Advanced Application of the DRM

Ocean Environment: Mapping to the SEDRIS Data Representation Model

SEDRIS™ Technology Conference
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Tutorial Description

DESCRIPTION

Much oceanographic data is either tabular or gridded over geographic regions. In this tutorial the SEDRIS representation of tabular and gridded data is reviewed using oceanographic data examples.

The modeling of other oceanographic "features" such as fish schools, sea mounts, and rain squalls are also discussed.

WHO SHOULD ATTEND

Data users and data modelers of oceanographic and atmospheric data as well as those interested in physics-based modeling. The tutorial:

"Fundamentals of the DRM"

is a prerequisite.

WHAT TO EXPECT

The attendee should gain an understanding of the power and flexibility of SEDRIS Data Table and other constructs in the setting of the larger Data Representation Model.

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Outline

- Tabular Data
  - Property Table Example
- Gridded Data
  - Property Grid Examples
- Ocean “Features”
- Hierarchy & Classification

Property Table: An Example

Table Type

Surface Backscatter Strength

as a Function of Angle of incidence and EM Band

EM Band	Angle of incidence in degrees					
	15	30	45	60	75	90
microwave	300	290	240	207	198	170
L-Band	160	230	180	167	158	130
S-Band	165	152	78	22	8	1.5
X-Band	179	122	45	11	6	1
V-Band	200	90	40	9	4	0.1

Regular Axis

Data Cells

Enumeration Axis

Cell values: Surface Backscatter in decibels
(negative sign assumed)

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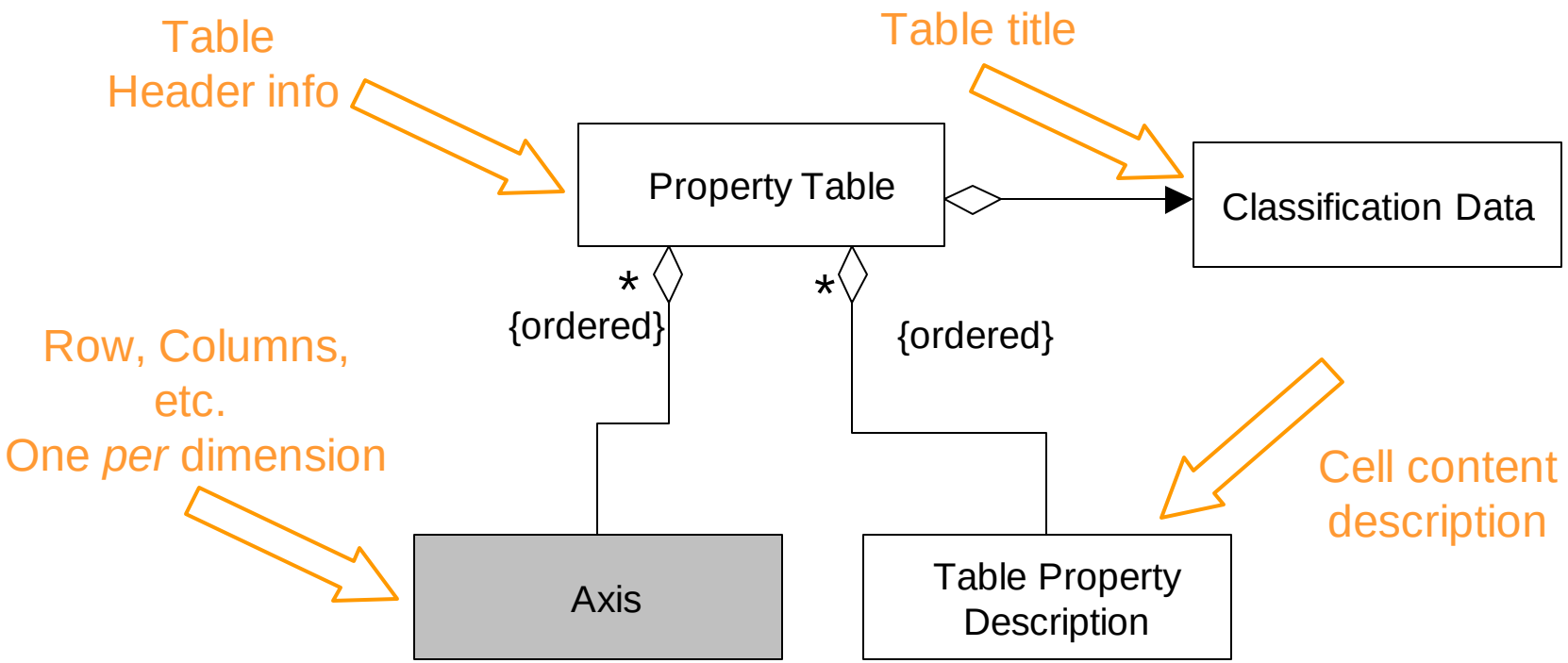
Property Table Class



See DRM sheet 6

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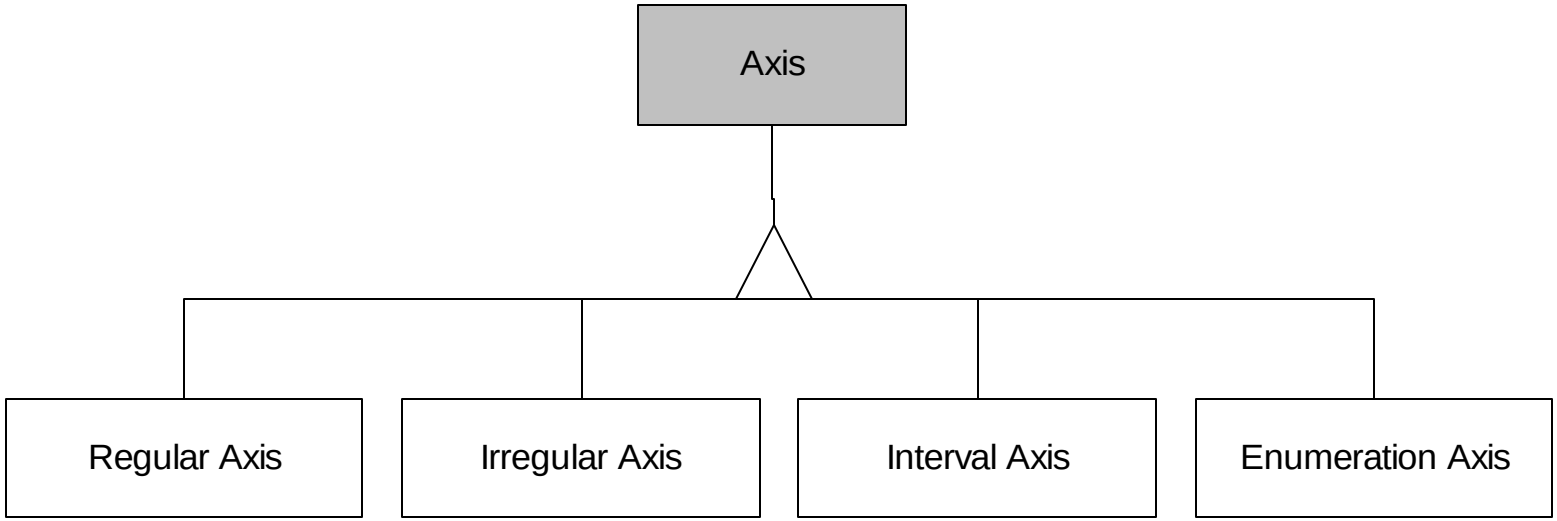
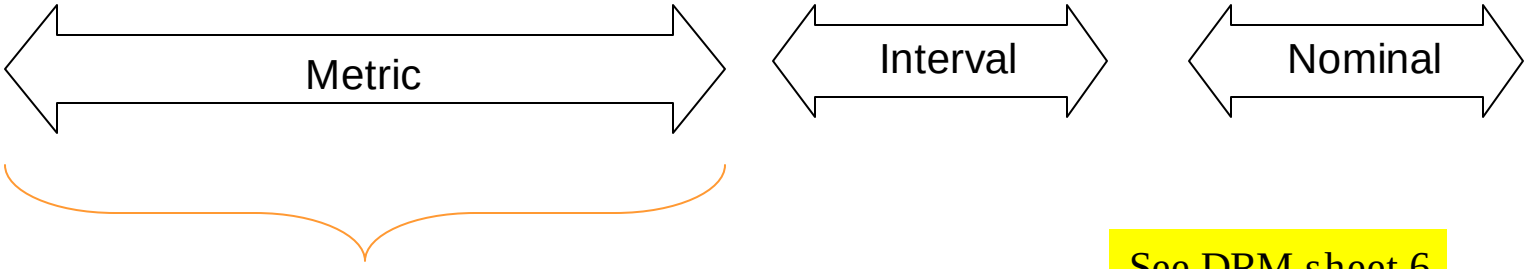
Axis Classes



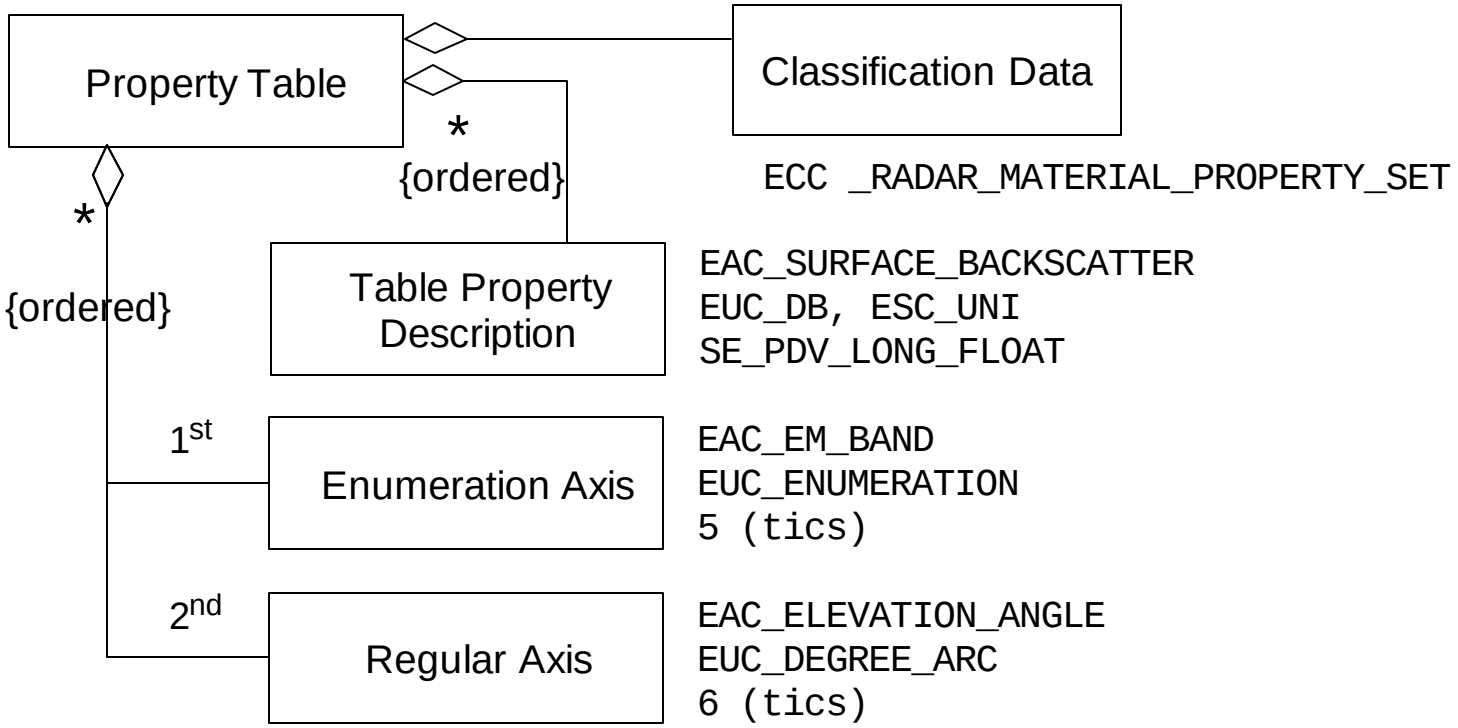
Measurement scale:



Spatial coordinate axes use metric scales

See DRM sheet 6

Property Table Example (cont'd)



Instance diagram

Combining Tables: An Example

Surface Backscatter in decibels

(negative sign assumed)

		Angle of incidence in degrees					
		15	30	45	60	75	90
EM Band	microwave	300	290	240	207	198	170
	L-Band	160	230	180	167	158	130
	S-Band	165	152	78	22	8	1.5
	X-Band	179	122	45	11	6	1
	V-Band	200	90	40	9	4	0.1

```
EAC_SURFACE_BACKSCATTER
EUC_DB, ESC_UNI
SE_PDV_LONG_FLOAT
```

Emissivity

		Angle of incidence in degrees					
		15	30	45	60	75	90
EM Band	microwave	.32	.97	.38	207	.98	.70
	L-Band	.24	.93	.48	167	.58	.30
	S-Band	.56	.59	.78	22	.8	.5
	X-Band	.73	.58	.45	.51	.6	.1
	V-Band	.51	.43	.47	.19	.14	.1

```
EAC_EMISSIVITY
EUC_UNITLESS, ESC_UNI
SE_PDV_LONG_FLOAT
```

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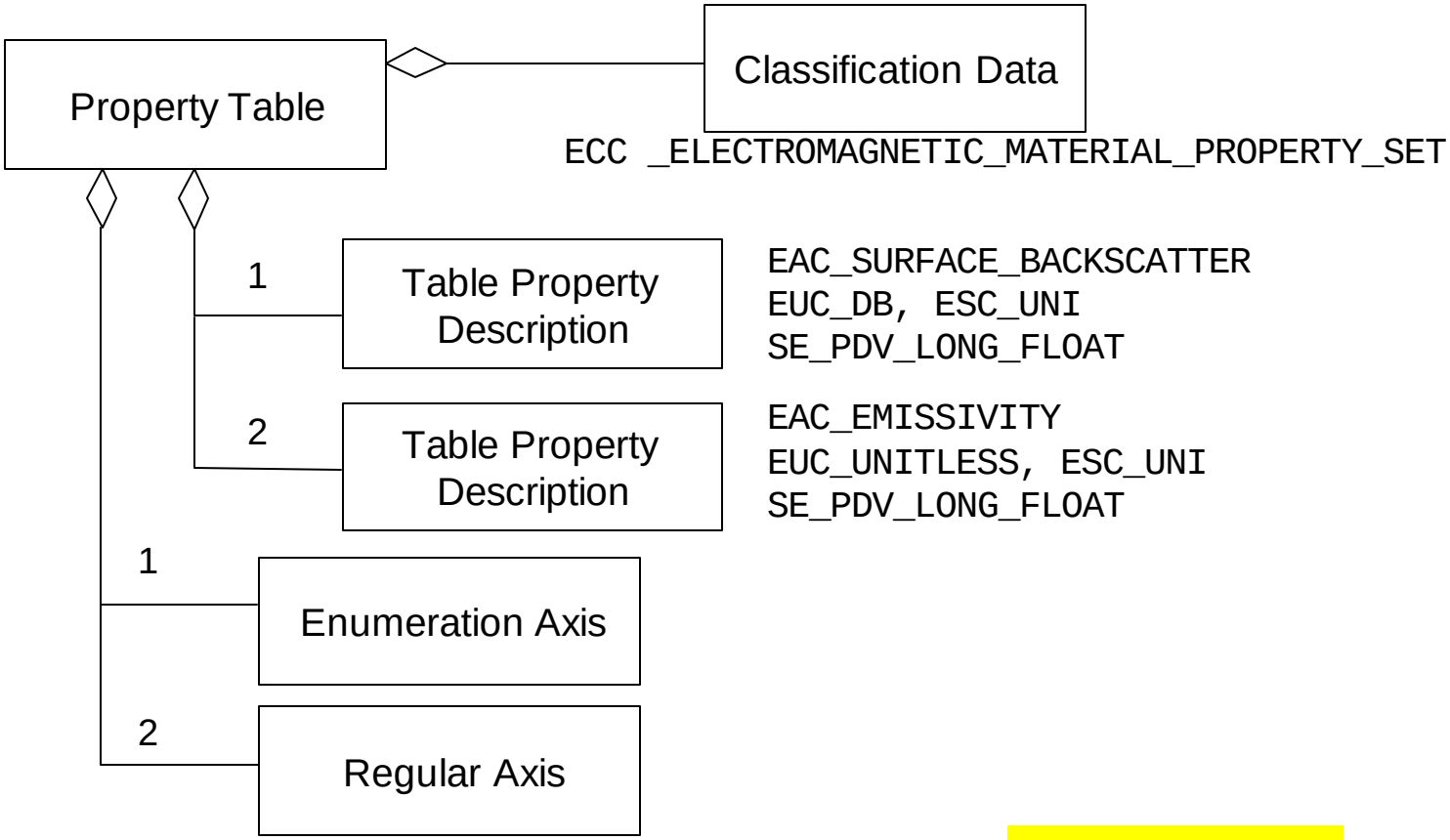
Combining Tables:
Multiple Signature Items



Instance diagram

Data Tables

- What can be represented?
  - Axis Types: Any EDCS attribute type
  - Cell Content: Any EDCS attribute type
- Arbitrary Dimensions (n-axes)
- Other capabilities
  - Data Table Reference Class
    - Allows entry into given row of table
    - Support for “physics based” modeling
  - Data Table Library
    - Promotes re-use of tables
  - Meta-data Representation

Outline

- Tabular Data
  - Property Table Example
- Gridded Data
  - Property Table Examples
- Ocean “Features”
- Hierarchy & Classification

Property Grids

- Data Tables whose cells form a grid in space
  - "Griddedness" is dependent on the Spatial Reference Frame.
- Grid Structure (Relative spatial extents)
  - Layout
    - Axis types
      - Spatial Coordinate axes (1+ required)
      - Other axes (optional)
    - Axis Ticks (relative position of cells)
  - Location
    - Hook Point
      - Where in the world?
      - Which cell is designated?
  - Alignment
      - Where in the cell?

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Property Grid Example: Sea Surface Temperature

- Grid Structure
  - Layout
    - 2-D
    - 30’ Geodetic Latitude/Longitude cells
  - Location
    - Designated cell
      - Example: SW corner
    - Hook Point
      - World location of designated cell
  - Alignment
      - Measured at center of cell

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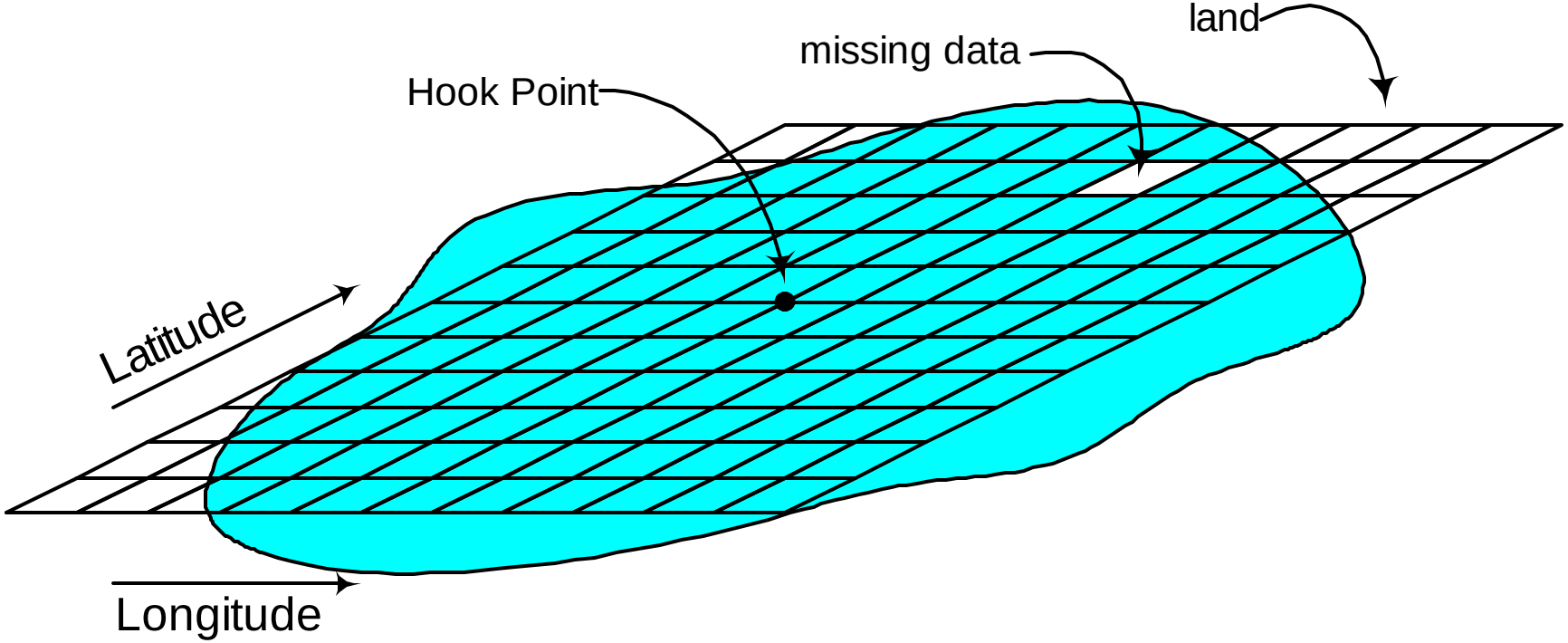
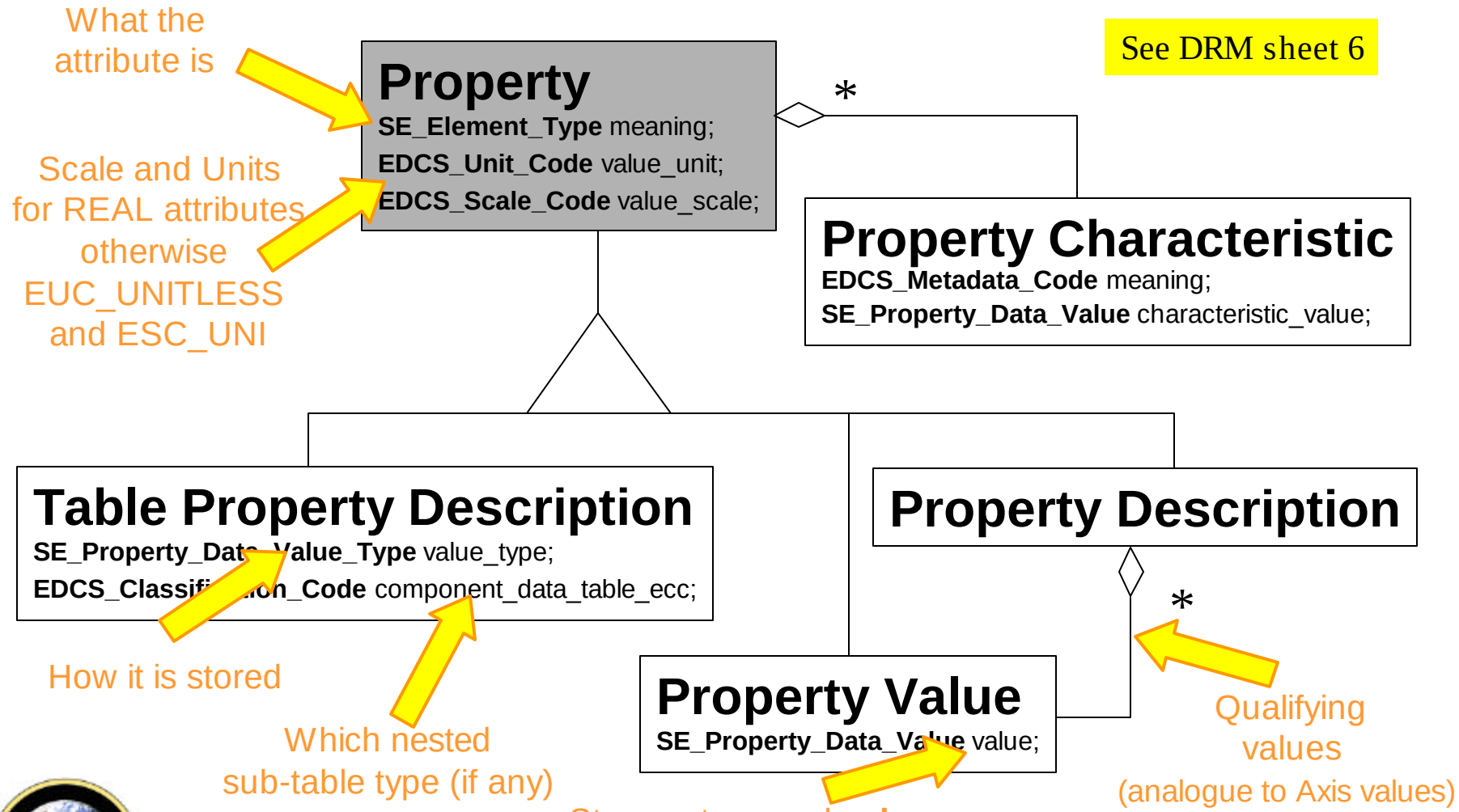
Property Grid Example: Sea Surface Temperature (cont'd)



Example: Sea Surface Temperature (cont'd)

- Data Signature
  - Type
    - EDCS Attribute Code
  - Units and Scale
    - EDCS_Unit_Code, EDCS_Scale_Code
  - Storage Type
    - SE_Property_Data_Value_Type
  - Sentinel Values & Data Characteristics
    - Overland, Missing
    - Valid range, precision, …

Property Classes



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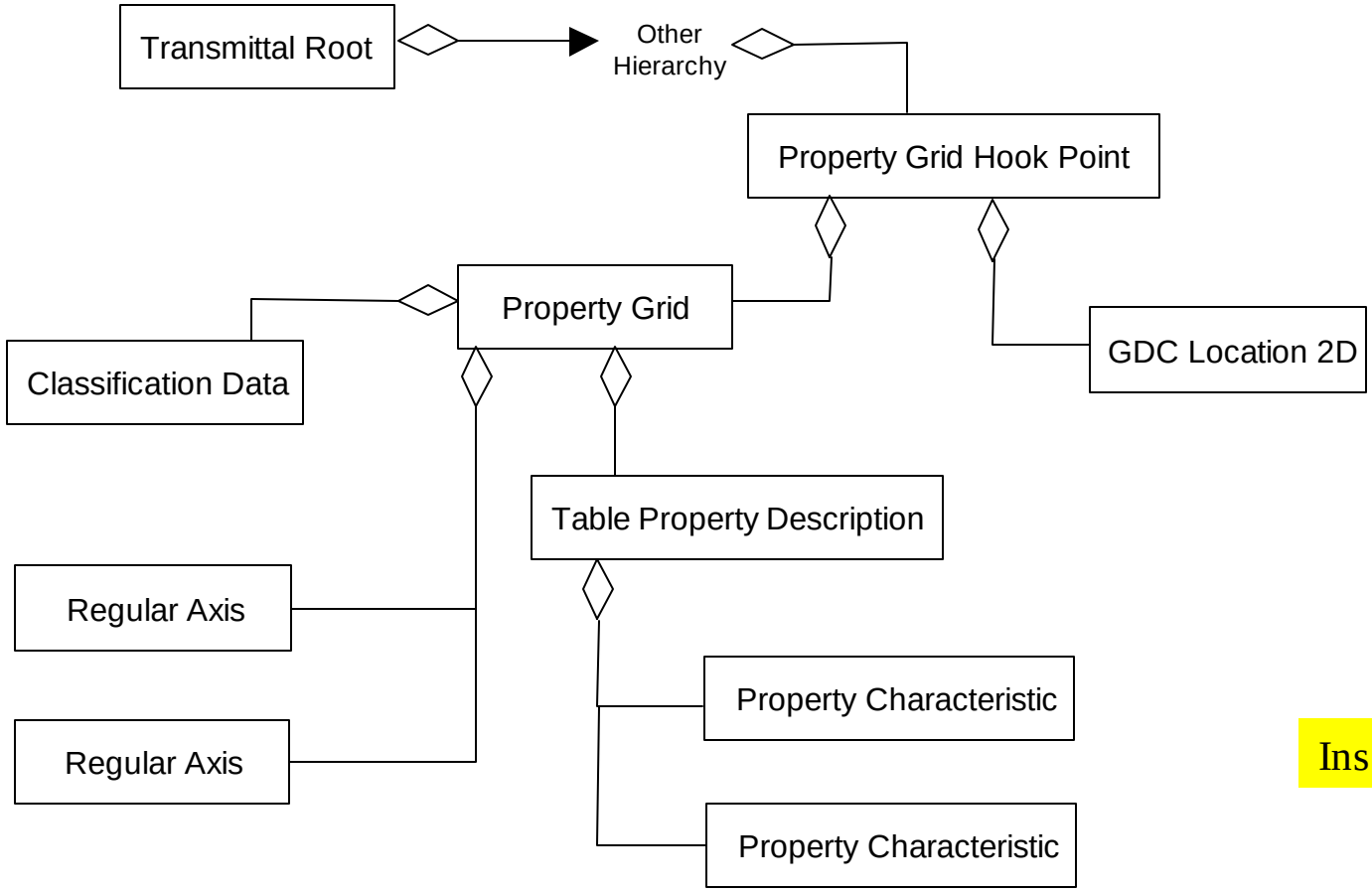
Example: Sea Surface Temperature



Instance diagram

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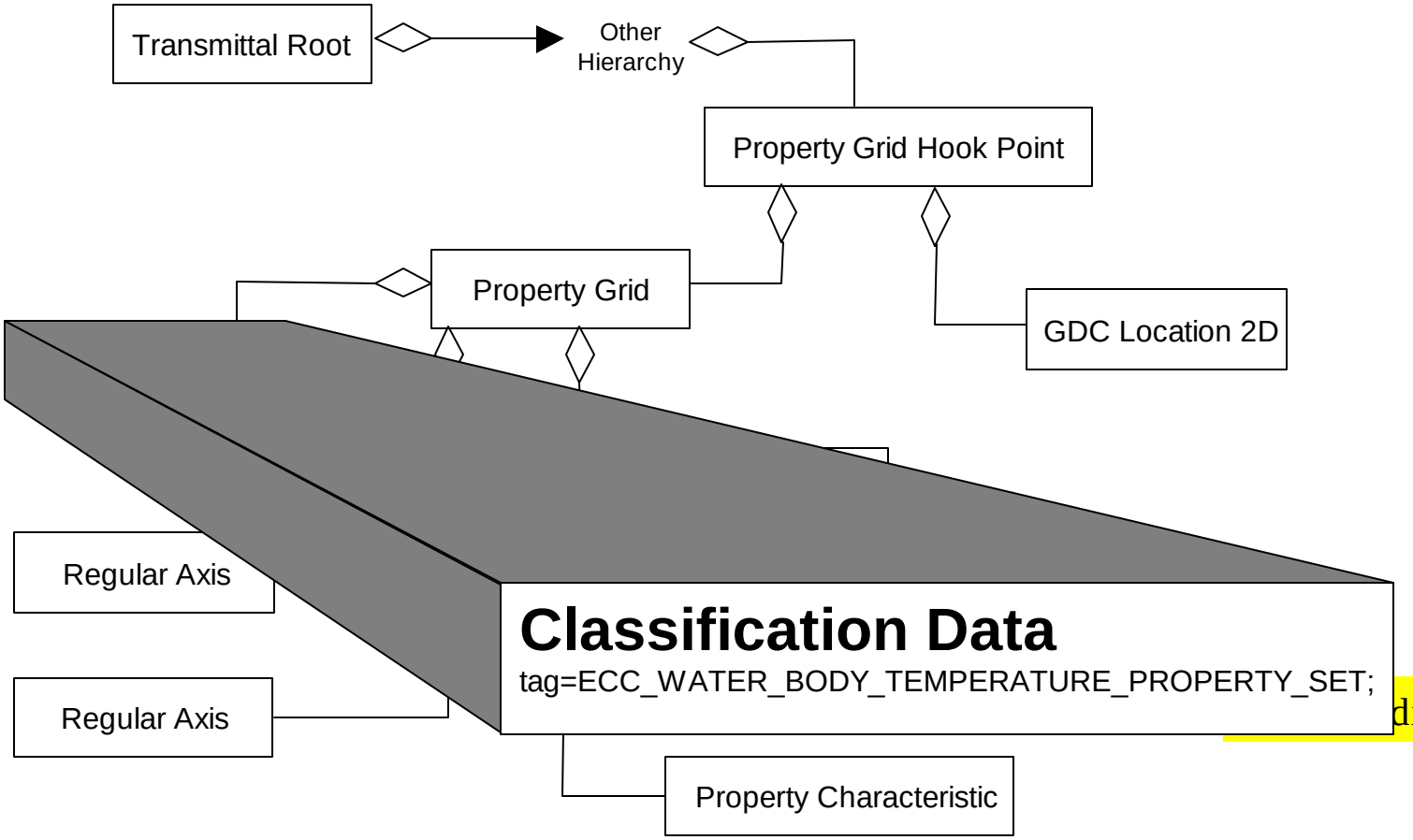
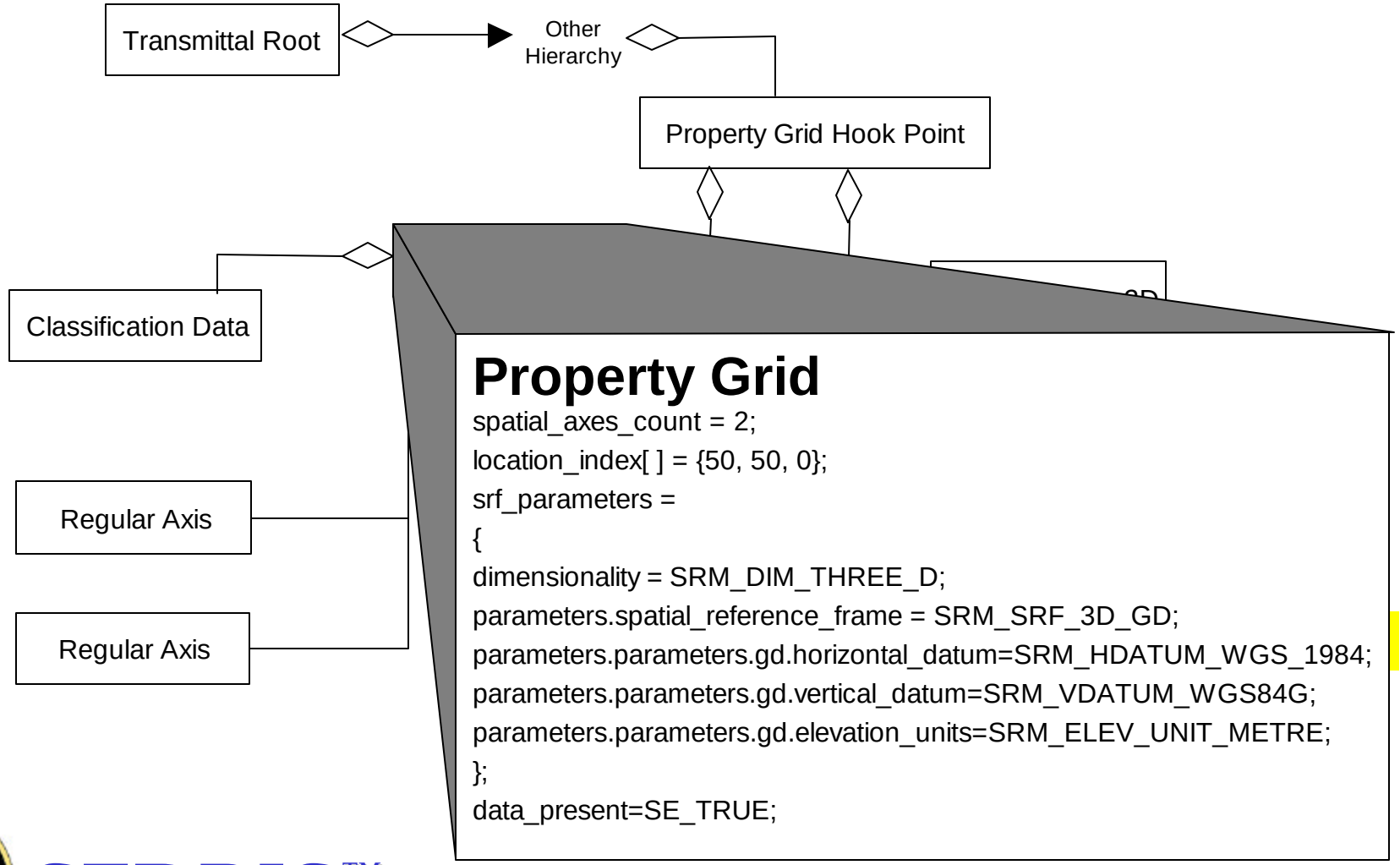
Example: Sea Surface Temperature
(cont'd)



diagram

Example: Sea Surface Temperature
(cont'd)



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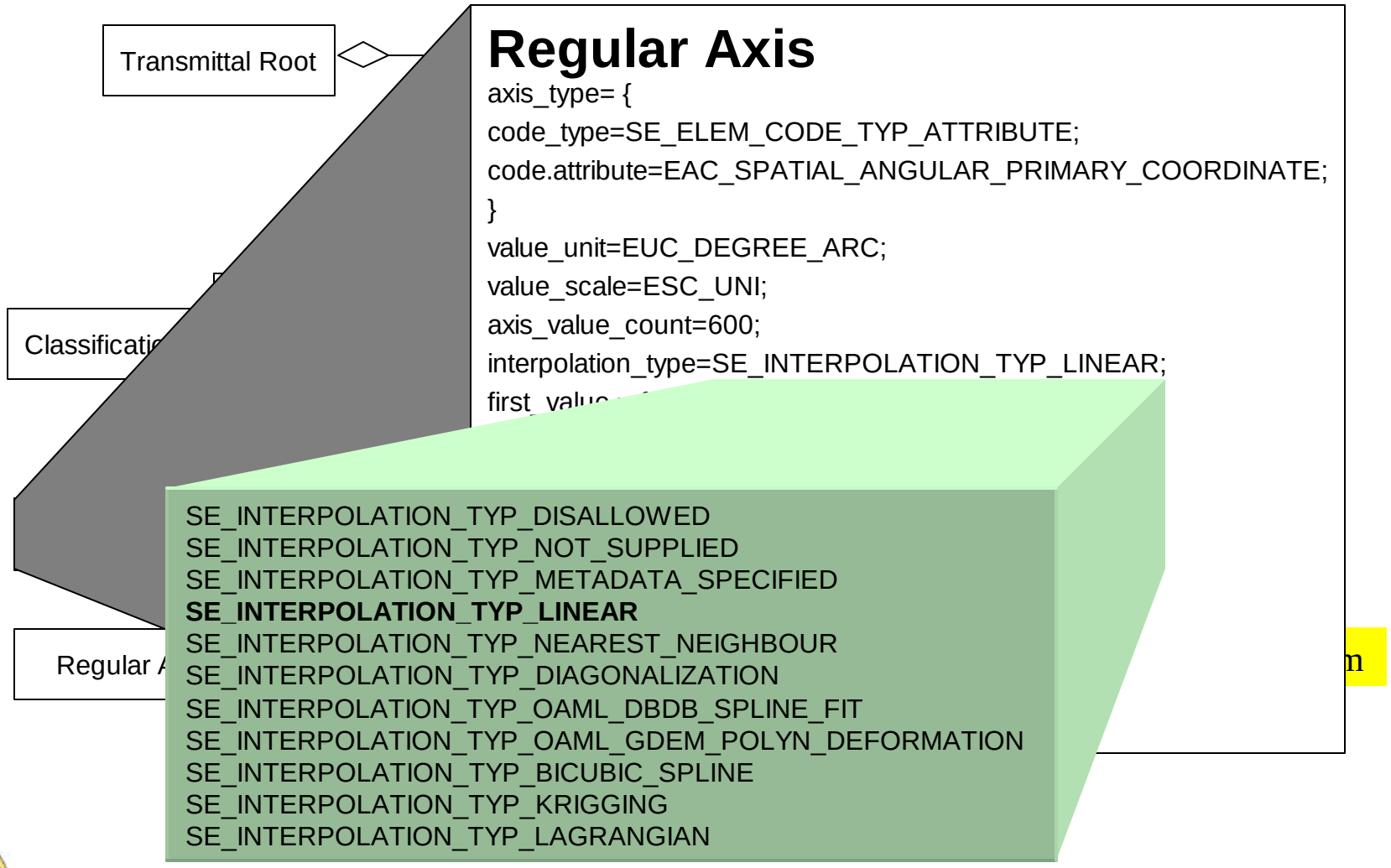
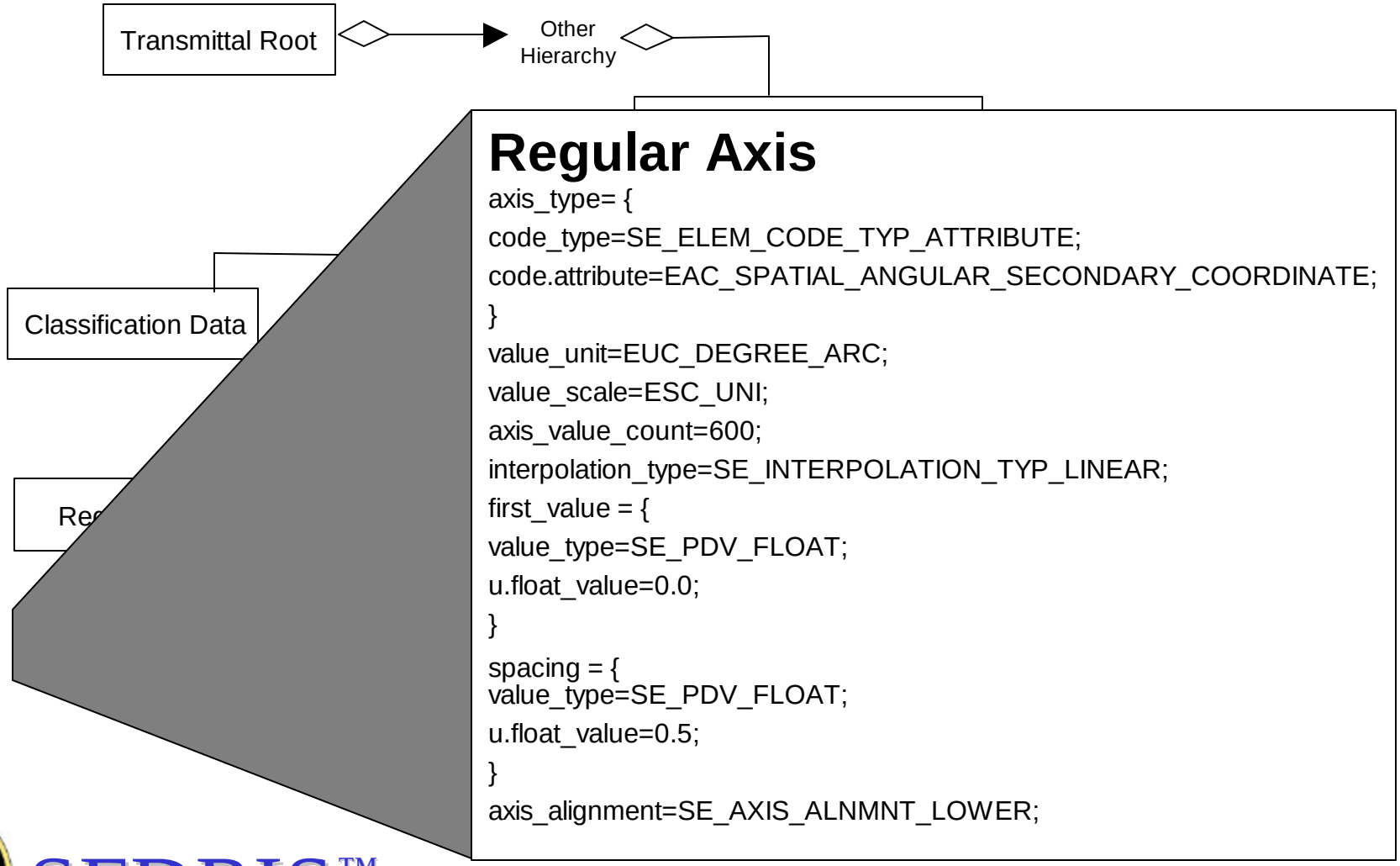
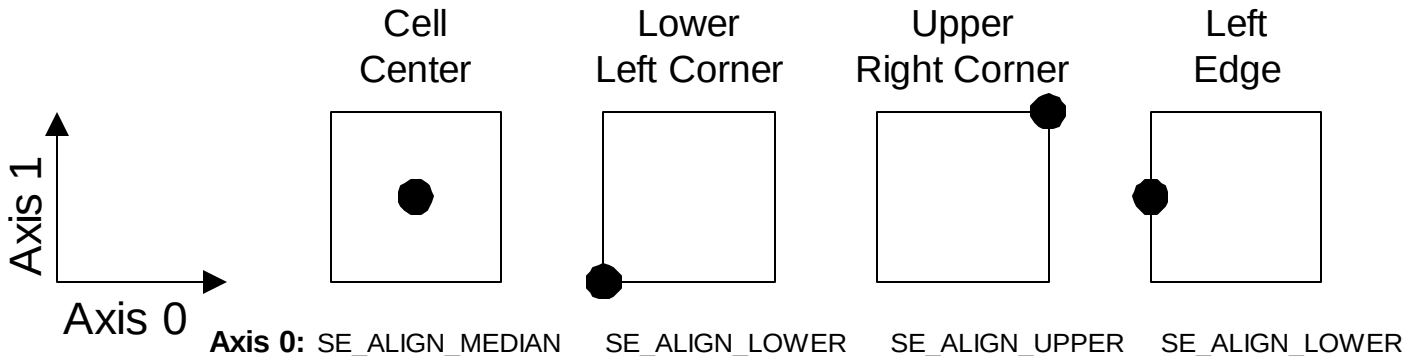
Example: Sea Surface Temperature (cont'd)



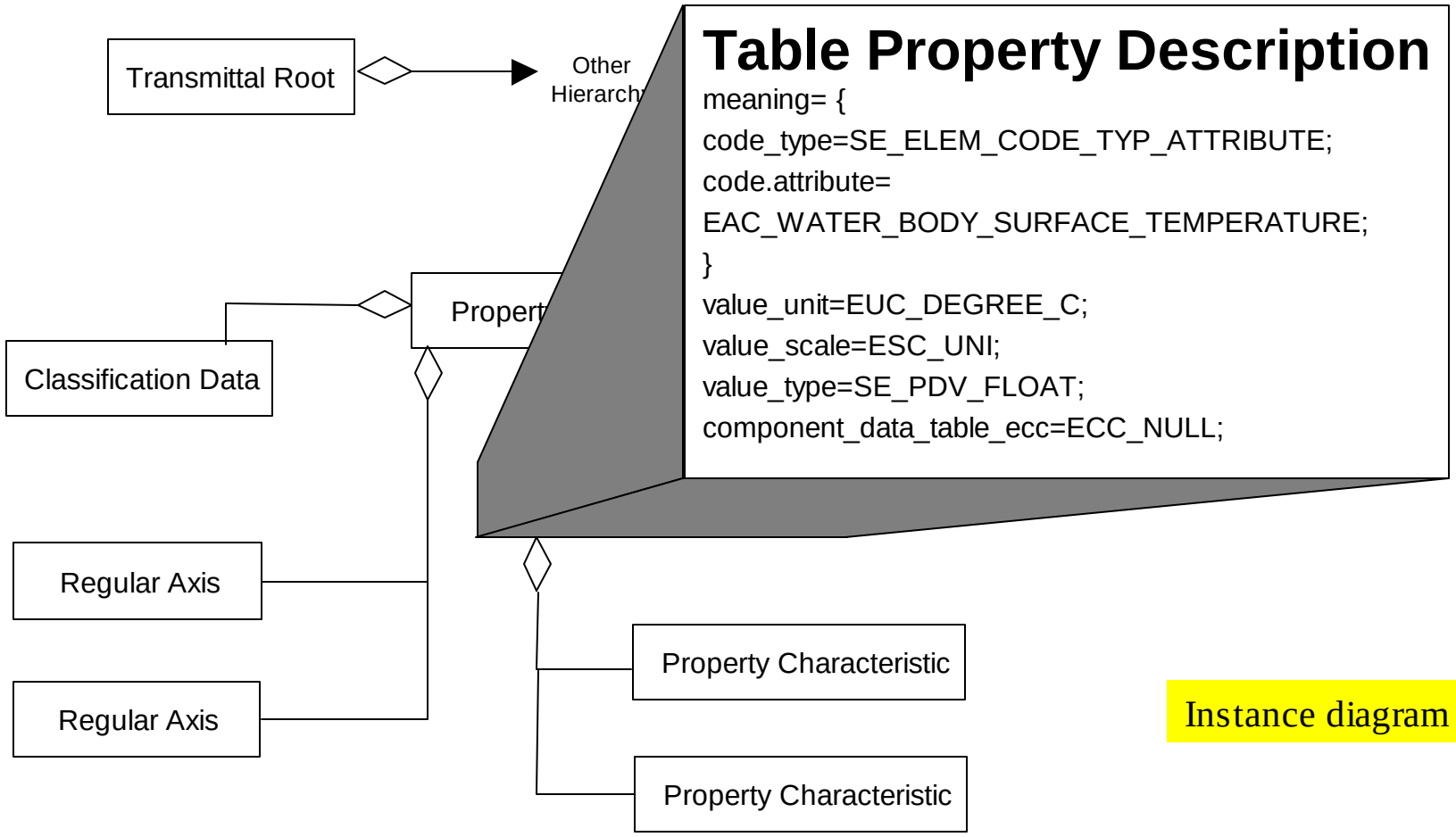
Example: Sea Surface Temperature
(cont'd)



Specifying Axis Cell Alignment

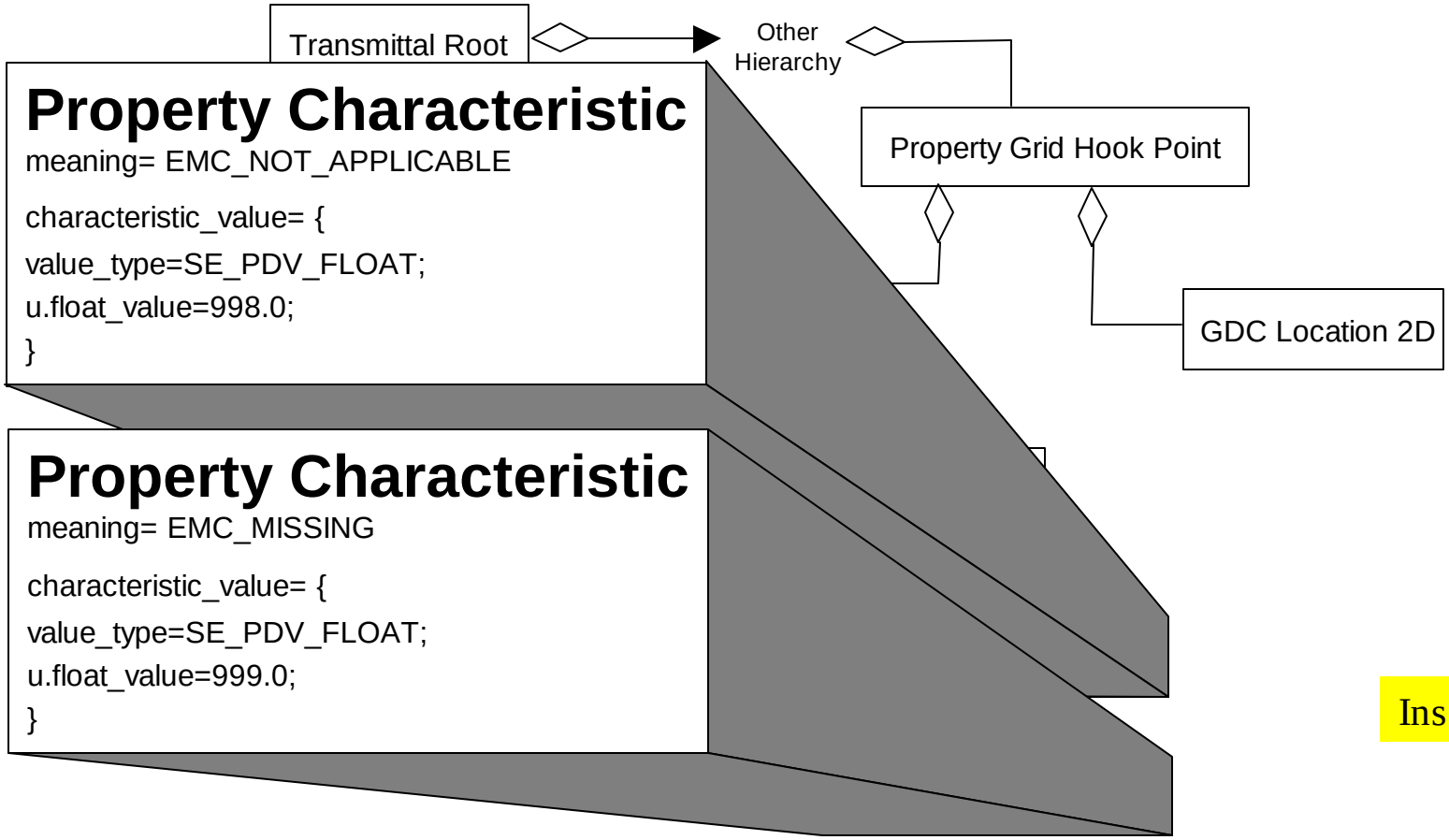


Example: Sea Surface Temperature



Instance diagram

Example: Sea Surface Temperature
(cont'd)



Instance diagram

Property Characteristic Enumerants

- Sentinels - information about specific Data Cells
  - EMC_NOT_APPLICABLE
    - This value indicates that data is not applicable for the data cell
  - EMC_MISSING
    - This value indicates that no data is available for the data cell
  - EMC_VALUE_WITHHELD
    - This value indicates that data is withheld for the data cell
  - EMC_POSITIVE_OVERFLOW, EMC_NEGATIVE_OVERFLOW
    - The values which represent +/- infinity
  - EMC_POSITIVE_UNDERFLOW, EMC_NEGATIVE_UNDERFLOW
    - The values which are too small to represent
  - EMC_UNDESIGATED, EMC_MULTIPLE
    - “exceptional” cases

Property Characteristic Enumerants (cont'd)

- Information about all the Data Cells
  - EMC_CONSTANT_VALUE
    - The given signature item has this value in every data cell
  - EMC_MAX_VALUE, EMC_MIN_VALUE
    - The "legal" limits for the data item
  - EMC_UPPER_BOUND, EMC_LOWER_BOUND
    - Bounds for data in this specific table/grid
  - EMC_TOLERANCE, EMC_MEASUREMENT_ERROR, EMC_SIGNIFICANT_DIGITS
    - Useful information if you convert units etc.

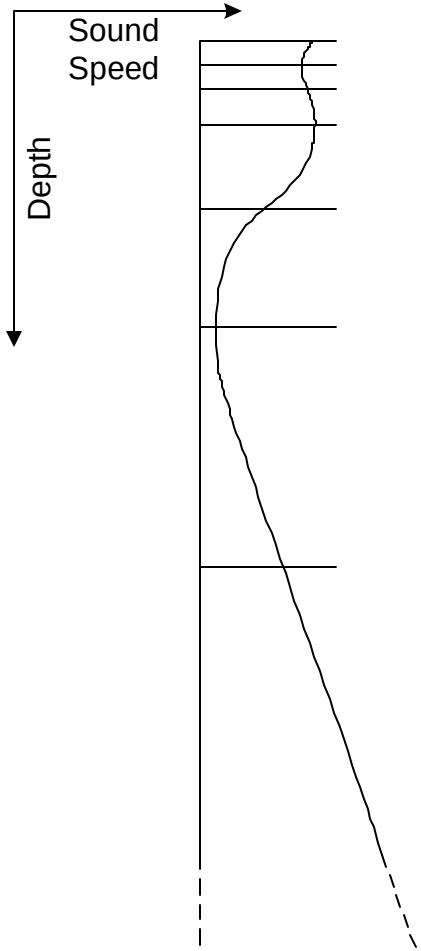
Data Table Compression

- Part of the STF implementation of the API
- Compression *per* Data Signature Item
- Requires
  - EMC_UPPER_BOUND, EMC_LOWER_BOUND, and EMC_TOLERANCE
    - The tighter the bounds and looser the tolerance, the better the compression.
- Compression Algorithm is similar to GRIB
- STF implementation also “compresses” EMC_CONSTANT_VALUE signature items

Where is the Cell Data?

- Not explicit in the DRM
- Accessed *via* the API
  - Data insertion
    - SE_PutDataTable()
    - SE_PutDataTableSubExtent()
    - SE_PutElementOfDataTable()
    - SE_PutElementOfDataTableSubExtent()
    - SE_PutPackedDataTable()
    - SE_PutPackedDataTableSubExtent()
  - Data extraction
    - SE_GetDataTable()
    - SE_GetElementOfDataTable()
    - SE_GetPackedDataTable()

Sound Speed Profile: Irregular Axis



Axis

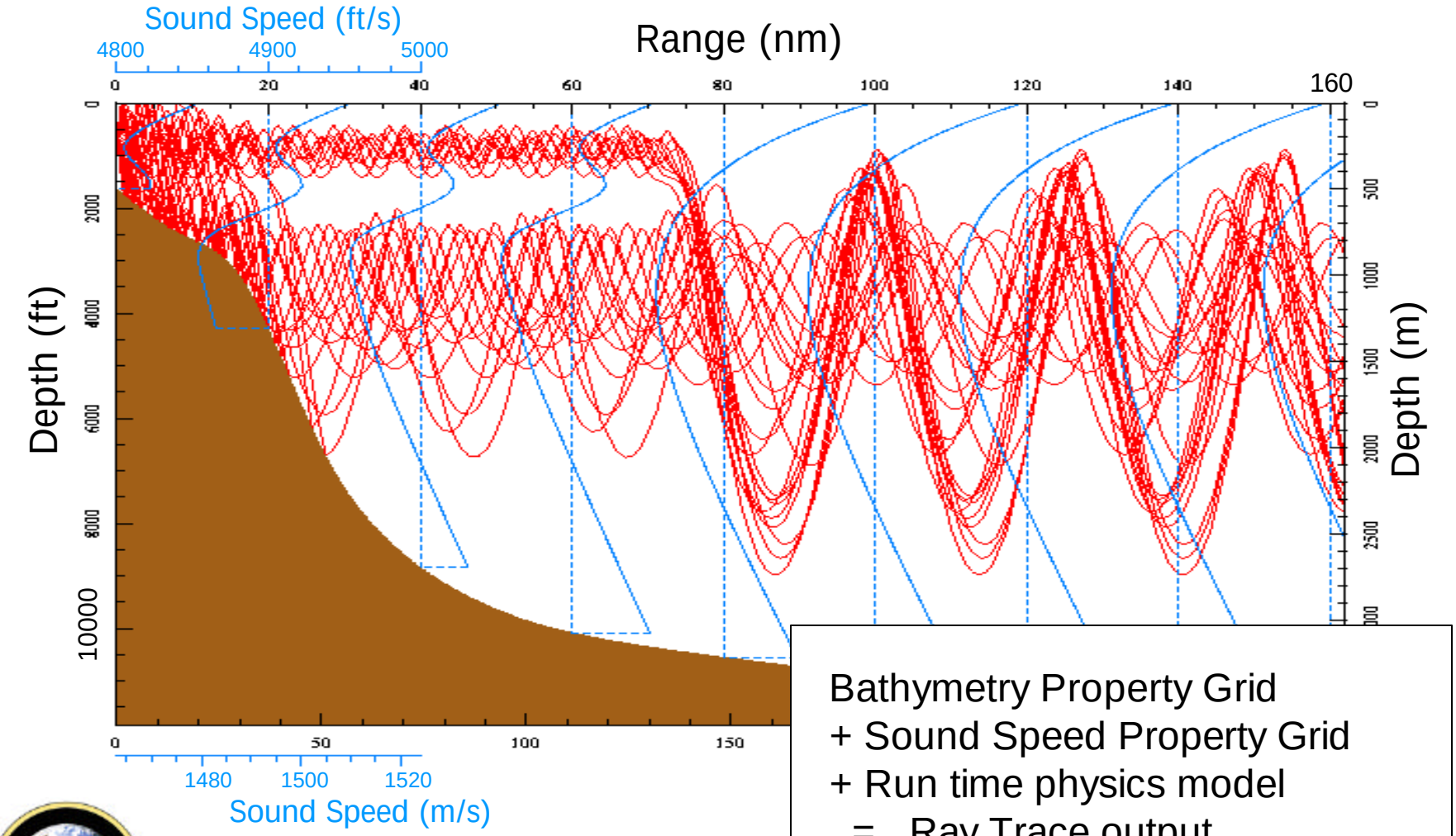
SE_Axis_Type axis_type;
EDCS_Unit_Code value_unit;
EDCS_Scale_Code value_scale;
SE_Short_Integer_Positive axis_value_count;

Irregular Axis

SE_Property_Data_Value axis_value_array[ ];
SE_Interpolation_Type interpolation_type;

```
axis_value_array[ ] = { 0, 10, 20, 30,
                        50, 75, . . . }
```

Physics Based Modeling: Acoustic Ray Trace



Bathymetry Property Grid
+ Sound Speed Property Grid
+ Run time physics model
= Ray Trace output

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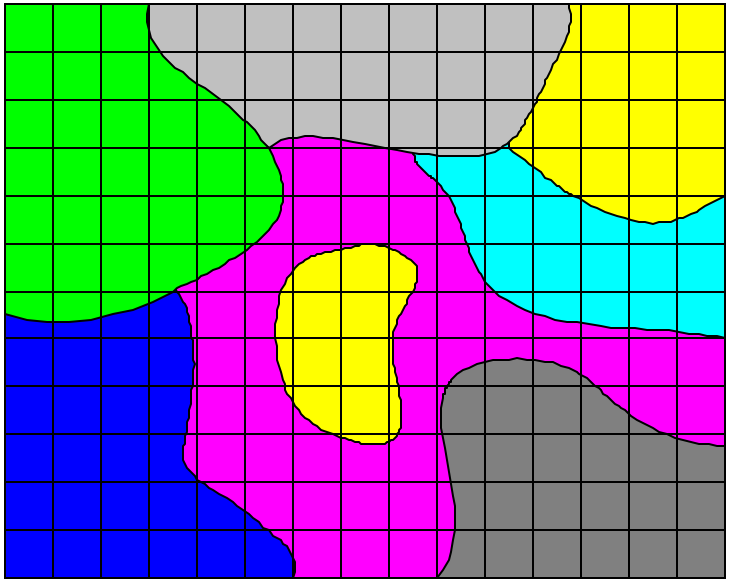
A 3-D Property Grid

- Grid of Sound Speed Profiles
  - Axes
    - Profile location:
      - Latitude Axis
      - Longitude Axis
    - Profile depth dependence
      - Depth Axis
  - Example
    - Thermodynamic Ocean Prediction System (TOPS)

Nested Property Grids



- Use Case
  - Many Grid Cells
  - Few Region Types
    - Each Region a Grid or a Property Table
  - Examples
    - Climatological Sound Speed Profile Regions **(ECC_WATER_BODY_SOUND_SPEED)**
    - Bottom type parameters **(ECC_BOTTOM_CHARACTERISTIC)**

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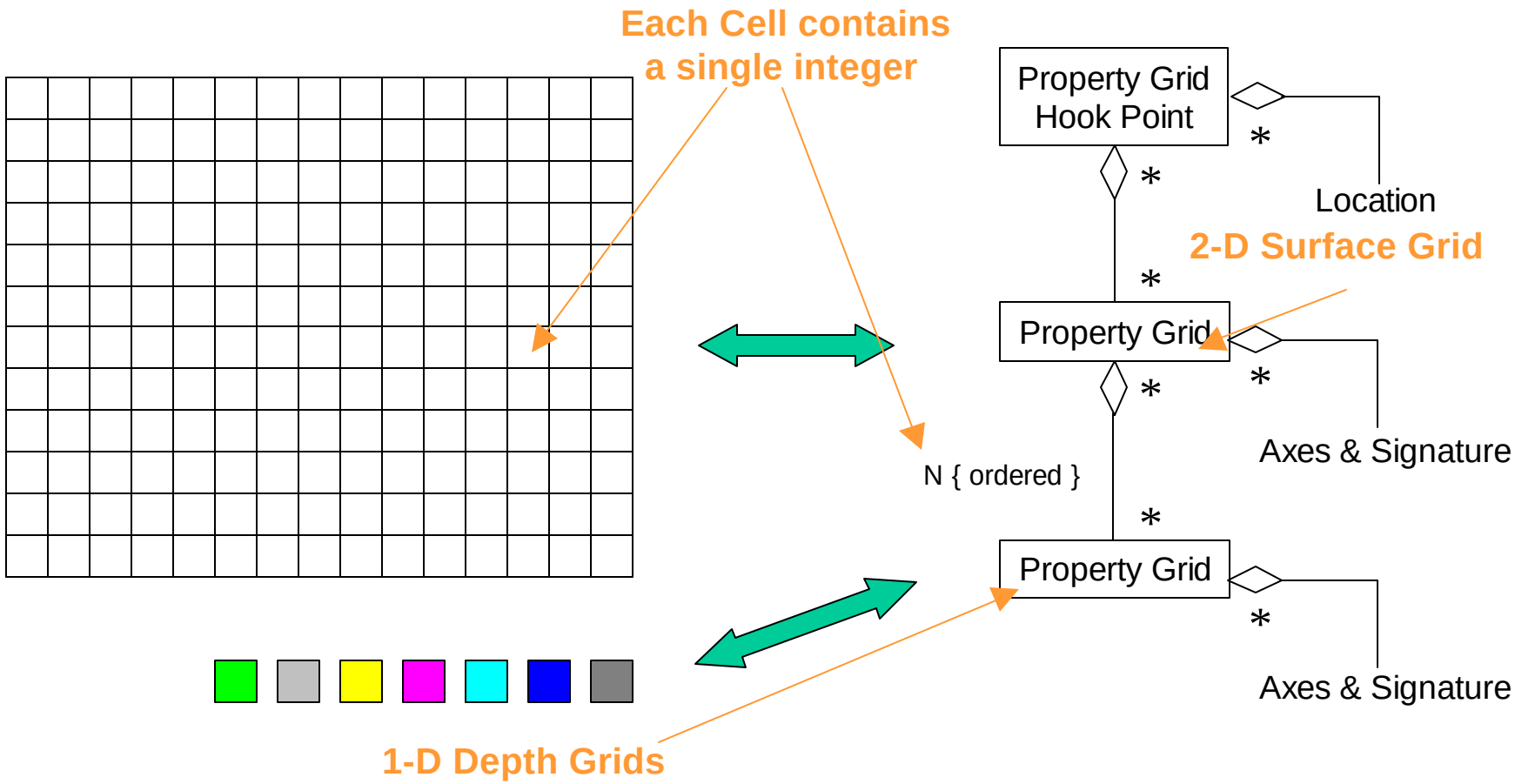
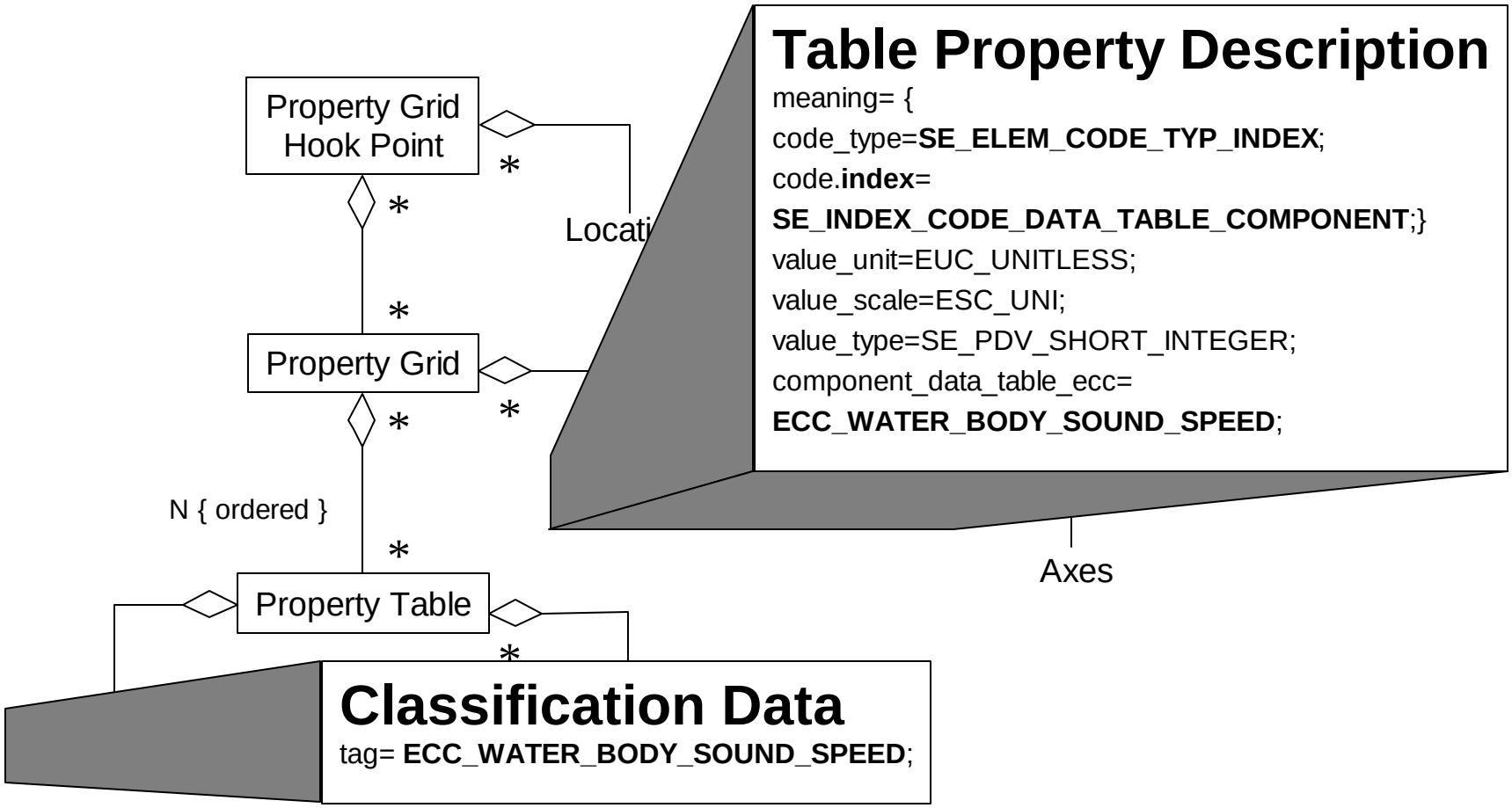
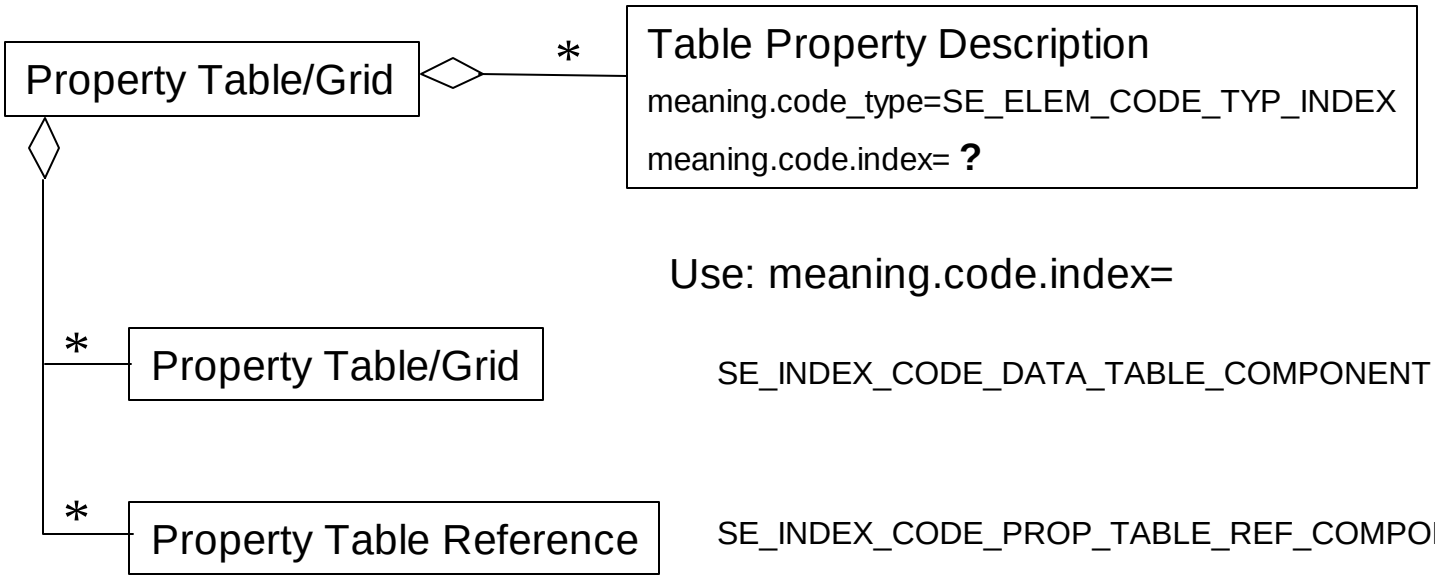
Nested Property Grids (cont'd)



Nested Property Grids (cont'd)



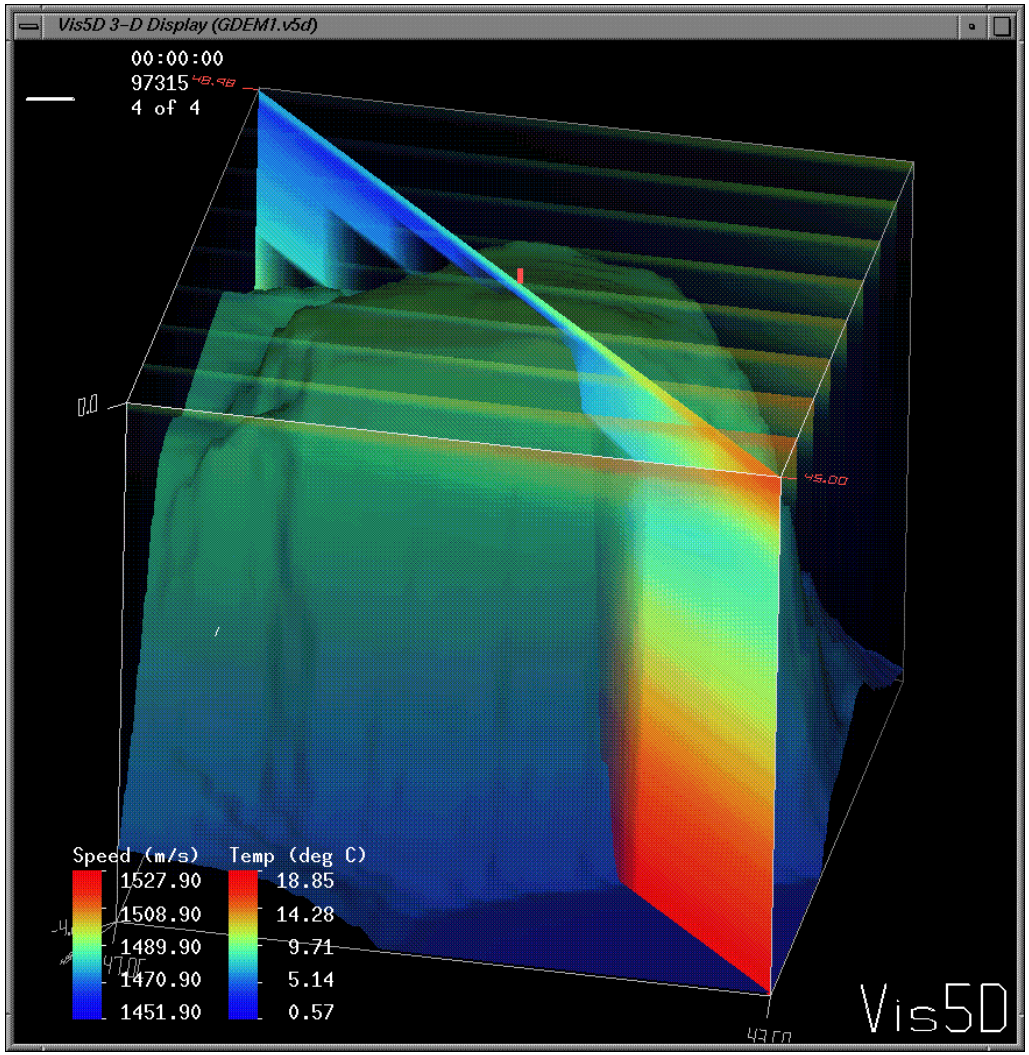
Other Table Nesting Capabilities



For cell values in the Data Table Library: SE_INDEX_CODE_DATA_TABLE_LIBRARY

Ocean Acoustic Propagation Modeling

- Ocean volume sound speed
- Bottom bathymetry
- Bottom absorption parameters
- Surface roughness as a function of wind speed
- **All modeled by Property Grids or Property Tables**



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Outline

- Tabular Data
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- Gridded Data
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- Ocean “Features”
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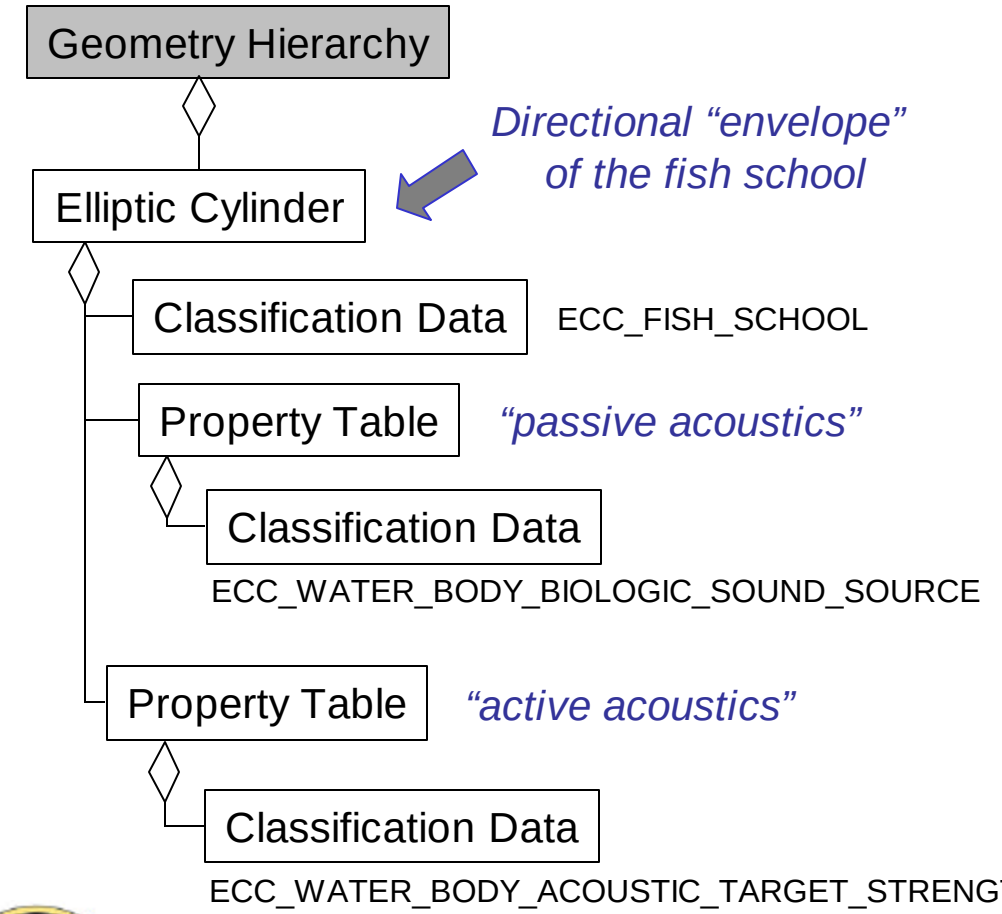
Ocean “Acoustic Feature” Examples

Example: Fish School acoustic characteristics



Similar Elliptic Cylinder Models for:

- -Whale pods
- -Cold water eddy

Similar Ellipse Model

- -Kelp beds
- -Shrimp beds
- -Rain squalls
- - etc.

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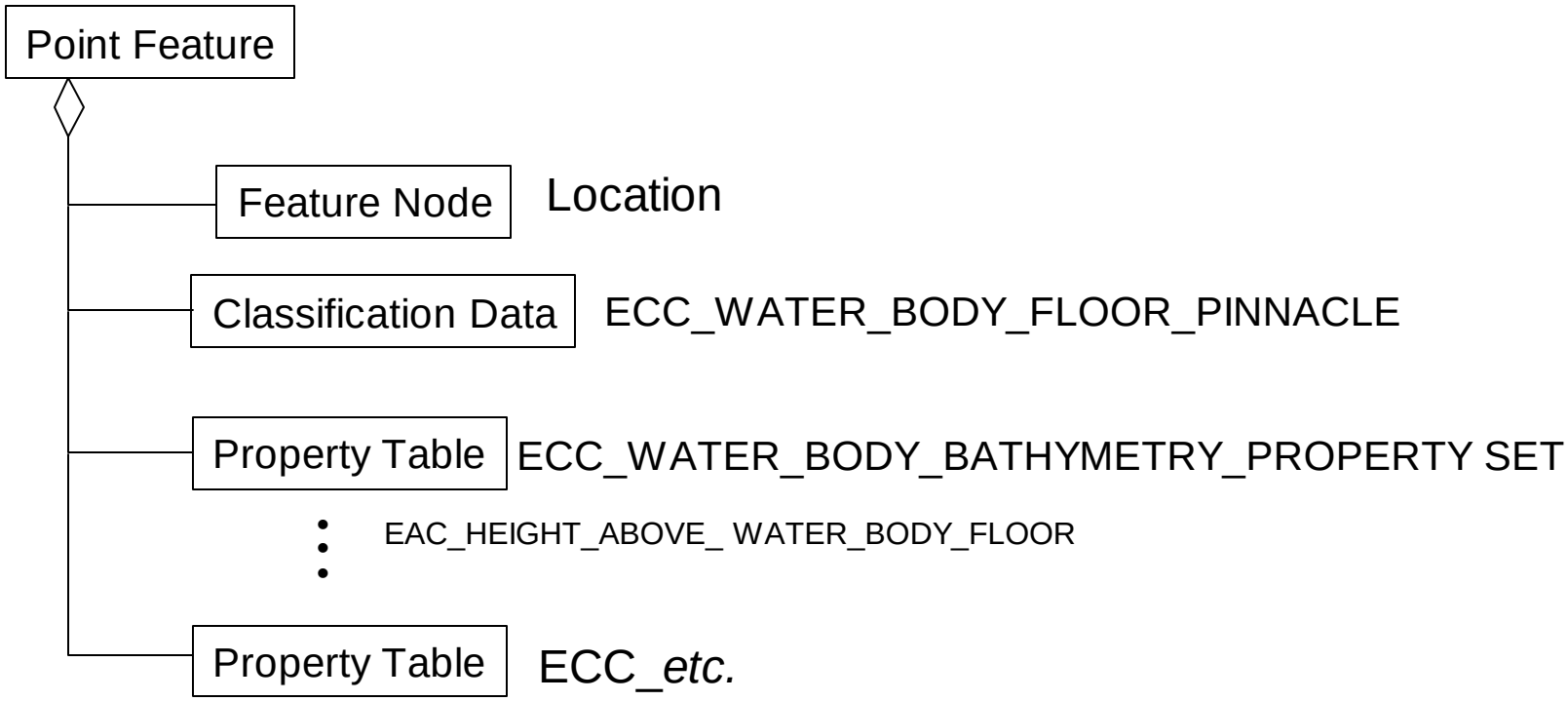
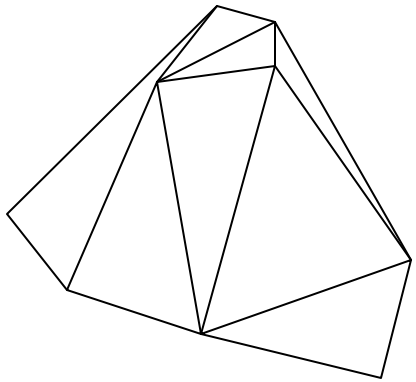
Pinnacle:
As Feature



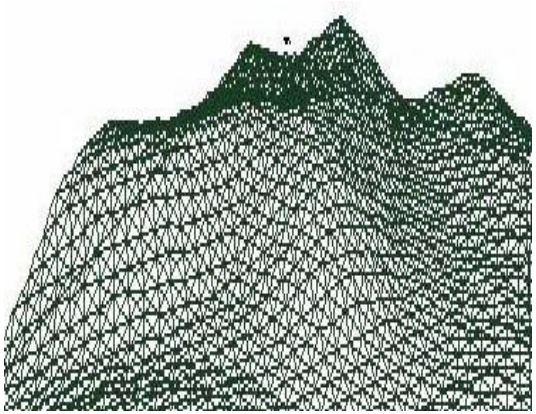
Instance diagram

Pinnacle:
As Polygon Geometry



With:
Classified Union of Geometry
Material Characteristics as
Property Values
and/or
Property Tables

Pinnacle:
As Property Grid



Cells:

Bathymetry
and
Other Material Characteristics
Pointers to scattering tables
(as Property Table References)

Outline

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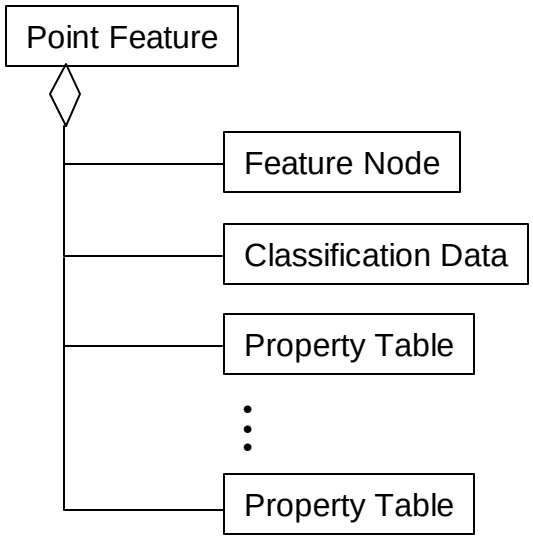
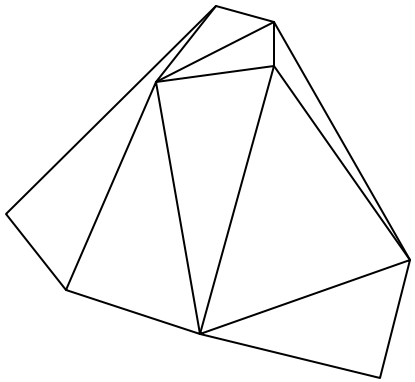
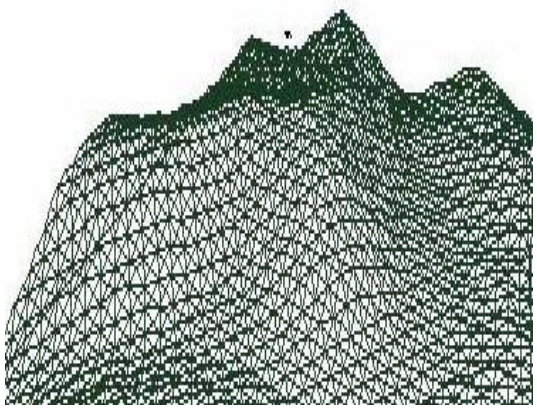
Pinnacle:
Alternate Representations

Feature ⟷ Geometry ⟷ Property Grid







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Hierarchical Organization

- Alternate Hierarchy
  - and associated features
- Spatial Index
  - Sparse grids
- Time Related
  - Time point, Interval, Season,…
- Classification Related
- Level of Detail
- State Related

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SEDRIS Data Representation Model Support Summary

- Flexible Data Tables Constructs
- Flexible Gridded Data Constructs
- Coordinate System Support
- Properties
  - Attribute classification scheme encompasses METOC designations
- Hierarchical Organization
- Full meta-data capability

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