Model Driven Development of ArcGIS Geodatabases with UML 2


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The value of modeling

- Manage complexity
- Plan and mitigate risk
- Facilitate communication
Typical request for modeling GDB design…

“I need a UML profile of the Geodatabase schema so I can:

- Round-trip the design of our geodatabase
- Trace our geodatabase design to upstream corporate models – requirements, goals etc.
- Communicate geodatabase designs to non-GIS peers like enterprise architects, analysts etc.”
Legacy workflow for ArcGIS modelers

UML & enterprise modeling tools
- Lose traceability
- Manual rework
- Synch issues

Visio, ArcDiagrammer

ArcGIS, ArcCatalog

Analysis & Abstract Data Modeling

Geodatabase Design

Application Architecture

Geodatabase Implementation

Application Implementation

Deploy
Proposed workflow with automation

Analysis & Abstract Data Modeling → Geodatabase Design: ArcGIS UML Profile → Generate XML Workspace Schema → Import to ArcGIS → Deploy

Automate Transform

Eliminate or Reduce Manual Rework

Import XML Workspace Schema

Automate
UML Profile for ArcGIS Schema

- Modern ArcGIS profile initially developed by CSIRO, based on UML 2
- Profile used in CSIRO’s projects to align existing geodatabases to standards by ISO/TC 211, OGC
- Supports visual modeling of geodatabase feature types using simple UML Class models
- Similar to original UML 1.x profile for ArcGIS CASE Tools
- Overcomes limits of original UML profile. For example, supports specification of spatial reference information.
The ArcGIS Workspace is represented by UML a Package, stereotyped as: «ArcGIS»

Workspace contains one or more feature dataset packages

Use unstereotyped sub-packages as organizational “folders”
UML Profile for ArcGIS Schema: Feature Dataset

- Container for custom feature types
- Spatial reference linked via tagged value
A stereotyped UML Class
- «Point»
- «Polyline»
- «Polygon»
- «MultiPatch»

UML model pattern automatically adds indexes, OBJECTID field

Usually suppress display of system-level fields (OBJECTID etc)
A stereotyped UML Class:
«ObjectClass»

- OBJECTID : esriFieldTypeOID
- OBJECTID_IDX
A UML Attribute stereotyped as «Field»

Field stereotype used in tables and classes

Attribute type is one of the predefined Esri data types (esriFieldTypeString etc.)
An unstereotyped UML Class. Useful for modeling common concepts shared by numerous features.

- **UML property:** IsAbstract = True
- **Inherited fields copied down to child classes**
- **Multiple Inheritance OK!**
UML Profile for ArcGIS Schema: Abstract Class

Building
  + StreetAddress : esriFieldTypeString

```
<DataElement xsi:type="esri:DEFeatureClass">
  <CatalogPath>FD:Features/FC=House</CatalogPath>
  <Name>House</Name>
  <DatasetType>esriDTFeatureClass</DatasetType>
  <Fields xsi:type="esri:Fields">
    <FieldArray xsi:type="esri:ArrayOffield">
      <Field xsi:type="esri:Field">
        <Name>Material</Name>
        <Type>esriFieldTypeString</Type>
      </Field>
      <Field xsi:type="esri:Field">
        <Name>StreetAddress</Name>
        <Type>esriFieldTypeString</Type>
      </Field>
    </FieldArray>
  </Fields>
</DataElement>
```
A stereotyped UML Class that inherits from a feature class

Use the SubtypeCode tag for a unique identifier, or copy down the SubtypeField attribute

Coded Value Domains can specify default field values
UML Profile for ArcGIS Schema: Relationship Class

- A stereotyped UML Class that inherits from a feature class
- Use binary Association if relationship is unattributed
- Use Association Class for attributed relationships
- Origin Class is source (starting) element
A stereotyped UML Class with tagged values

Captures a predefined, ArcGIS-supported coordinate system for the workspace

Link to any feature or table class or «FeatureDataset» package

Multiple spatial references per workspace OK

```
<uml: Stereotype>
<uml: TaggedValue Name="CoordinateSystemType" Value="GeographicCoordinateSystem" />
<uml: TaggedValue Name="HighPrecision" Value="true" />
<uml: TaggedValue Name="LeftLongitude" Value=-180 />
<uml: TaggedValue Name="MOrigin" Value=-100000 />
<uml: TaggedValue Name="MScale" Value=10000 />
<uml: TaggedValue Name="MTolerance" Value=0.001 />
<uml: TaggedValue Name="WKID" Value=4326 />
<uml: TaggedValue Name="WKT" Value=<memo> />
<uml: TaggedValue Name="XOrigin" Value=-399.99999999999989 />
<uml: TaggedValue Name="XYScale" Value=1000000000.0000001 />
<uml: TaggedValue Name="XYTolerance" Value=8.9831528411952133E-09 />
<uml: TaggedValue Name="YOrigin" Value=-399.99999999999989 />
<uml: TaggedValue Name="ZOrigin" Value=-100000 />
<uml: TaggedValue Name="ZScale" Value=10000 />
<uml: TaggedValue Name="ZTolerance" Value=0.001 />
```
UML Profile for ArcGIS Schema:
Other types in profile

- Geometric Network
- Topology
- Raster Dataset
- Raster Band
- Raster Catalog
- Coded Value Domain
- Range Domain
- Spatial Index
- Attribute Index
- Relationship Rule
- Connectivity Rule

UML Package

«ArcGIS Stereotype»
UML Class

UML Association
Example: Relate Houses to Smart Meters. Package Structure
Example: Relate Houses to Smart Meters. Package Structure
Example: Relate Houses to Smart Meters. Features
Example: Relate Houses to Smart Meters. ArcCatalog (10.1)
Leveraging legacy models...
Reuse existing CASE models!

- Commonality between UML 2 profile and legacy CASE tools approach facilitates knowledge transfer.
- CASE tools profile uses UML 1.x. An upgrade to UML 2.x is relatively painless.
- Automated upgrade feasible.
Profile upgrade: Examples of mapping rules

- **GeometryType** tag (Point, Polyline, Polygon etc.) → stereotyped Class

- **Subtype** Association → stereotyped Generalization

- **Table** → stereotyped Class (ObjectClass)

Complete profile mapping: [http://www.sparxsystems.com/arcqis/visio](http://www.sparxsystems.com/arcqis/visio)
Upgrade feature class, subtypes and relationship class
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Future work

The UML 2 profile provides good (not yet total) schema coverage. Future items include:

1. Modeling of Annotation and Dimension feature classes. (Binary data exchange with ArcGIS required for schema generation.)
2. UML $\leftrightarrow$ GML model transformations
3. ArcGIS Platform specific $\rightarrow$ UML Platform independent model transformations
Modeling geodatabase schemas, using an open standard (UML) is both feasible and beneficial.

Use the UML model to:

1. **Communicate** spatial components to non-spatial stakeholders
2. **Generate** the geodatabase schema for ArcGIS 10.0 and 10.1
3. **Document** existing geodatabases (reverse engineer designs)

Don’t discard your existing CASE tools models – upgrade and reuse them.

*Be vocal about any profile extensions you need.*
References

- **Modeling an ArcGIS geodatabase with UML**, Sparx Systems
- **Building Geodatabases with CASE Tools**, Esri Inc. (Original UML profile for ArcGIS)
- **Migrate existing models from CASE tools**, Sparx Systems
- **UML 2 modeling tool for ArcGIS 10.x**, Sparx Systems
- Background on **The UML**, and **The OMG**