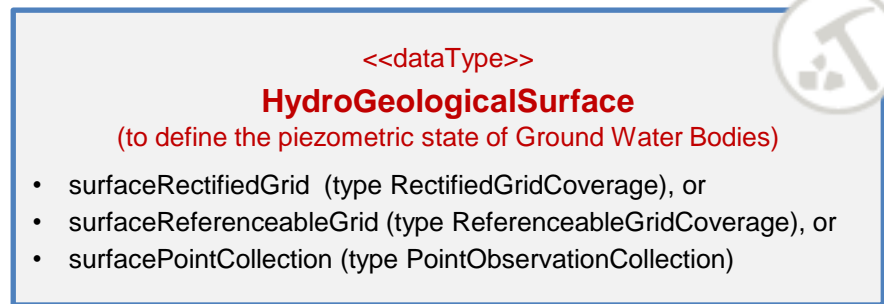
Deprecated use of coverages
Considered in TG SD rc2

Regular domain

Irregular domain



EL



GE

LC



OI



SO

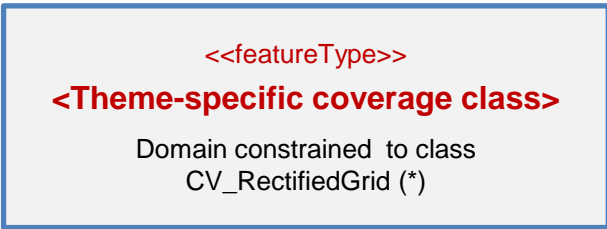
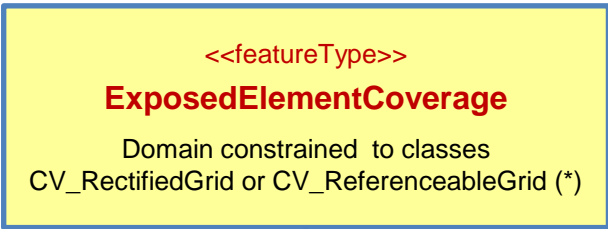


LU



(*) From ISO 19123:2007

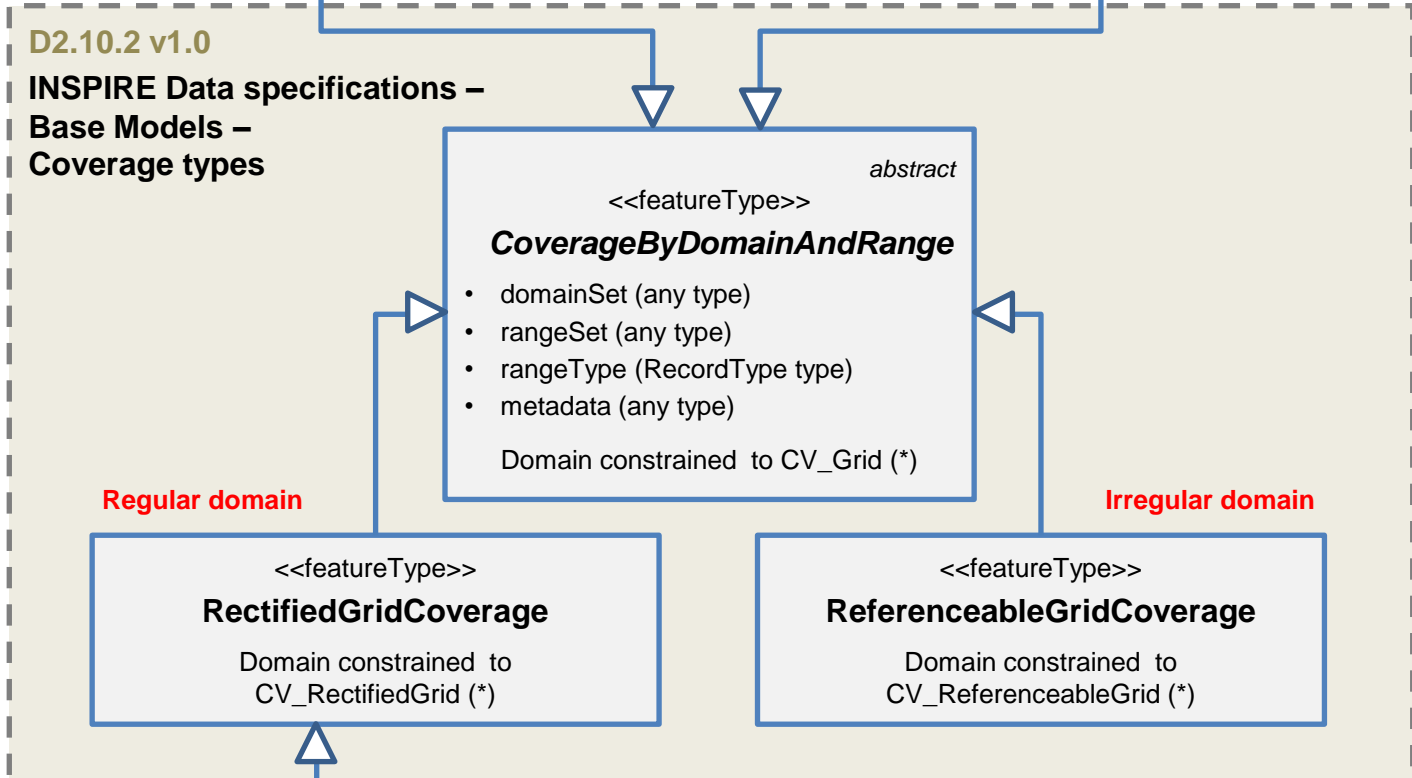
NZ



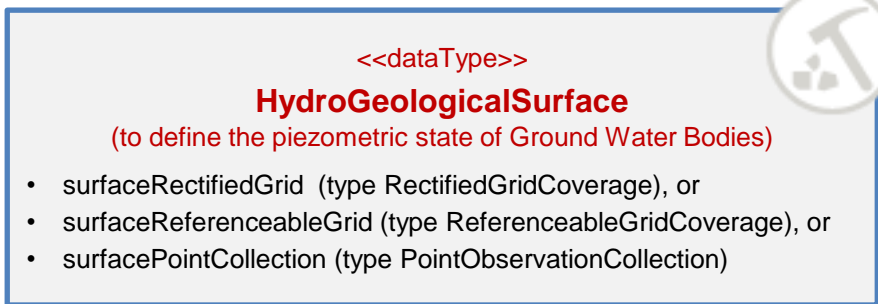
SD



ER



EL



GE

LC



OI



SO

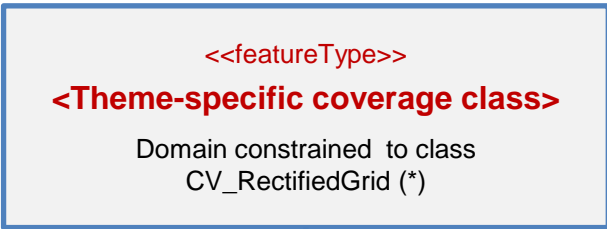
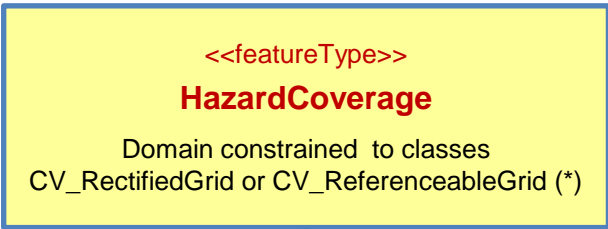


LU



(*) From ISO 19123:2007

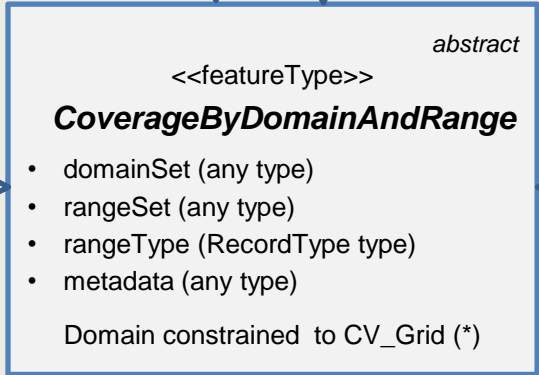
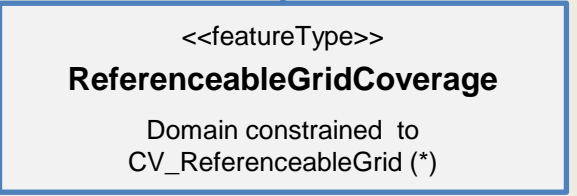
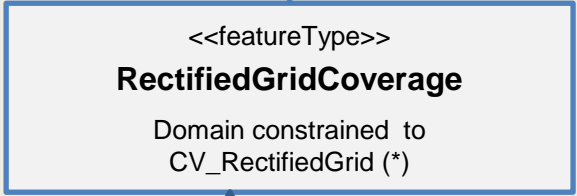
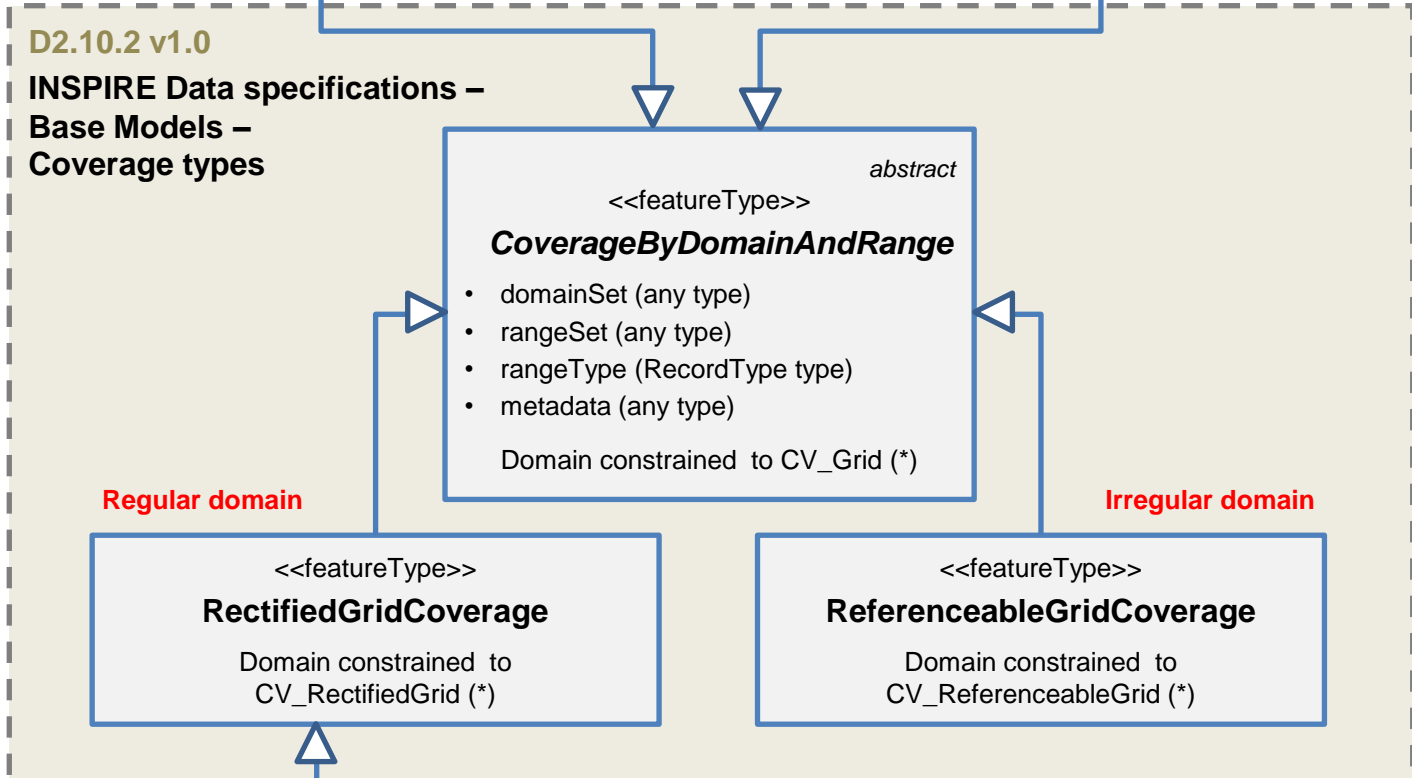
NZ



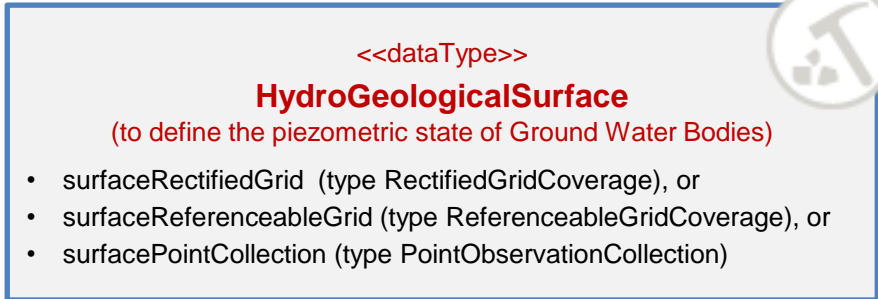
SD



ER



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LC



OI



SO

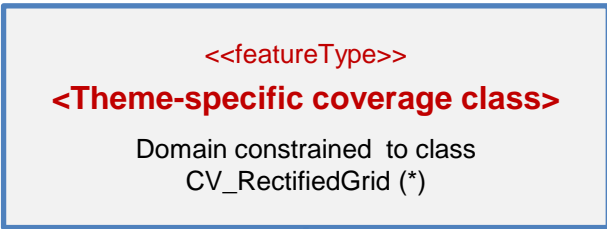
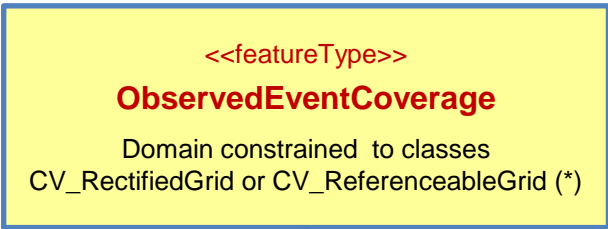


LU



(*) From ISO 19123:2007

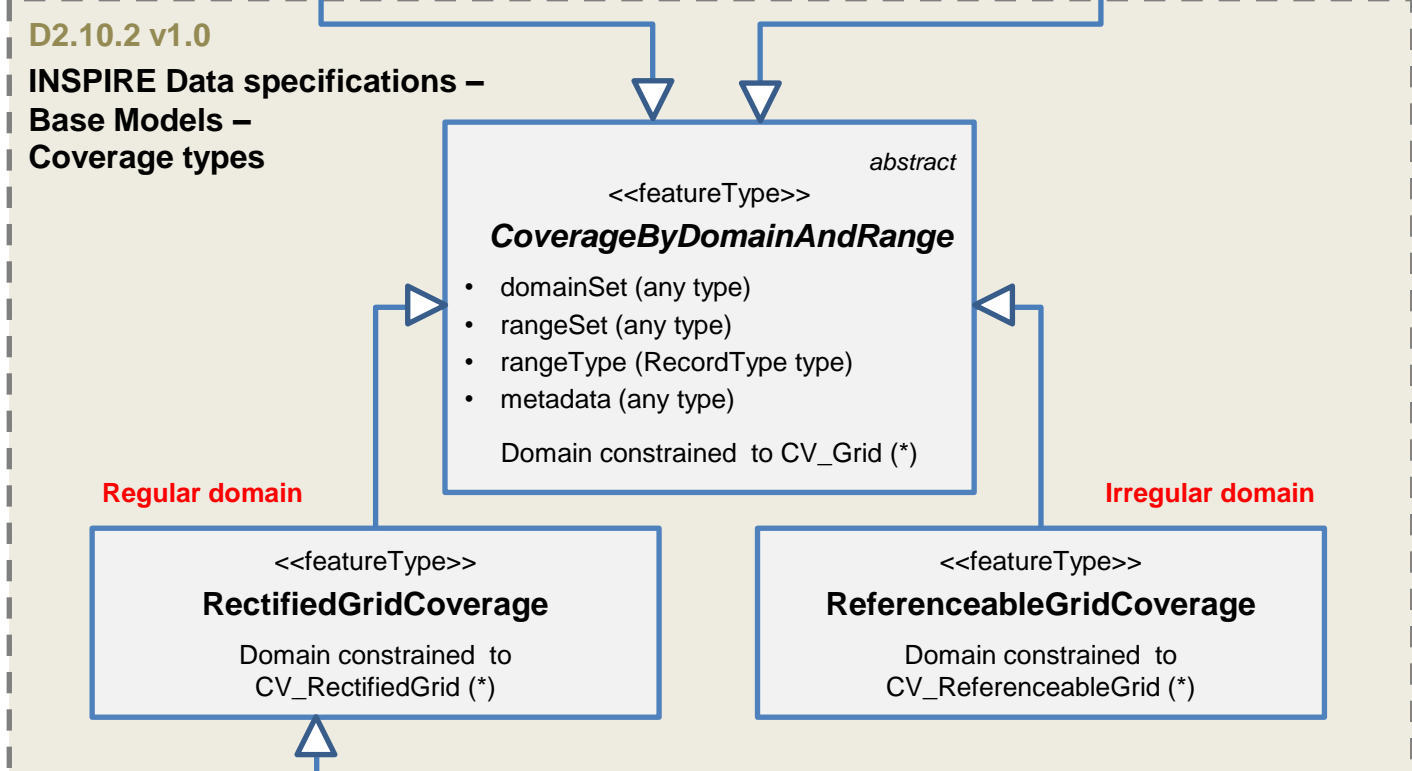
NZ



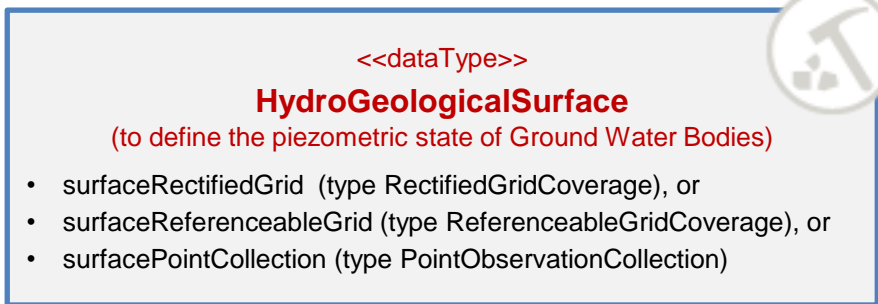
SD



ER



EL



GE

LC



OI



SO

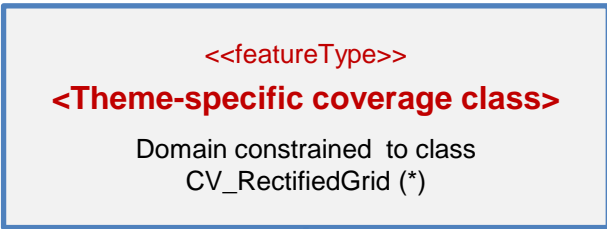
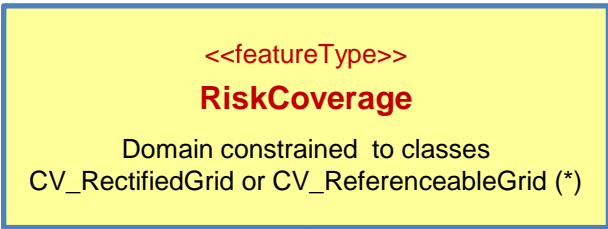


LU



(*) From ISO 19123:2007

NZ



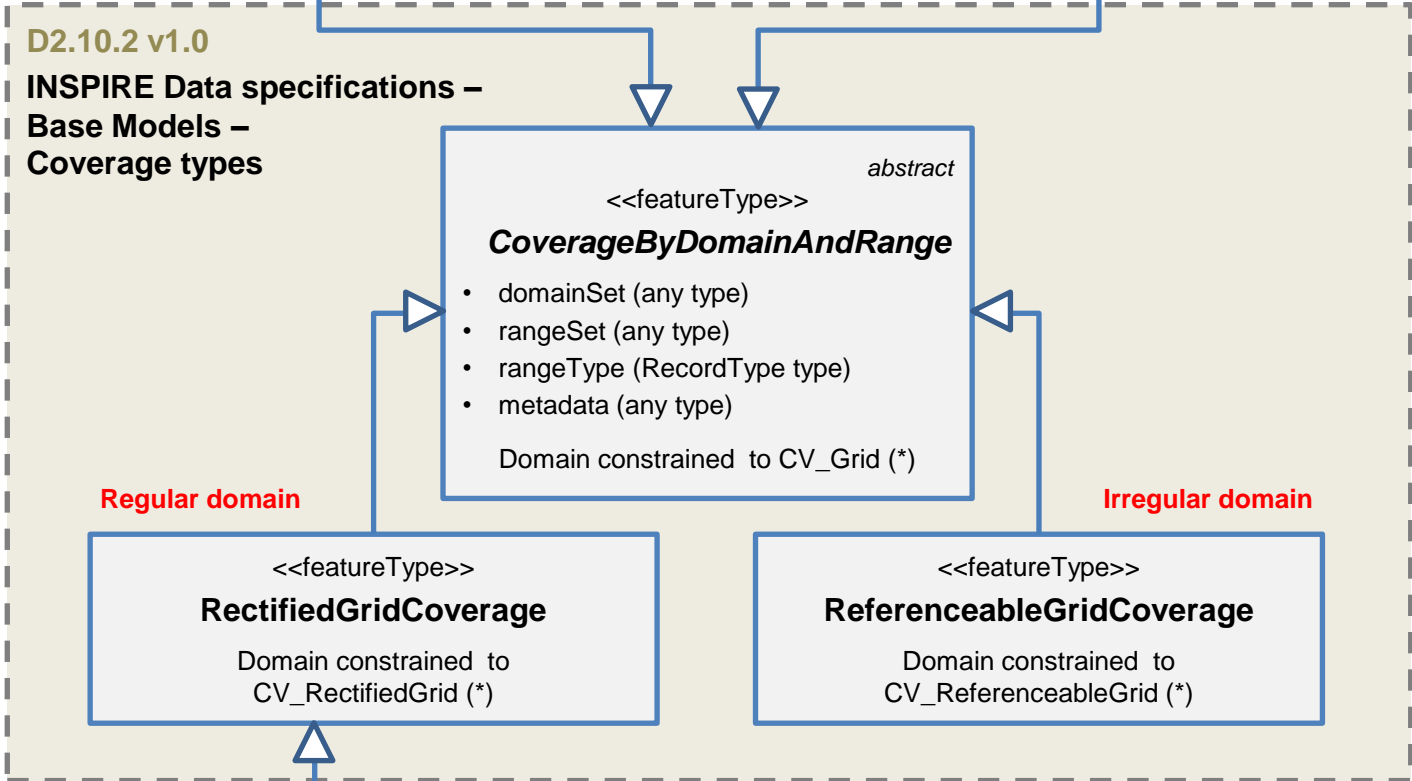
SD



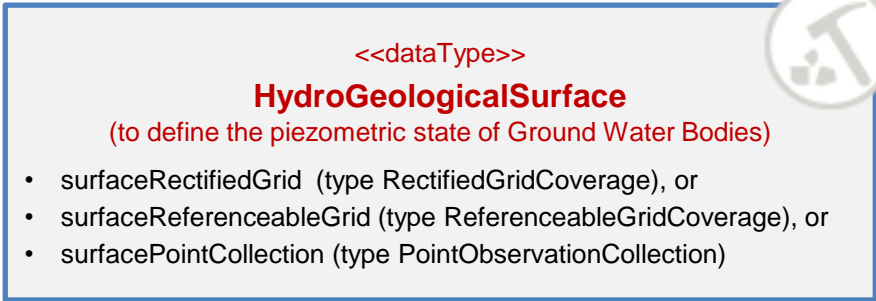
ER

D2.10.2 v1.0

**INSPIRE Data specifications –
 Base Models –
 Coverage types**



EL



GE

LC



OI



SO

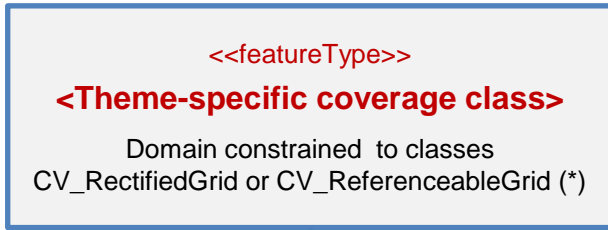


LU

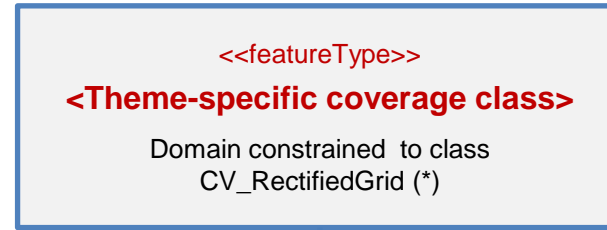


(*) From ISO 19123:2007

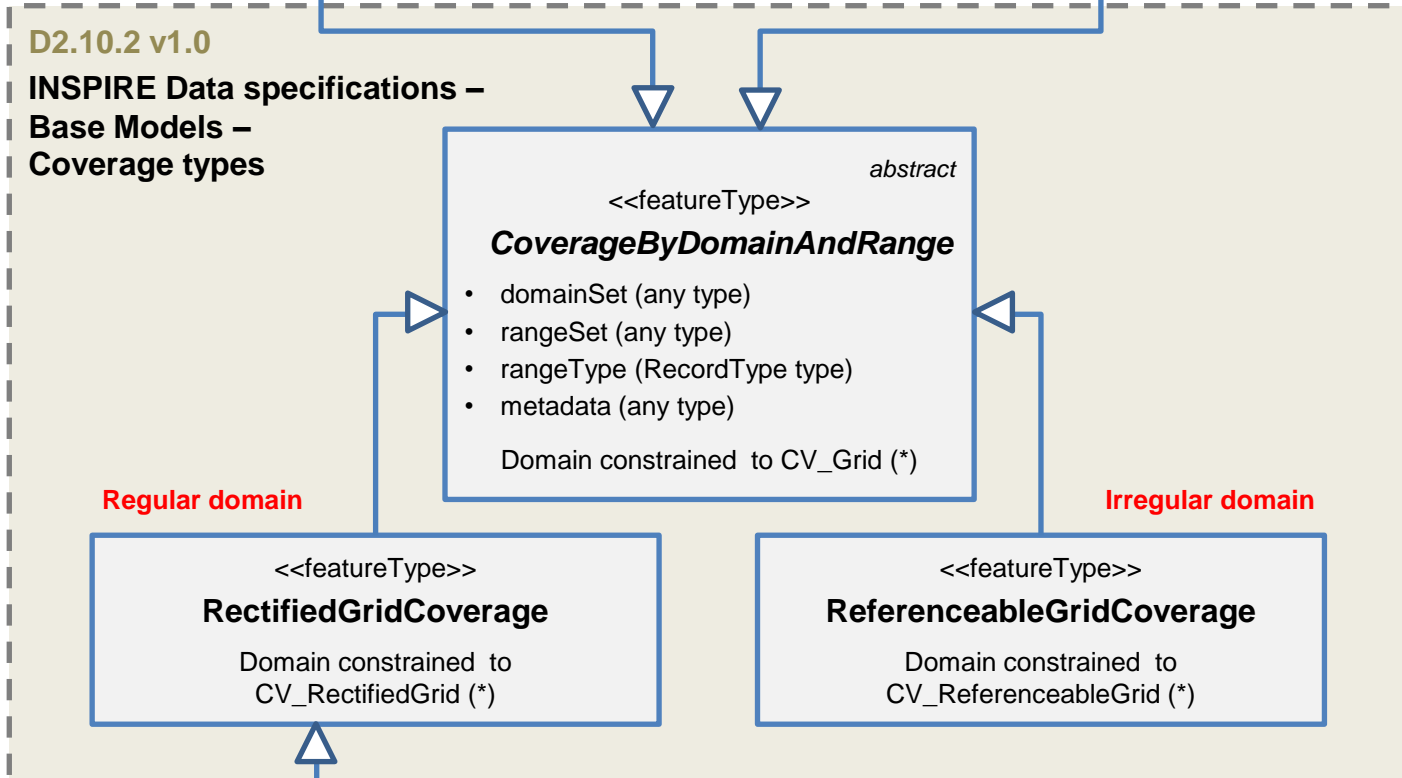
NZ



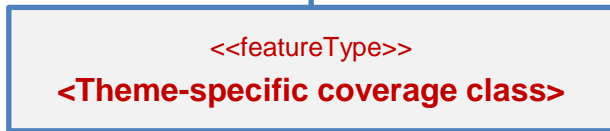
SD



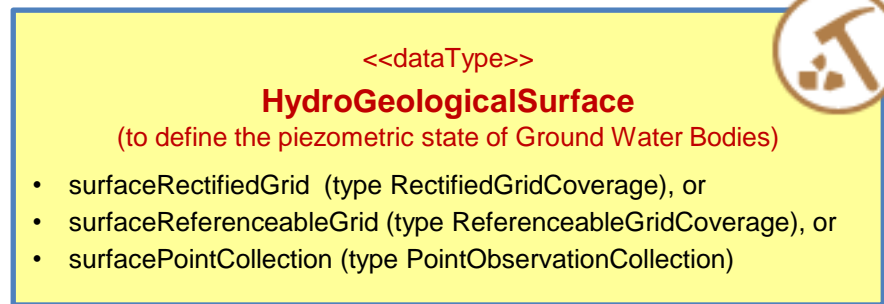
ER



EL



GE



LC



OI



SO



LU



(*) From ISO 19123:2007

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**

SOS view: Coverages as Observation Results



- **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**

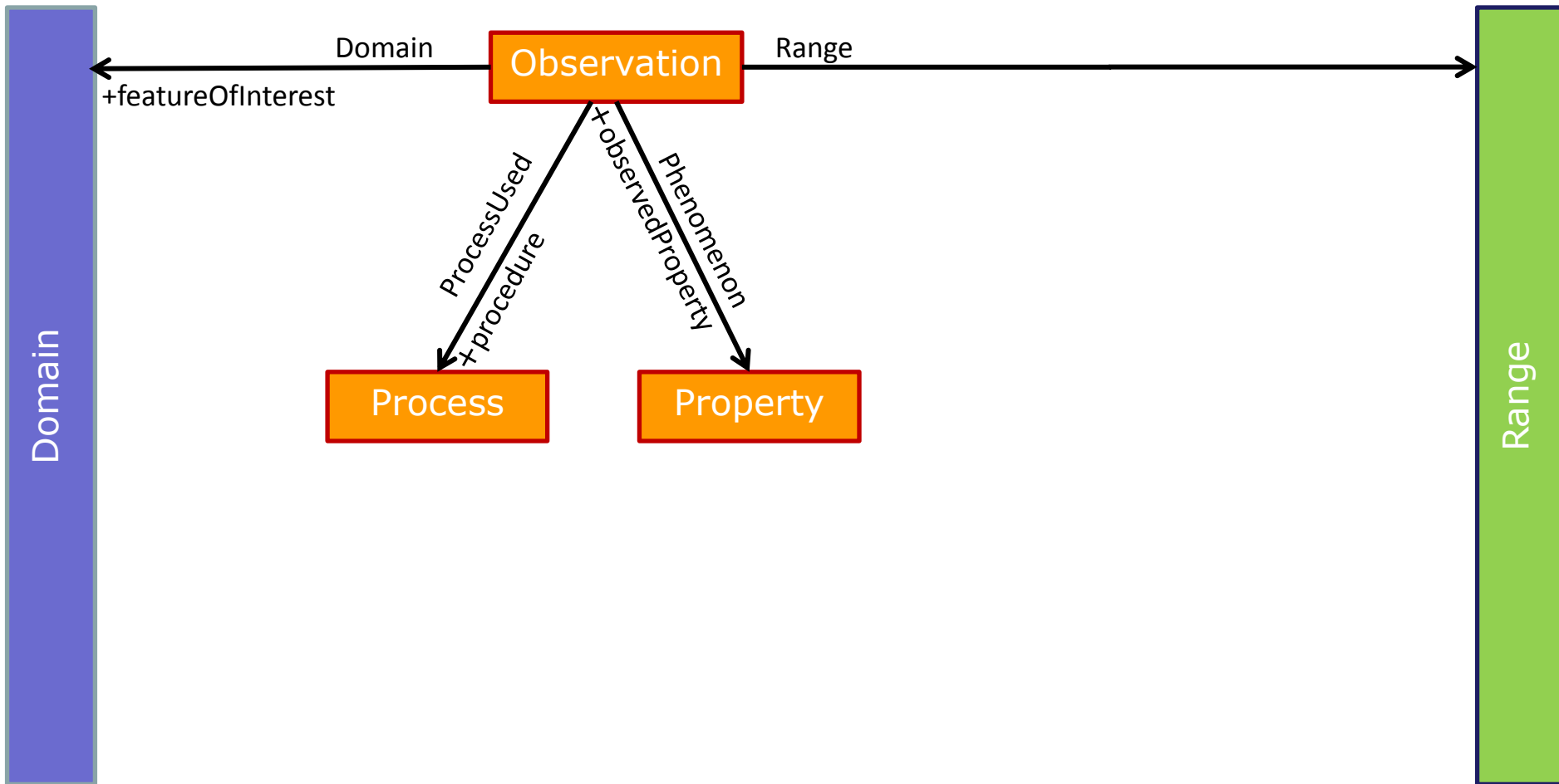
Based on ISO 19156:2011 Observations and Measurements standard (O&M in OGC)

Use of Gridded Data specialized observation types.



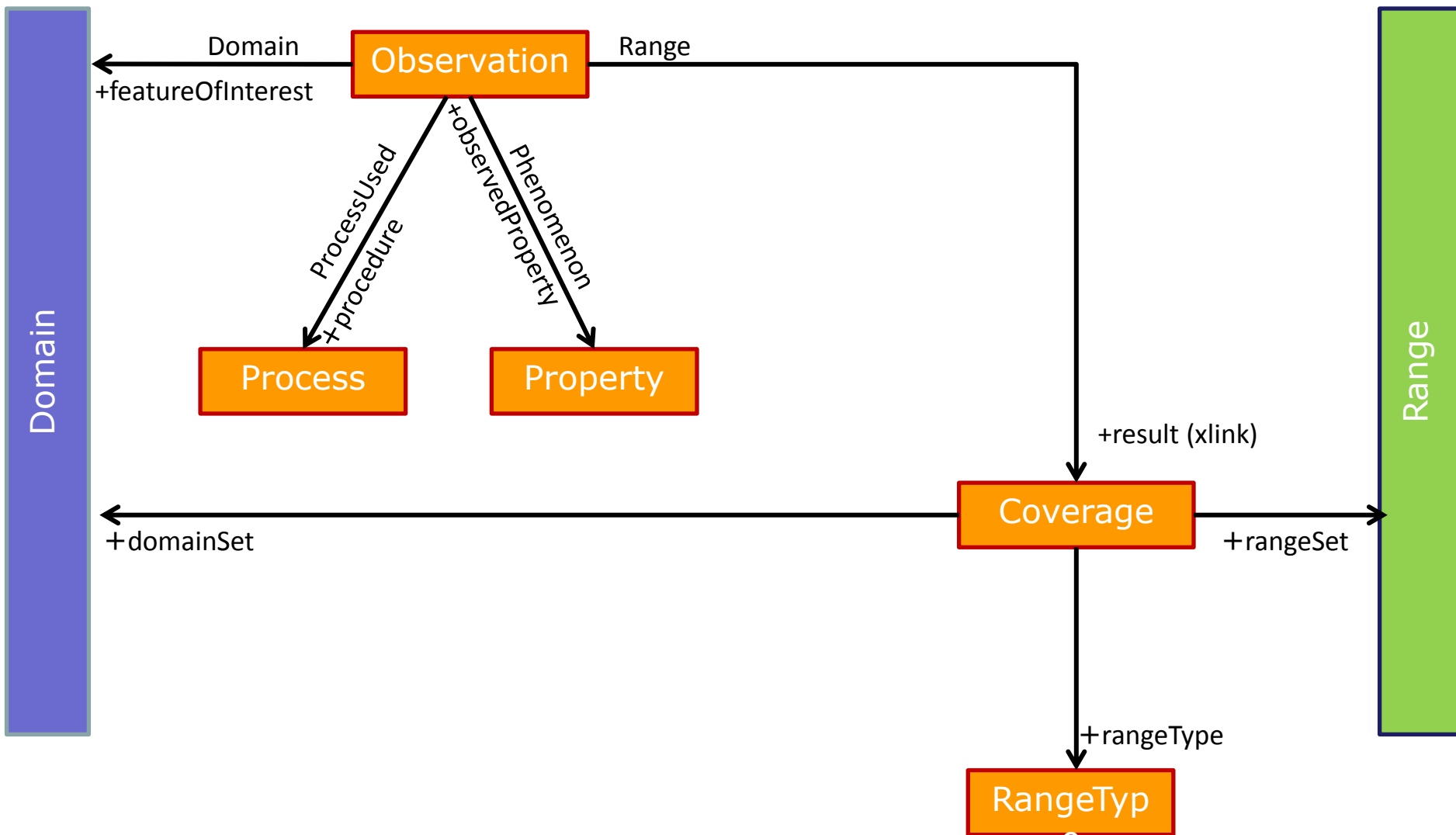
SOS view: Coverages as Observation Results

Coverage based models in the observational context



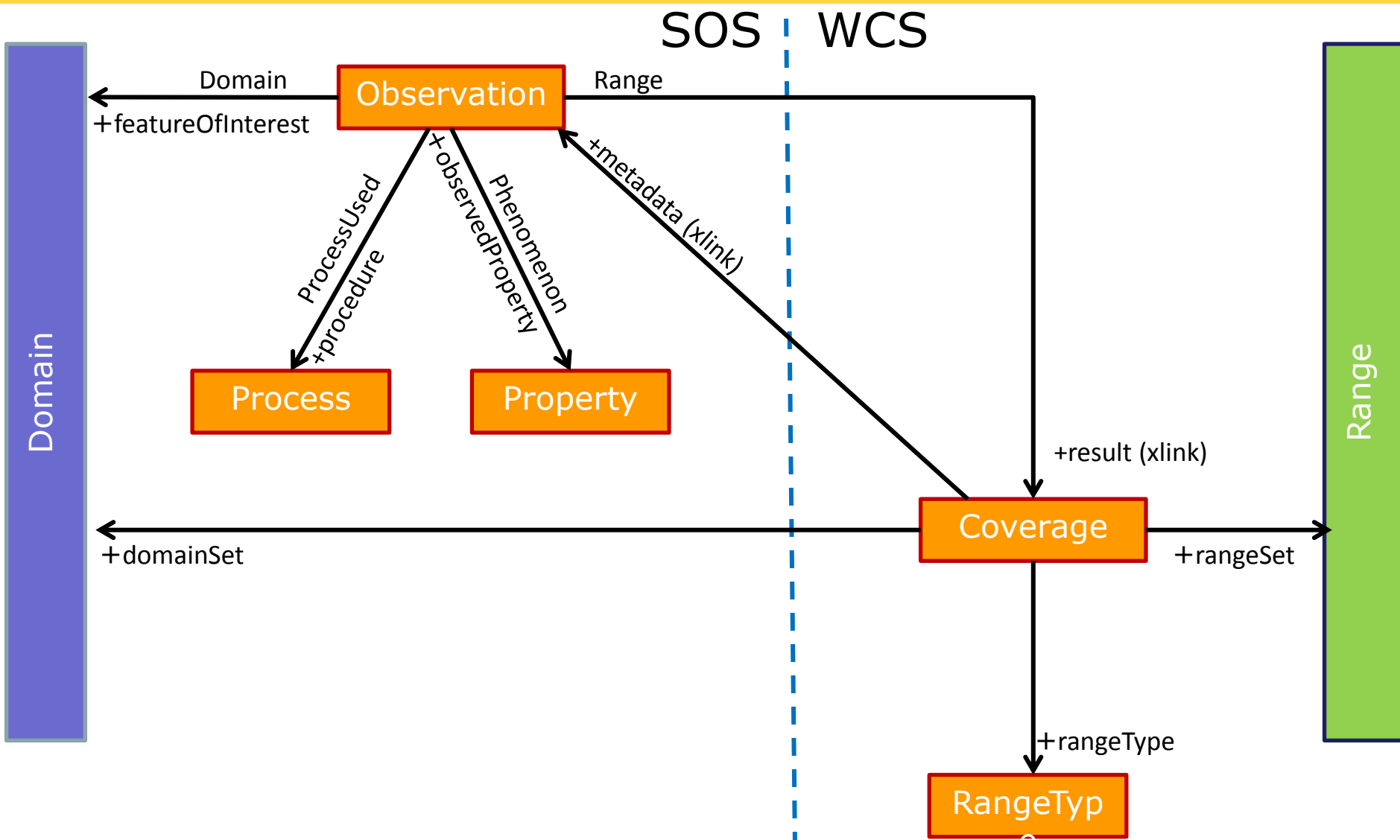
SOS view: Coverages as Observation Results

Coverage based models in the observational context



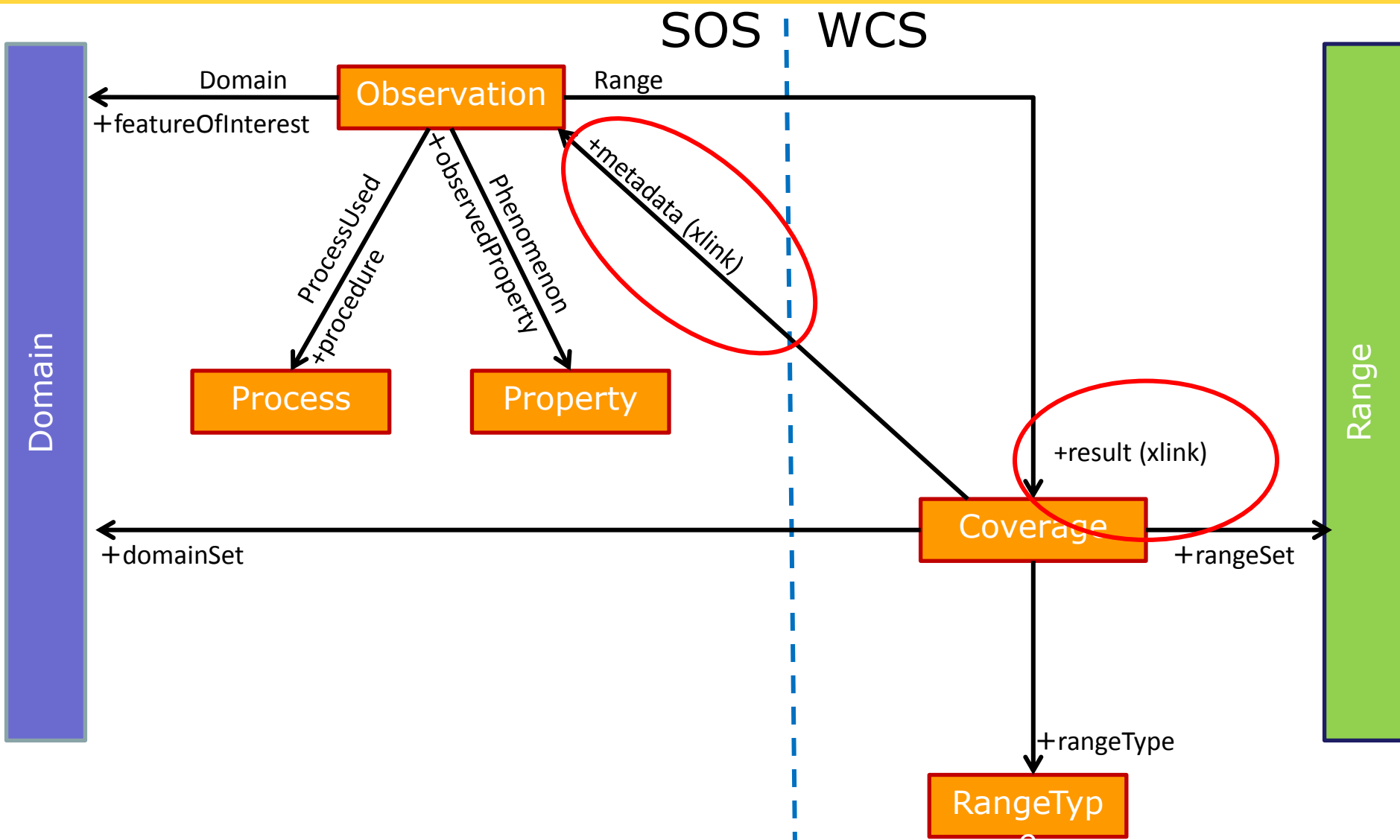
SOS view: Coverages as Observation Results

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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- **A revised model for INSPIRE coverages**
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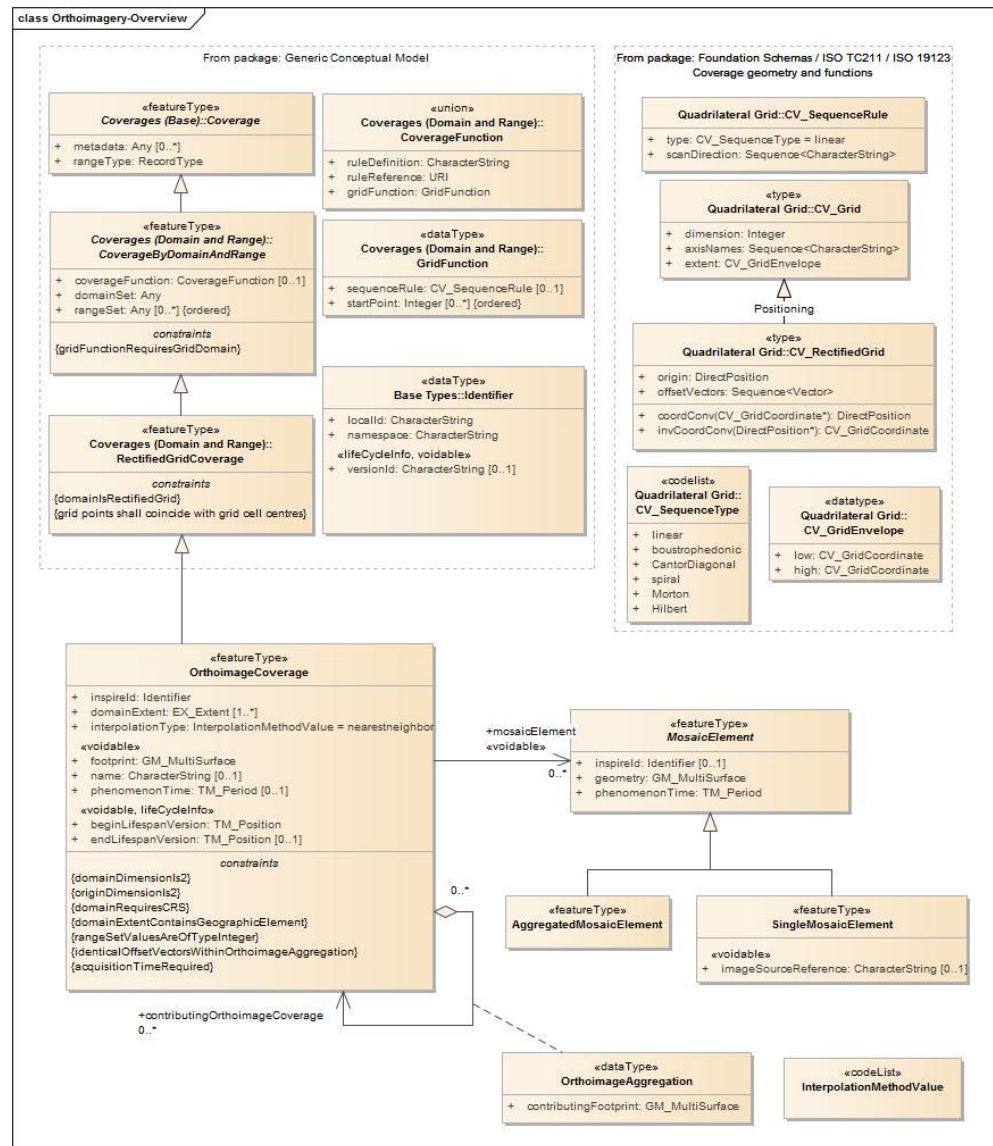
Issues in Provision by WCS

- **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

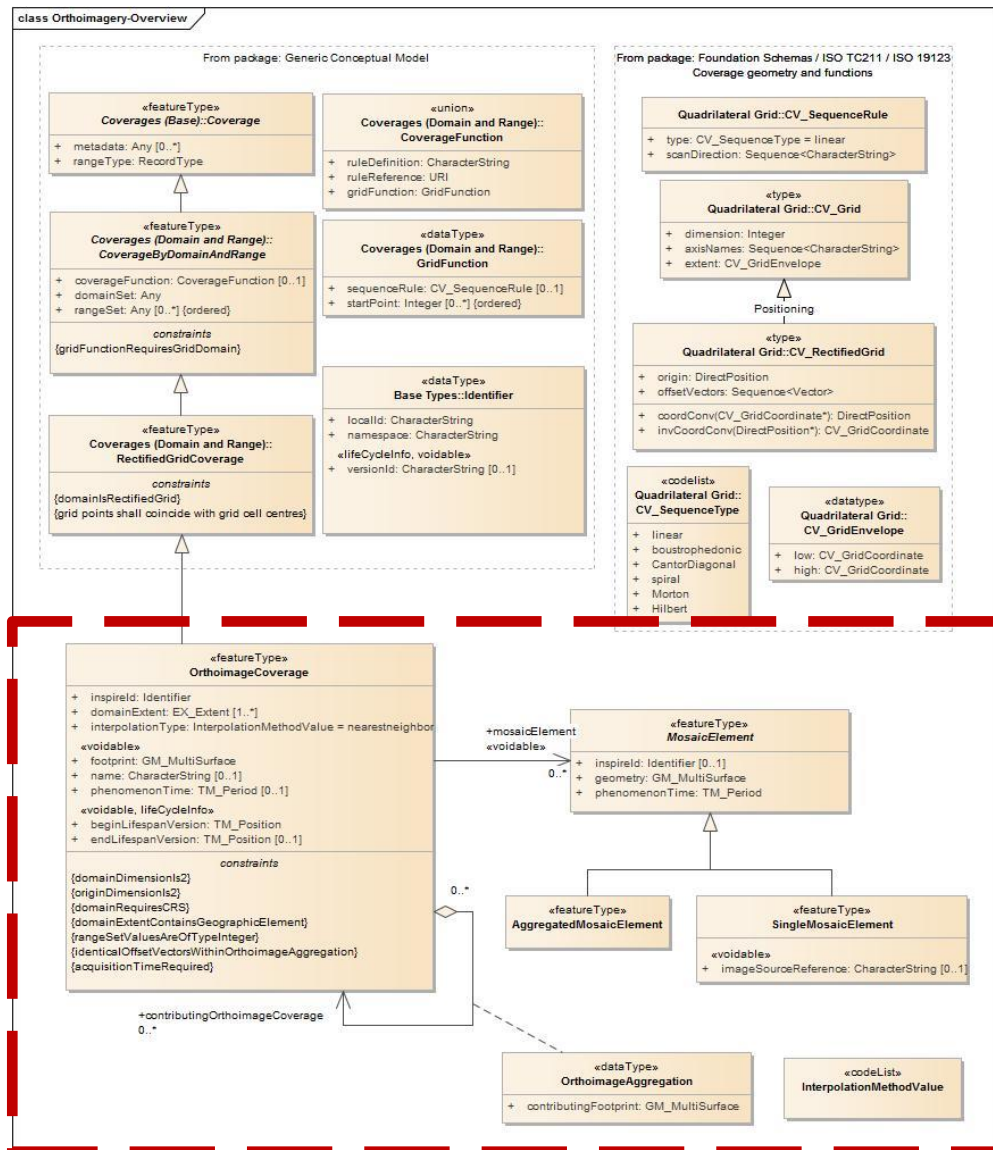
INSPIRE Coverage extensions

INSPIRE Orthoimagery



Issues in Provision by WCS

INSPIRE Coverage extensions

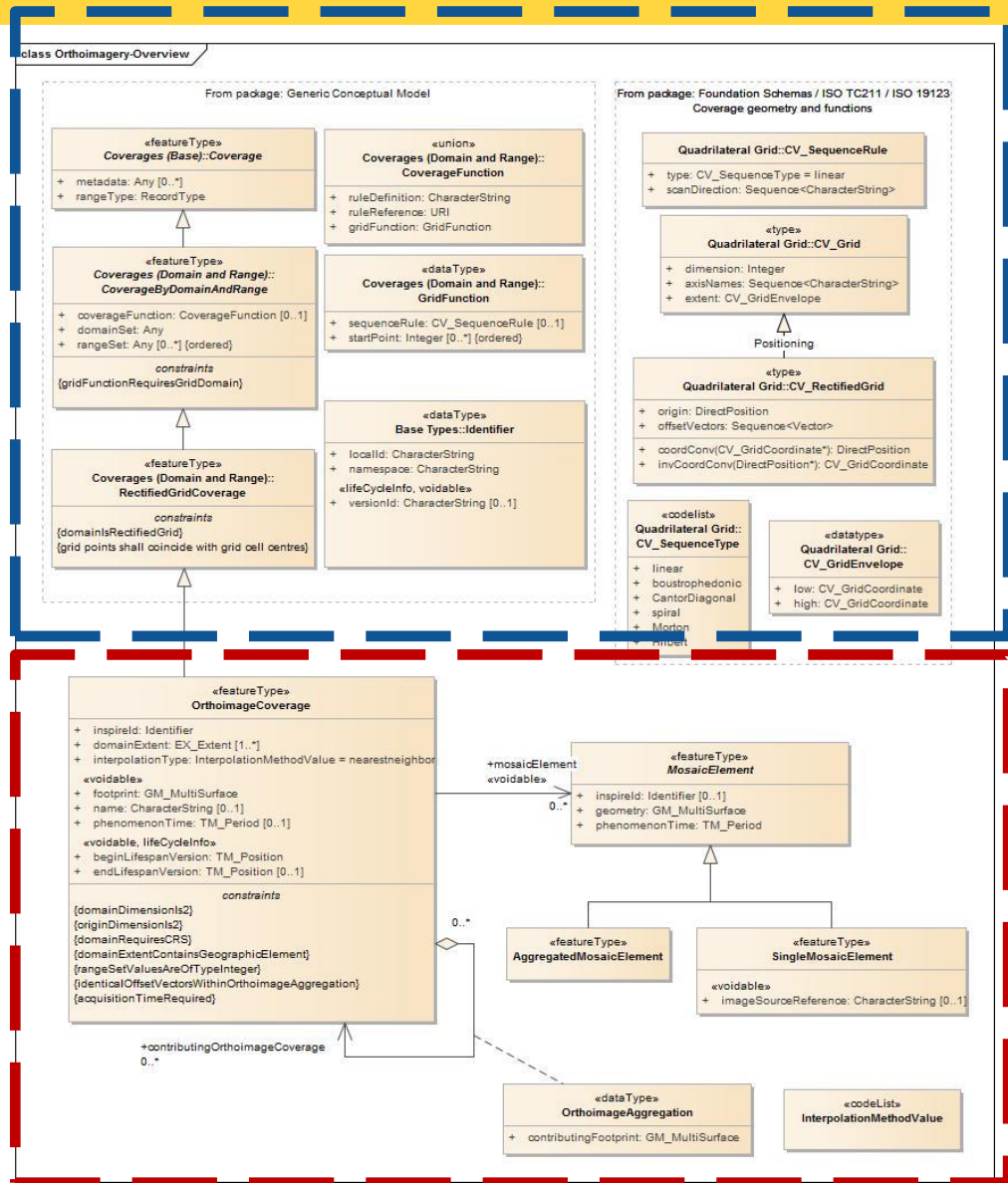


Issues in Provision by WCS

INSPIRE Coverage extensions

**Generic Conceptual Model
'Coverage – Domain and
range' schema
Based on ISO 19123**

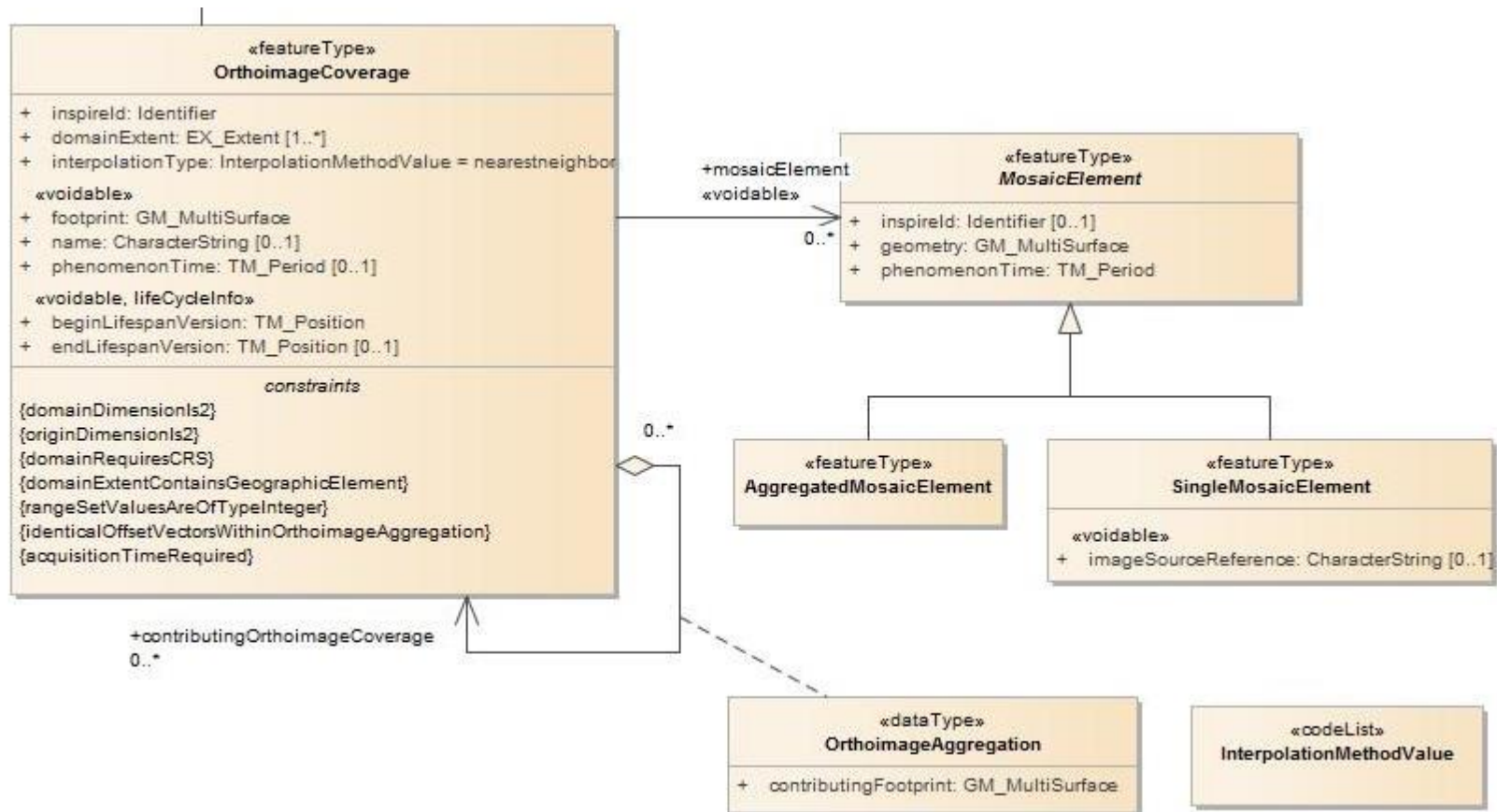
**INSPIRE Orthoimagery Model
'Orthoimage Coverage' schema**



INSPIRE Coverage extensions



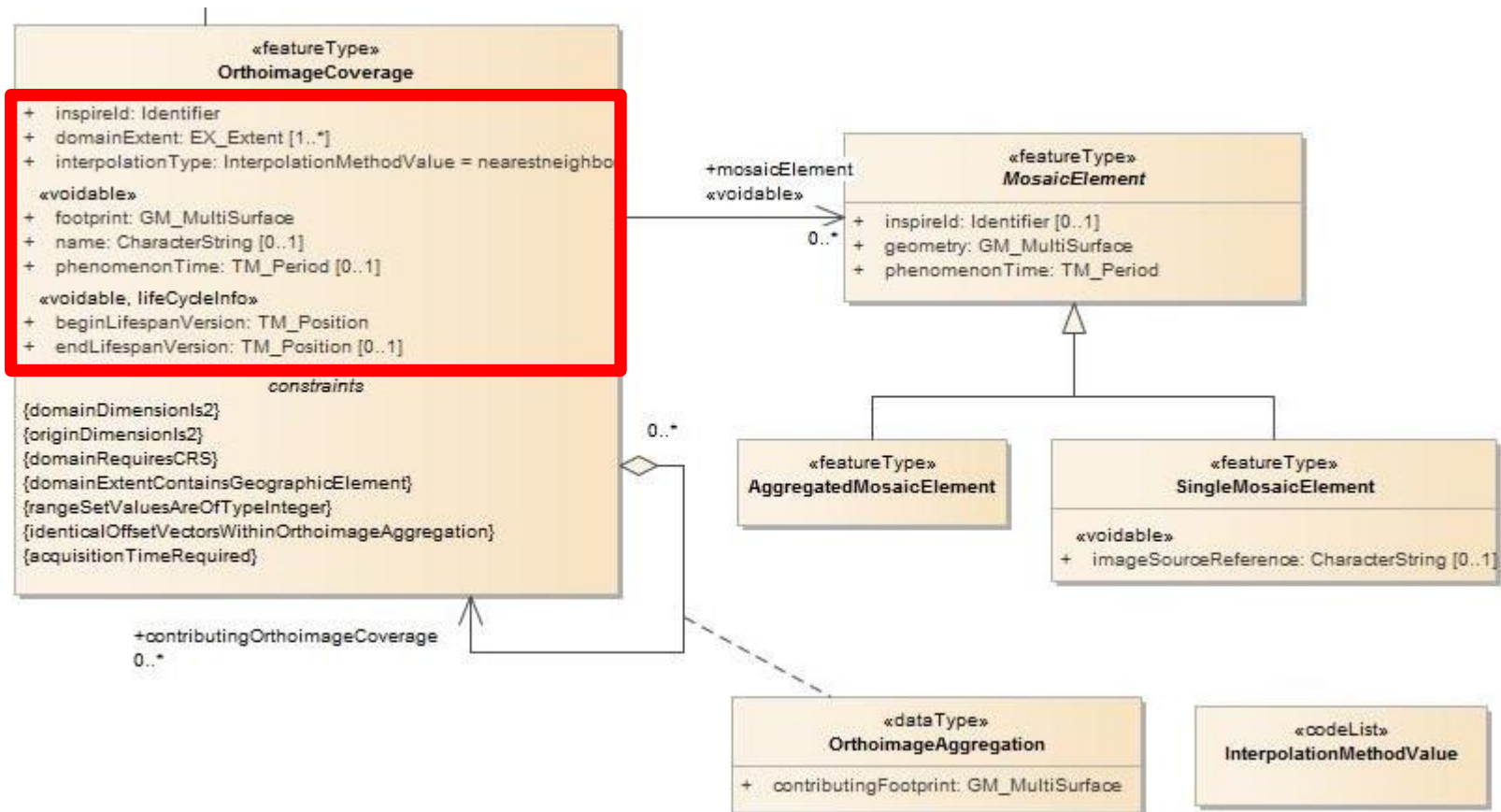
Existing model



INSPIRE Coverage extensions



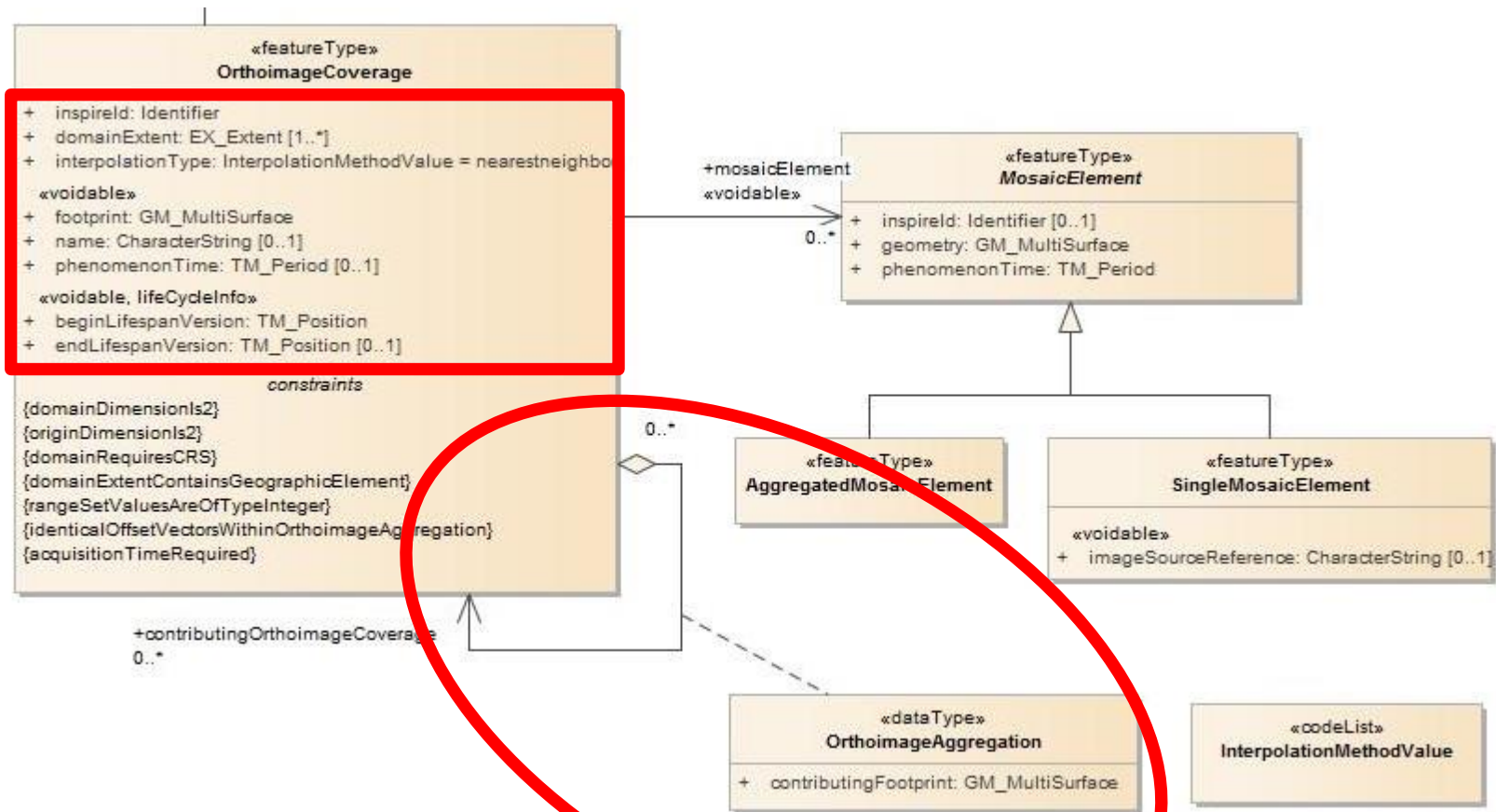
Existing model



INSPIRE Coverage extensions



Existing model

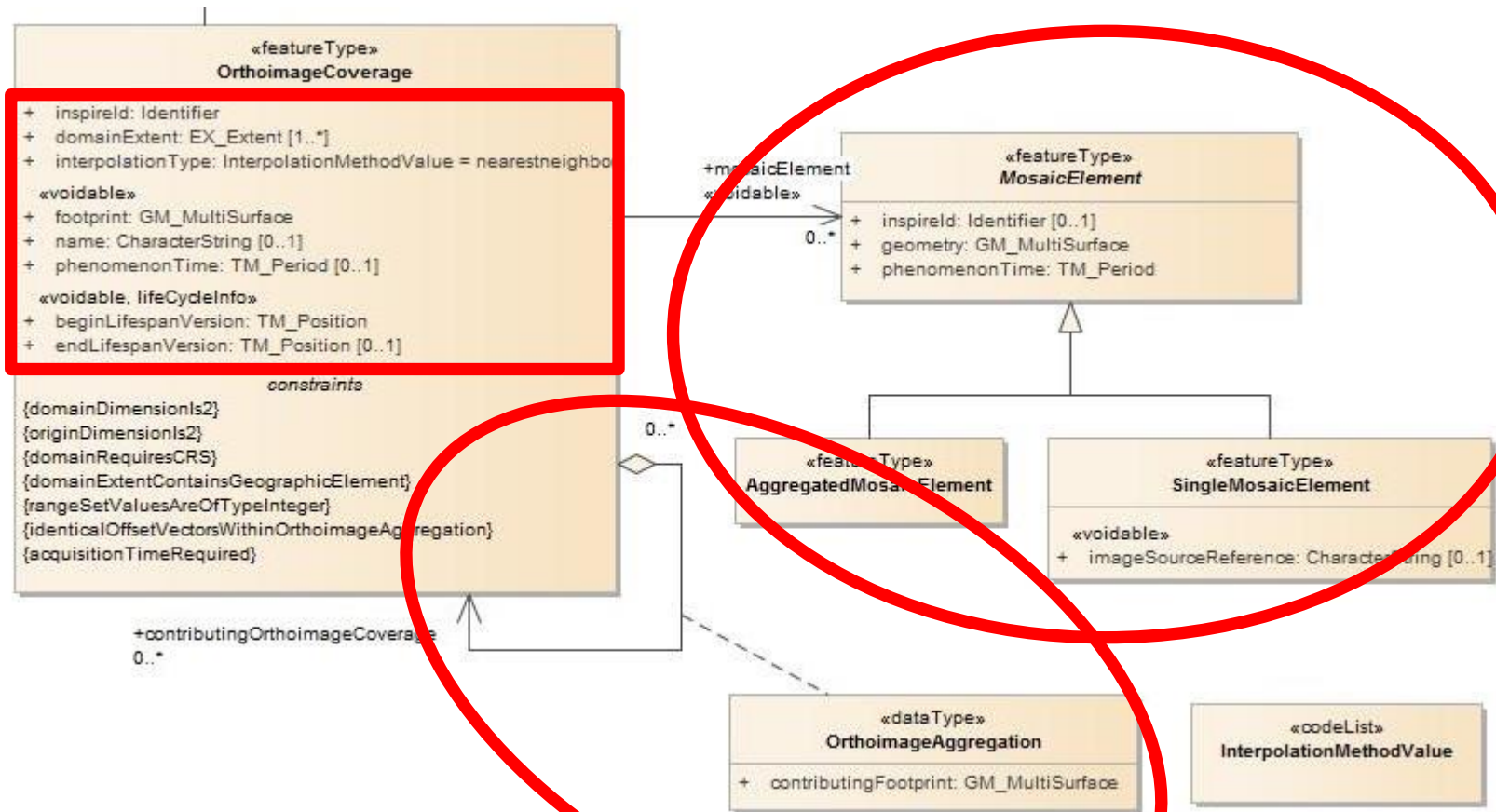


INSPIRE Coverage extensions



01

Existing model



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
 - <https://www.wetransform.to/news/2018/02/12/best-practices-for-inspire-ids/>

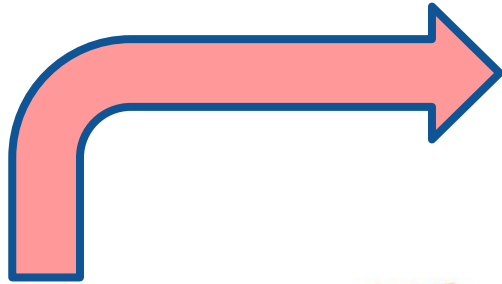
Issues in Provision by WCS

Coverage aggregation



Issues in Provision by WCS

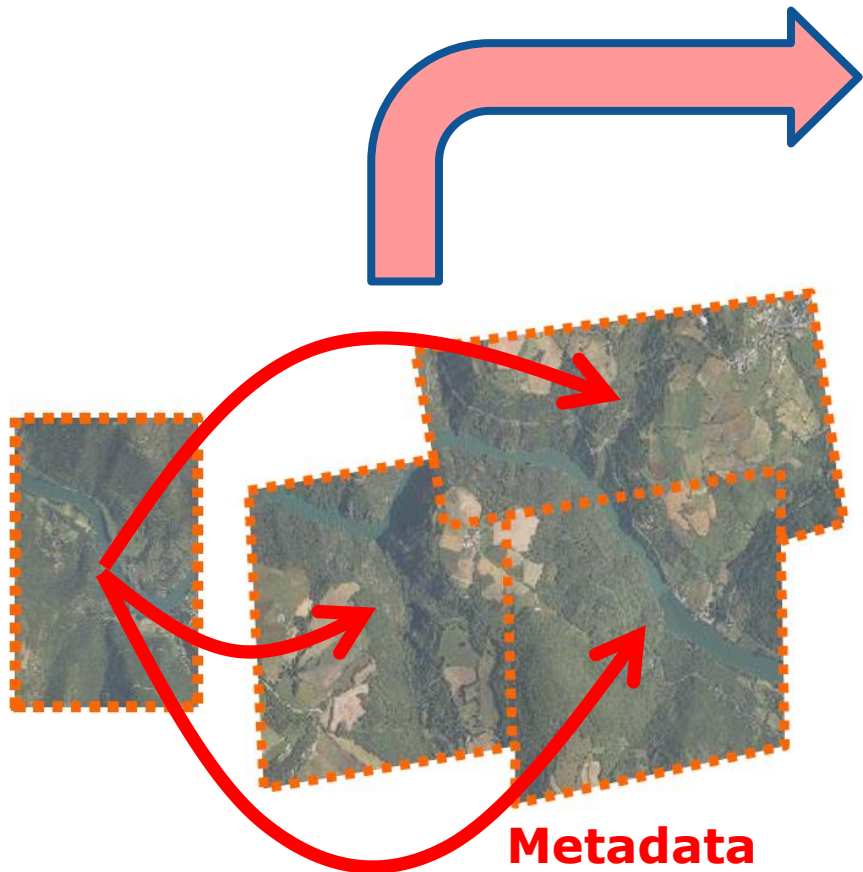
Coverage aggregation



Construction of the aggregated orthoimage coverage (**footprint in blue**) from subsets of the contributing orthoimage coverages (**contributing footprints in orange**)

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**)

Issues in Provision by WCS

Coverage aggregation

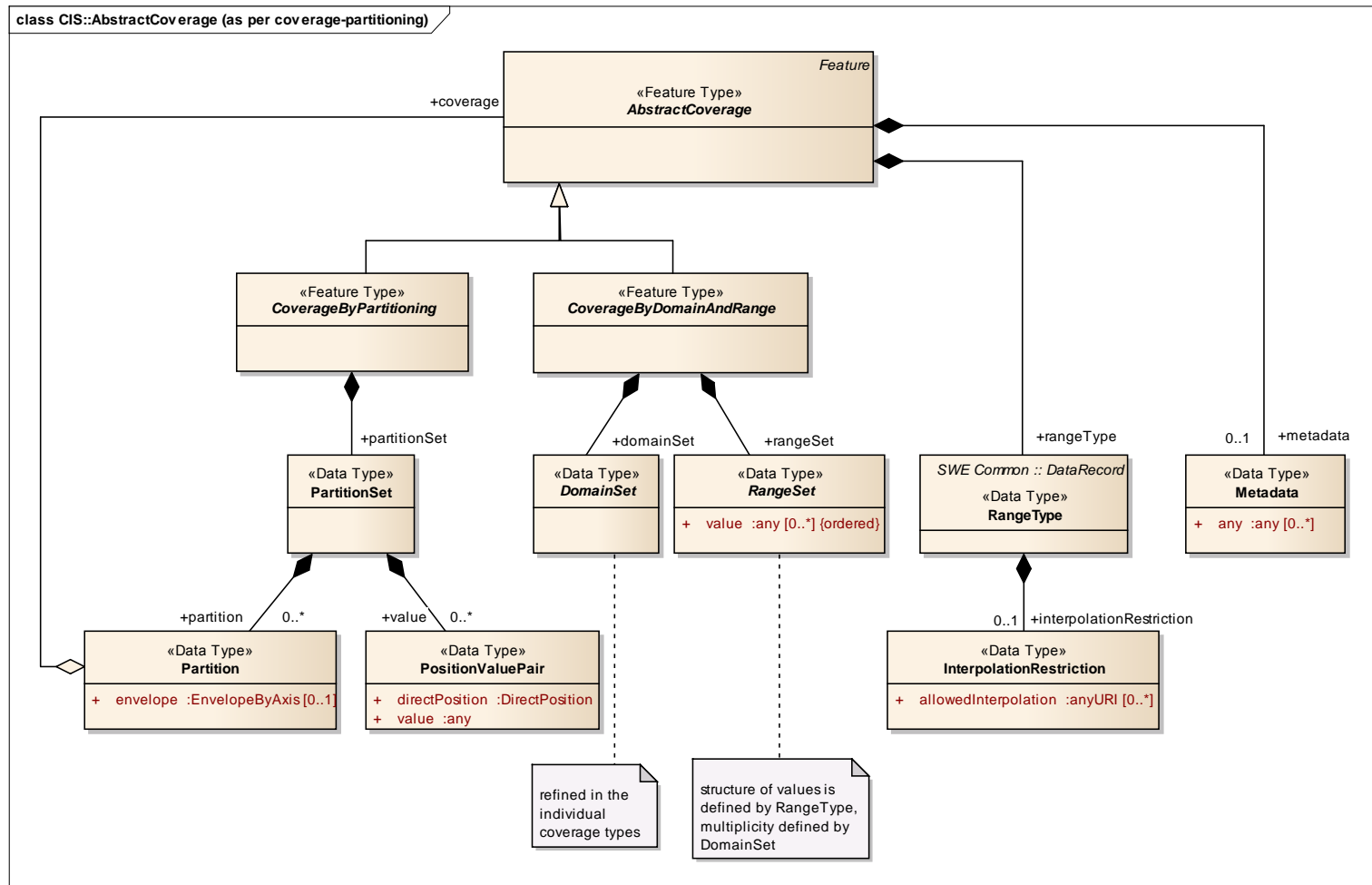


Footprint and contributing footprint of an orthoimage referred by an aggregated orthoimage (respectively in blue and orange).

Issues in Provision by WCS

Coverage aggregation

- Solution in CIS 1.1



Issues in Provision by WCS

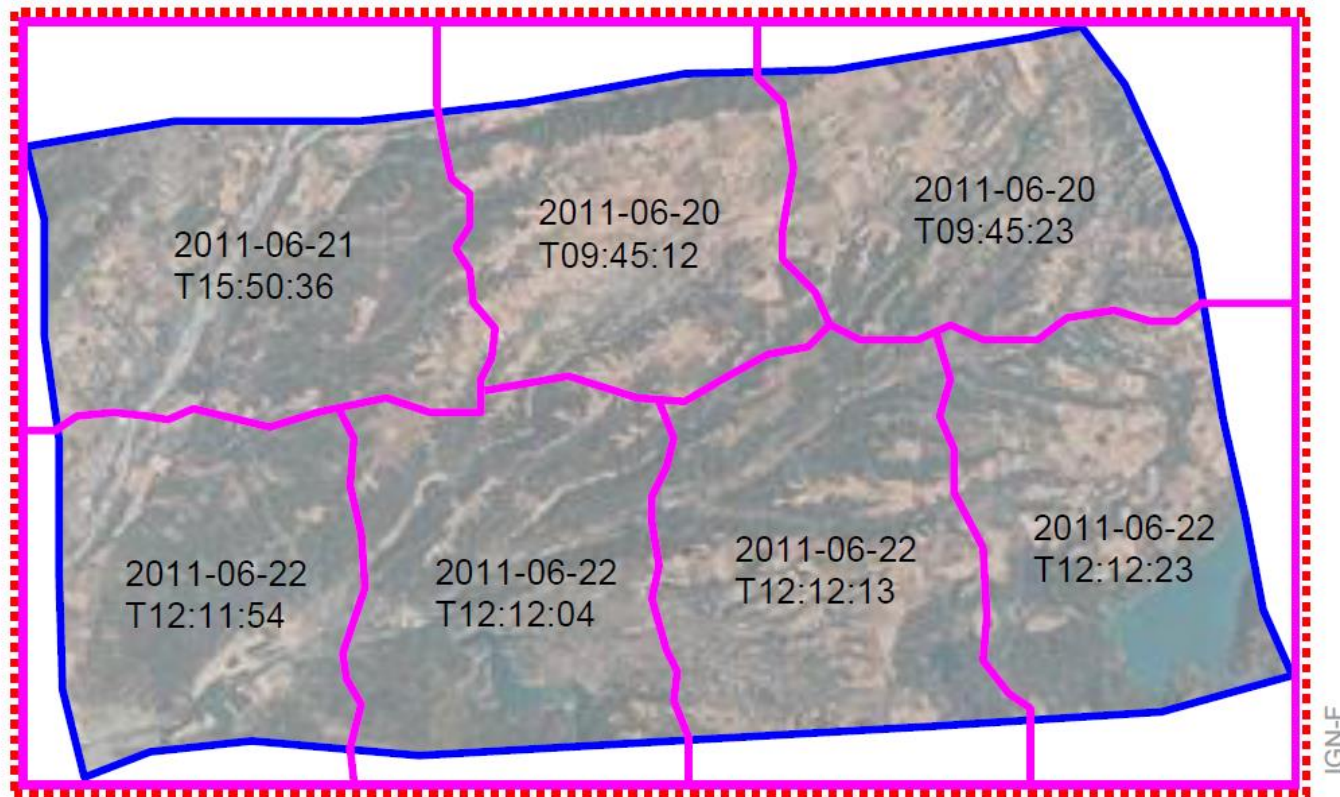
Coverage aggregation

- **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

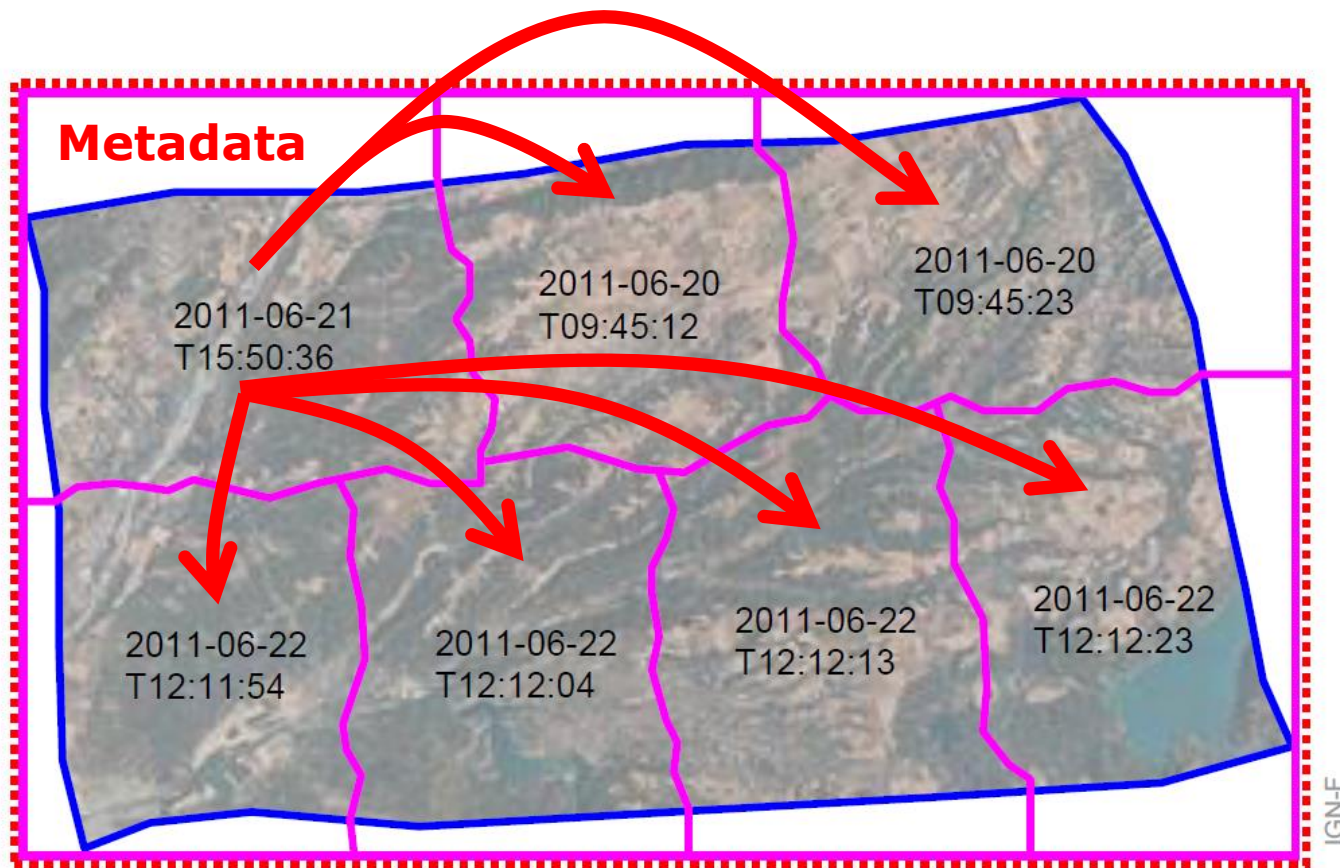
- Use of SingleMosaic-Element objects



Issues in Provision by WCS

Orthoimage mosaics

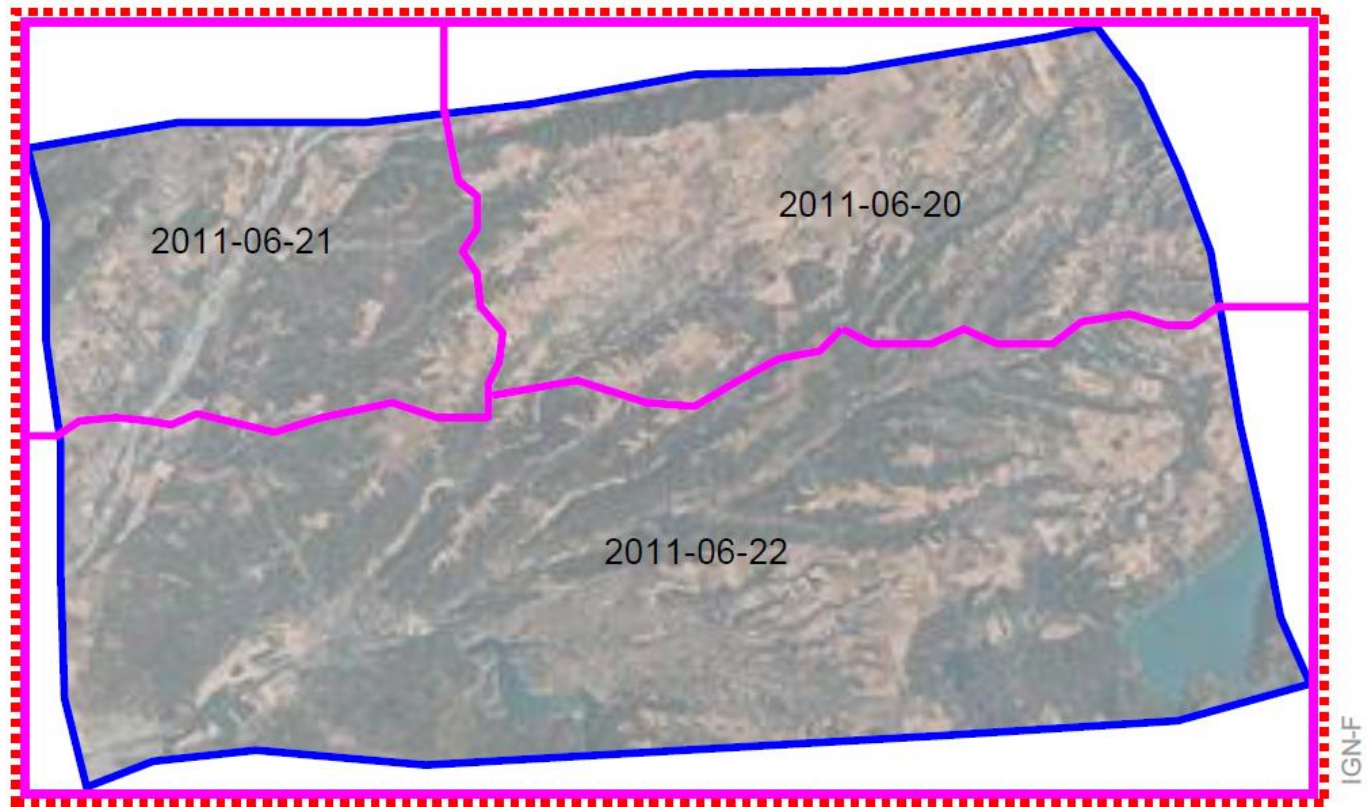
- Use of SingleMosaic-Element objects



Issues in Provision by WCS

Orthoimage mosaics

- Use of AggregatedMosaicElement objects



Issues in Provision by WCS

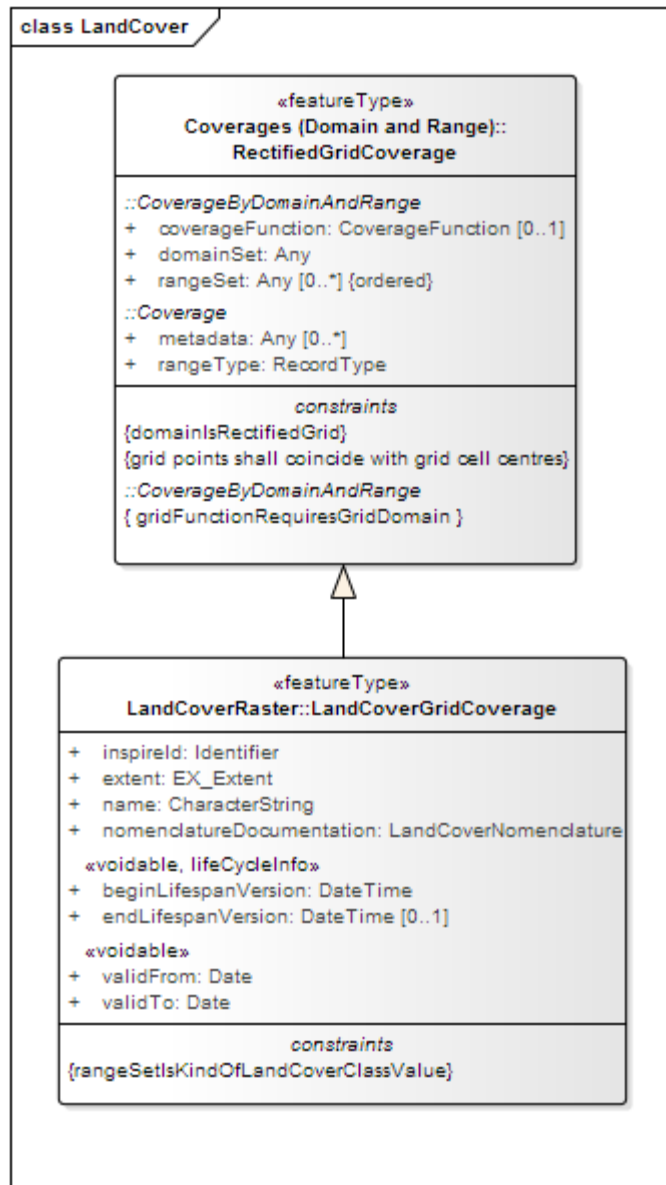
- **Coverage range options**
 - Non-numeric Range: how to provide categories (i.e. CORINE Land Cover values)
 - Multiple Range Components: profile measurements with depth together with measurement
- **Non-Spatial CRS** - pressure used for oceanographic depth & meteorological height

Workshop agenda

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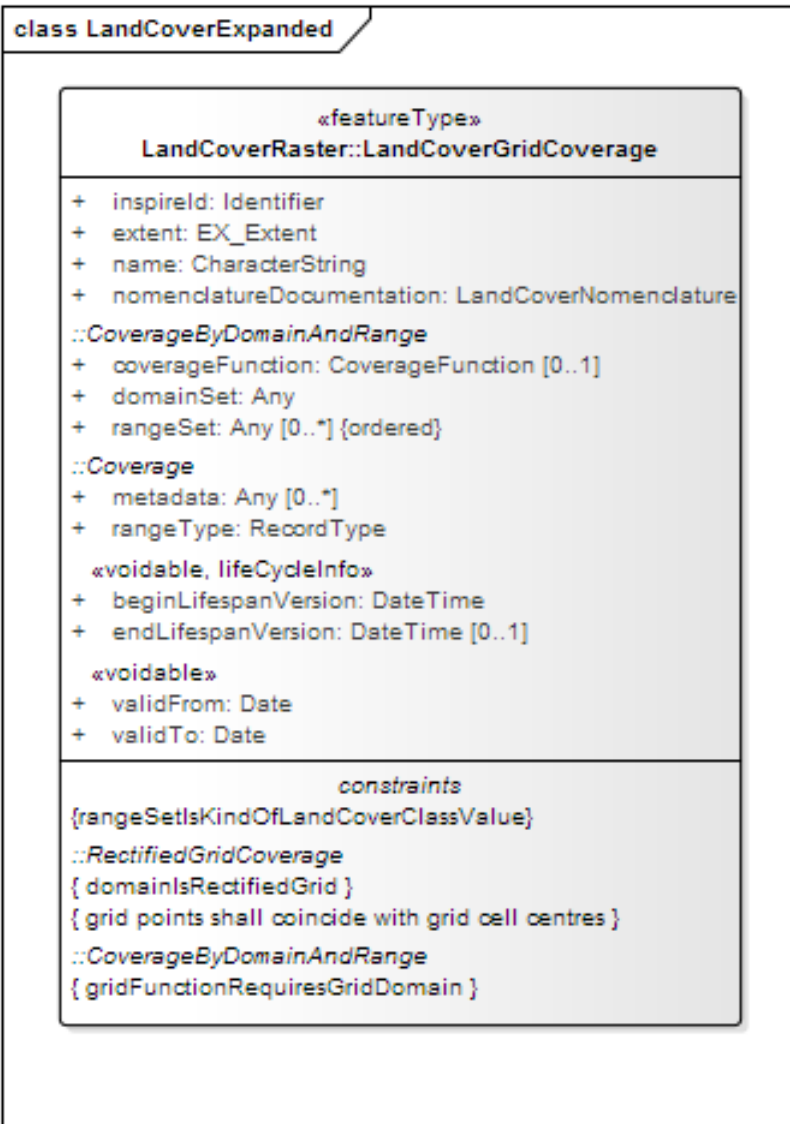
A revised model for INSPIRE coverages

Coverage Metadata Model



A revised model for INSPIRE coverages

Coverage Metadata Model



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
«avoidable, lifecycleInfo»
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
«avoidable»
+ validFrom: Date
+ validTo: Date

constraints

{rangeSetIsKindOfLandCoverClassValue}
::RectifiedGridCoverage
{ domainsIsRectifiedGrid }
{ grid points shall coincide with grid cell centres }
::CoverageByDomainAndRange
{ gridFunctionRequiresGridDomain }

class Coverage

«featureType»

Coverages (Domain and Range)::

RectifiedGridCoverage

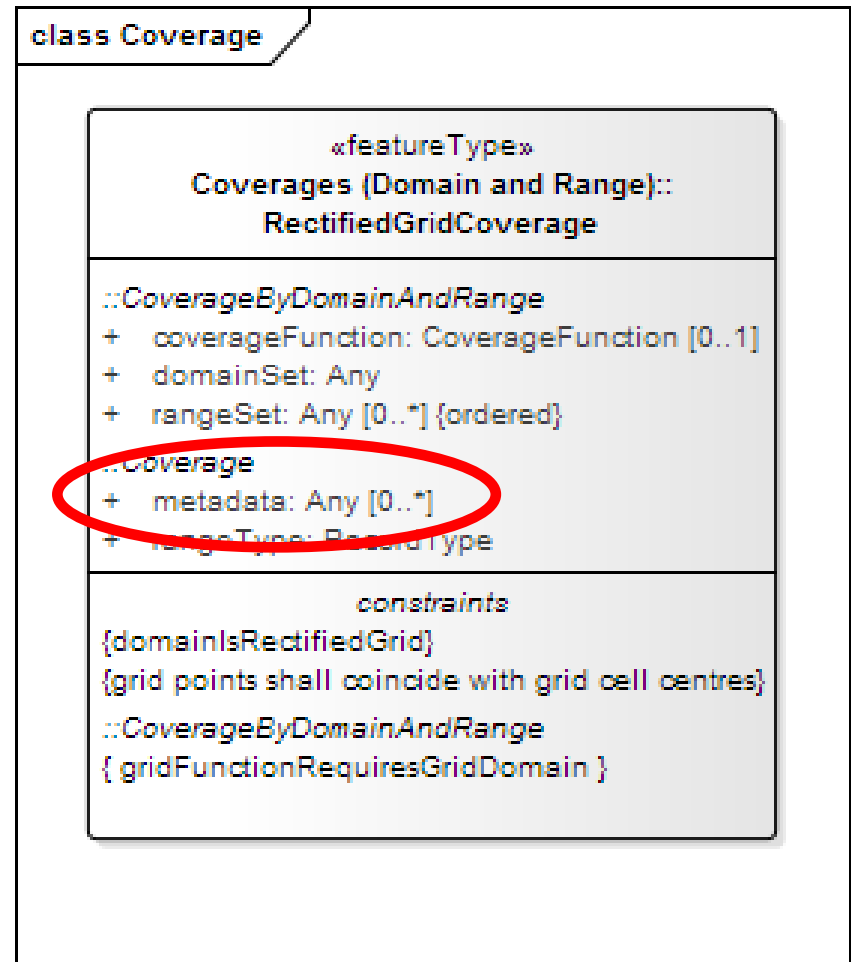
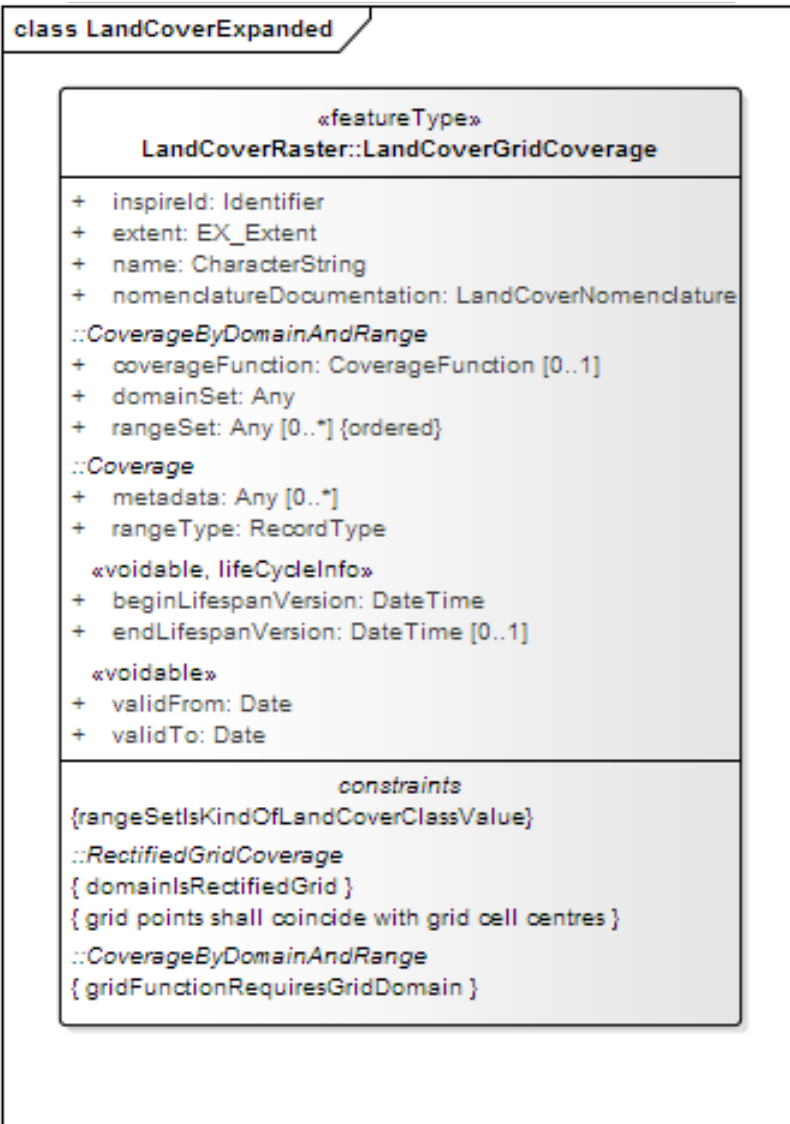
::CoverageByDomainAndRange
+ coverageFunction: CoverageFunction [0..1]
+ domainSet: Any
+ rangeSet: Any [0..*] {ordered}
::Coverage
+ metadata: Any [0..*]
+ rangeType: RecordType

constraints

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

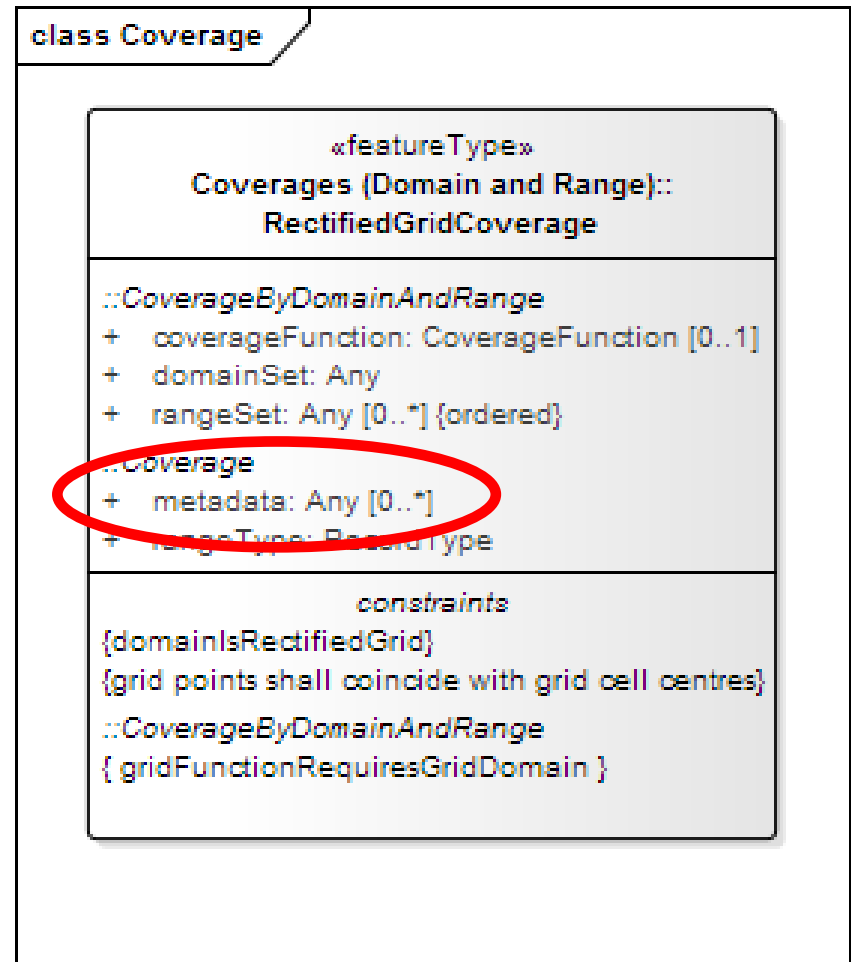
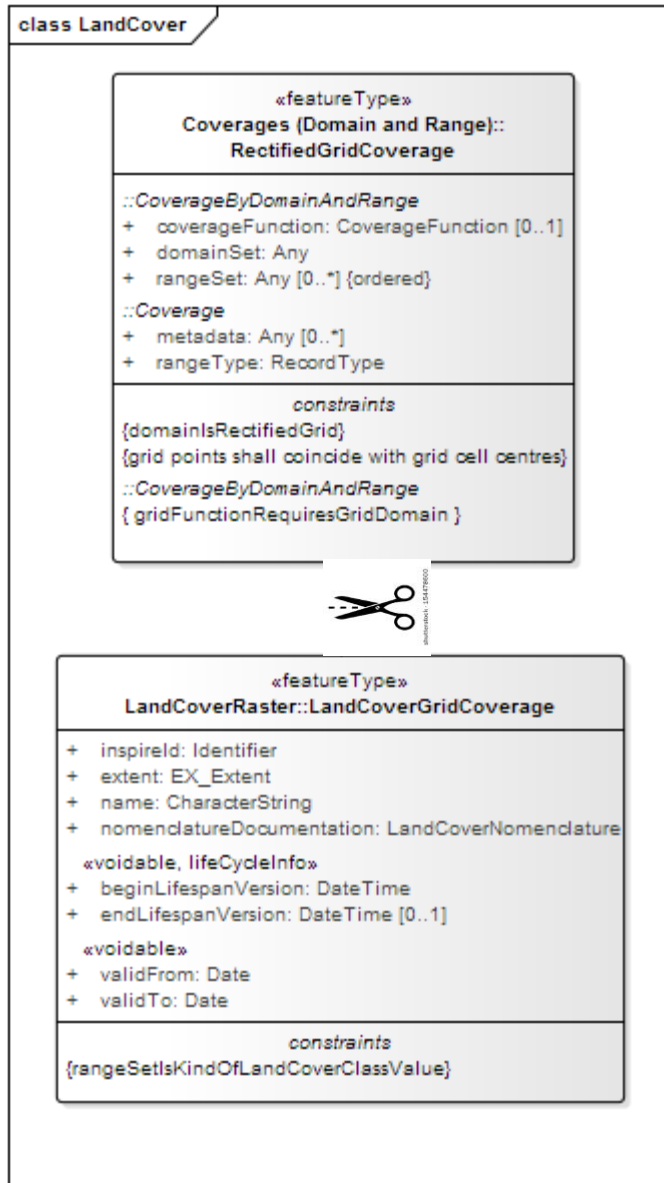
A revised model for INSPIRE coverages

Coverage Metadata Model



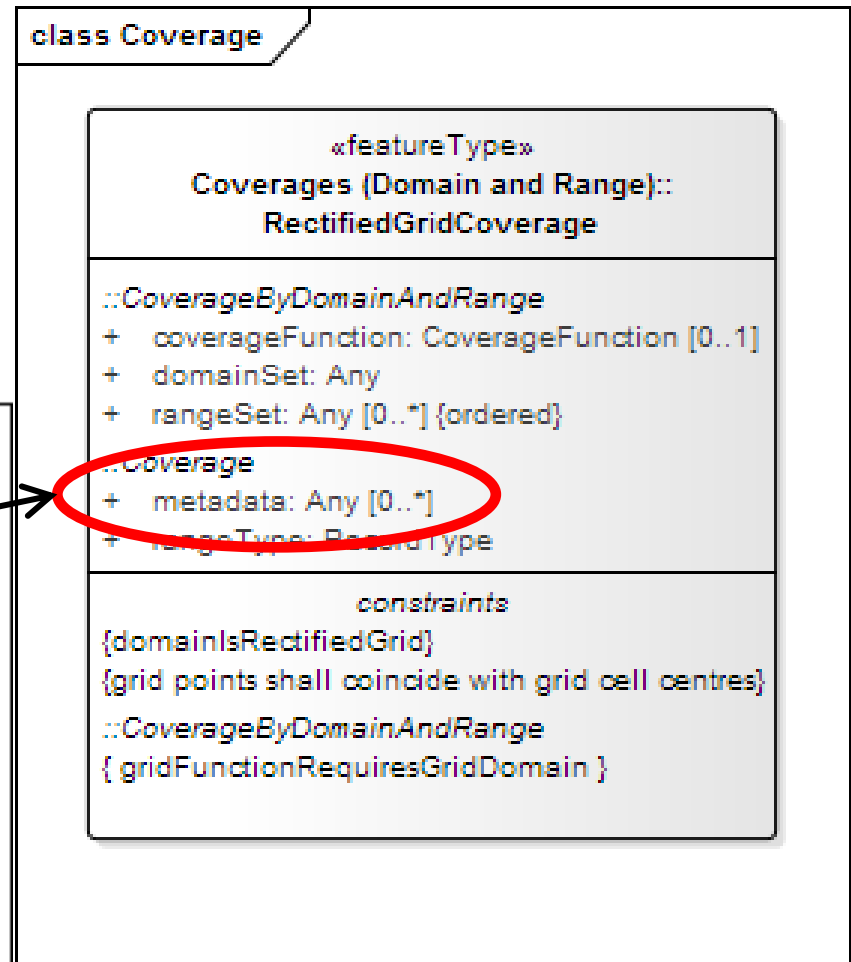
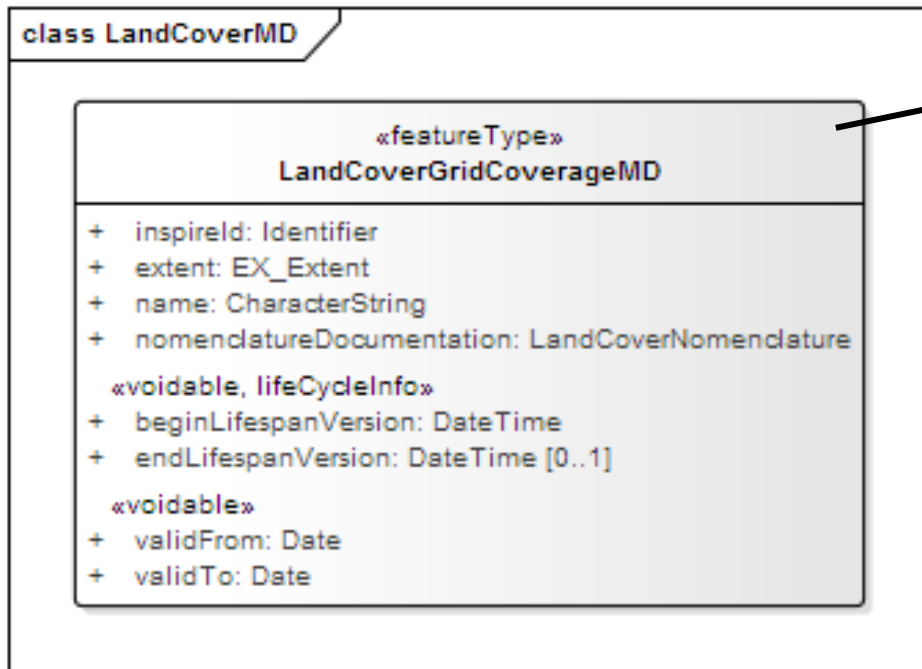
A revised model for INSPIRE coverages

Coverage Metadata Model



A revised model for INSPIRE coverages

Coverage Metadata Model



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\(7220000,7220050\)](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))

A revised model for INSPIRE coverages

Mapping between INSPIRE EL & OI models & CIS

INSPIRE Conceptual data model	Mapping to OGC CIS v1.0
Coverage element: type [cardinality] <<stereotype>> <i>Element type</i>	CIS (gmlcov:) / GML element (gml:)
ElevationGridCoverage (type RectifiedGridCoverage as defined in D2.10.2 [18]) <<featureType>> Spatial object	gmlcov:RectifiedGridCoverage
OrthoimageCoverage (type RectifiedGridCoverage as defined in D2.10.2 [18]) <<featureType>> Spatial object	
domainSet: Any [1] (type constrained to CV_RectifiedGrid) <i>Attribute</i>	gmlcov:RectifiedGridCoverage.domainSet [1] (type gml:RectifiedGrid)
rangeSet: Any [0..*] (type duly constrained in each theme; represents each of the coverage values) <i>Attribute</i>	gmlcov:RectifiedGridCoverage.rangeSet [1] (type gml:RangeSet; represents the set of coverage values)
rangeType: RecordType [1] <i>Attribute</i>	gmlcov:RectifiedGridCoverage.rangeType [1] (type swe:DataRecord)
metadata: Any [0..*] <i>Attribute</i>	gmlcov:Coverage.metadata: Any [0..*]

A revised model for INSPIRE coverages

Mapping between INSPIRE EL & OI models & CIS

INSPIRE Conceptual data model	Mapping to OGC CIS v1.0
Coverage element: type [cardinality] <<stereotype>> Element type	CIS (gmlcov:) / GML element (gml:)
inspireId: Identifier [1] Attribute	gml:id property (To be further analysed)
domainExtent: EX_Extent [1..*] Attribute	gml:boundedBy / gml:Envelope / gml:EnvelopeWithTimePeriod
beginLifespanVersion: DateTime [1] <<voidable>> Attribute	Not matched (INSPIRE Extension).
endLifespanVersion: DateTime [1] [0..1] (Cardinality [1] in EL; [0..1] in OI) <<voidable>> Attribute	Not matched (INSPIRE Extension).
contributingElevationGridCoverage [0..*] Aggregation relationship	Not matched (INSPIRE Extension).
contributingOrthoimageCoverage [0..*] Aggregation relationship	Not matched (INSPIRE Extension).
ElevationGridCoverageAggregation Association class	Not matched (INSPIRE Extension).
OrthoimageAggregation Association class	Not matched (INSPIRE Extension).

INSPIRE Conceptual data model	Mapping to OGC CIS v1.0
Coverage element: type [cardinality] <<stereotype>> Element type	CIS (gmlcov:) / GML element (gml:)
propertyType: ElevationPropertyTypeValue [1] Attribute	Not matched (INSPIRE Extension).
surfaceType: SurfaceTypeValue [1] Attribute	Not matched (INSPIRE Extension).
interpolationType: InterpolationMethod [1] Attribute	Not matched (INSPIRE Extension).
footprint: GM_MultiSurface [1] <<voidable>> Attribute	Not matched (INSPIRE Extension).
name: CharacterString [0..1] <<voidable>> Attribute	Not matched (INSPIRE Extension).
phenomenonTime: TM_Period [0..1] <<voidable>> Attribute	Not matched (INSPIRE Extension).
mosaicElement [0..*] <<voidable>> Association relationship	Not matched (INSPIRE Extension).

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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