ESRI Data Modeling for Petroleum

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Overview

- **Topics**
  - Data model concepts with focus on Petroleum
  - Basic data model implementations
  - 3D applications specific to petroleum

- **Goals**
  - Review corporate data holdings
  - Get you started with ESRI data modeling for petroleum
  - Review and define specific elements of the PPDM data model
Models and reality

A model is a representation of a system on which simulations are run from inputs and predictions are made.

A map is a scale model of geographic reality.

A GIS data model is a set of representation objects, such as points, lines, polygons, and rasters, capturing the behavior of a system, such as network flow.
Map features drawn as points, lines, and areas

Small objects are drawn as points
Objects long but not wide are drawn as lines
Objects with extent are drawn as areas
Map scale determines representation

1 : 5,000
Buildings are polygons
Roads drawn by curb lines
All road names are labeled

1 : 25,000
Only prominent buildings drawn
Roads drawn by centerlines
Selective labeling of roads

1 : 50,000
Important buildings drawn as landmark symbols and labels
Minor roads filtered out

1 : 250,000
Built areas become aggregated into polygons
Only major roads displayed
Key places labeled
The Data Modeling Cycle

Conceptual model
understand information requirements
driven by domain expert

Logical model
use geodatabase elements
driven by GIS expert

Physical model
tune schema for deployment
driven by data administrator

Pilot
Prototype
Production
Levels of data models

- DOT
- US County
- Federal agency

**Project data models**
- Transportation
- Land parcels
- Hydrography

**ArcGIS template data models**
- Object
- Feature
- Topology

**ArcGIS core data model**
- Tables
- Rows
- Types

**Relational database**

**GIS/IT standards**
- ISO
- FGDC
- OGC
- Industry
Data Models that ESRI Produces

Created and owned by user groups and industries

Forestry
Census
IHO S-57
Defence-Intel
Energy Utilities
Geology
Archaeology
Agriculture
Land Parcels
Address

Atmospheric
Water Utilities
Env Reg Facilities
Local Govt
Biodiversity
Health
Pipeline

Transportation
Telecommunications
Hydro

Basemap
Petroleum
Marine

Hydro
ArcGIS Data Models Web site
http://support.esri.com/datamodels

- Over 25 industry-specific data models
- Conceptual and logical diagrams
- Case studies, Tips and Tricks documents
What is Schema?

- In the GIS it is a list of the names of contents and rules stored in the Geodatabase.

- Organized approach of grouping knowledge.

- The concepts and actions that can be revised and used to create a database.
Topics

- Spatial in context
- What is PPDM Spatial
- Value of Spatial to our industry
- Incorporating Spatial into existing and new business processes
Spatial in context

- Storing geometry with attributes in a database
- Spatial Index
- Storing behavior
  - sub-types
  - domain control (reference tables)
  - geometry rules

<table>
<thead>
<tr>
<th>Text</th>
<th>Date</th>
<th>Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>03 27 95</td>
<td></td>
</tr>
</tbody>
</table>
Spatial store methods

ESRI ArcSDE

Binary Schema - BLOB or Long Raw

Oracle Spatial

Geometry Type - SDO_Geometry
The Geodatabase

ArcSDE Geodatabase
Oracle

Personal Geodatabase
Microsoft Jet Engine
Industry Transition

SDE geometry

SDE geometry behavior

SDE geometry behavior model complete
Benefits of Spatial

Improved Data Management

Connectivity

85% Oil and Gas
Is spatial

Master store

Spatial Analysis

Seamless

Advanced Business Applications

SHARED!
Digital Earth Model
Considerations

**Technical**
Spatial as a component of the corporate technical backbone

**People**
GIS specialists and spatial data managers incorporated within the business unit and support framework

**Process**
Procedures defined and implemented to enable the new architecture
SDE connectivity

Application dependent

GIS

Industry Applications

Digital File

SDE
SDE hubs (data vendors, bps)

IHS Canada

IHS International

Partners

PPOMS

GIS

Web GIS

Wood Mackenzie
New processes – not typically available in the standalone database

- Spatial query and analysis
- Data management and validation
- Storing remote Sensing data
- Technical Information Library
- 2D / 3D visualization
Spatial query

- Determine the daily production for all wells connected to a specific pipeline within a specific township range
- Determine the average reserves for all pools wholly or partially within a specific lease
- Others?
Spatial Analysis Recovery factor
(higher oil in place)
Step one - Original Oil in place calculation using the raster calculator. Inputs are oil pay, water saturation, and porosity.

Step two - Recovery factor determined from oil in place, cumulative oil, and spatial drainage area.
Spatial interpolation

- Predict value for each point
Compare predicted to published

- Look at all errors say > -50
- Yellow are wells that production did not meet expectations
- Engineering calculations in a spatial context
Pipeline routing
Pipeline Routing
Incorporate data edits through PPDM
Spatial transactions

- Manage data with relationship to object in SDE
- Apply attributes based on spatial data selection
- Validate using spatial analysis
- Apply geodetic shifts etc.
- Apply topology rules
- Apply behaviors
Nexen PPDM Land data

PPDM metadata

Spatial

Land
Store Remote Sensing data – the raster catalog -

- Master data store with complete metadata
- Images indexed and compressed
- Distribution through SDE
- RS data growing at an exponential rate
Visualization
3D Visualization

- 3D display
- Grids
- Wellbores
- Etc.
Building Blocks

Structured Data

Wells
Seismic
Lease
Production
Reserves
Building Blocks

Structured Data

- Culture
- Geology
- Environment
- Pipeline
- Transportation
- Project

- Wells
- Seismic
- Lease
- Production
- Reserves
Building Blocks

- Structured Data
- Unstructured Data

- Culture
- Geology
- Environment
- Pipeline
- Transportation
- Project
- Wells
- Seismic
- Lease
- Production
- Reserves
How Do I Use a Logical Template?

- You may only need a small part of the overall schema and template to match your data.
Differences between stages of the Data Model evolution:

- **Conceptual** = An overview of abstract ideas that are included in the database

- **Logical** = A design template that can be used to create or instantiate a database using case tools

- **Physical** = The parameters and workflow to fine tune the deployment of the database
The Layer Stack

Thematic groupings of data sets

Atmospheric Boundaries
Weather fronts, temperature boundaries
Vector polygons, lines
Multiple time series polygons can be merged and animated
1:15,000,000/1Km
High/Low pressure front lines and cones of intensity, can be animated
Identify the Key Layers

- Based on your information requirements
- Example: Marine data model
  - Bathymetry
  - Soundings
  - Contours
  - Points
Ten Steps to Designing Geodatabases

Conceptual design

– 1. Identify information products to be produced with your GIS.
– 2. Identify key thematic layers based on information requirements.
– 3. Specify scale ranges and spatial representations for each thematic layer.
– 4. Group representations into datasets.
Ten Steps to Designing Geodatabases

Logical design

- 5. Define tabular database structure and behavior for descriptive attributes.
- 6. Define the spatial properties of your datasets.
- 7. Propose a geodatabase design.
Ten Steps to Designing Geodatabases

- **Physical design**
  - 8. Implement, prototype, review, and refine your design.
  - 9. Design work flows for building and maintaining each layer.
  - 10. Document your design using appropriate methods.
Data Model Implementation
Four ways to build geodatabase schema

Database design
What data?
Spatial reference?
Relationships?
Validation rules?
Geometric networks?
Subtypes?

1. Create schema with ArcCatalog wizards
Four ways to build geodatabase schema

**Database design**
What data?
Spatial reference?
Relationships?
Validation rules?
Geometric networks?
Subtypes?

1. Create schema with ArcCatalog wizards
2. Import existing data
Four ways to build geodatabase schema

1. Create schema with ArcCatalog wizards
2. Import existing data
3. Create schema with CASE tools

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1. Create schema with ArcCatalog wizards
2. Import existing data
3. Create schema with CASE tools
4. Create schema in geoprocessing framework

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Set relationships
- Domains
- Connectivity
- Relationships
- Topology

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Load data
Data Model Templates
Petroleum Data Model Templates

- PPDM
- PPDM Lite
- Pipeline and well data
- Exploration, Conservation
What’s in a Data Model Template?

- A pre-designed schema of Objects
- Feature classes
- Tables
- Relationships
- Domains
- Subtypes
## Electric & Gas Data Model Templates

### Electric Distribution
- ArcFM
- MultiSpeak

### Electric Transmission

### Gas Distribution

### Gas Pipeline
Which template to use?
Typical Model Template Layout

- Points, lines, polygons
  - Well Classes
  - Pipelines
  - Basemap surfaces
  - Linear referencing
Petroleum Templates and Resources

- Logical Models
  - Visio Format
  - GIF Image
- Reference Books
- Tips & Tricks Link
Using a Design Template

Schema Wizard reads repository or template to create a geodatabase
Some Tips and Tricks Online

Data Models Tips and Tricks

Data Submitted: July 21, 2003
Last Modified: June 1, 2004

Summary:
These tips and tricks are designed to help guide in the use of common data model methods and best practices.

Description:

Sok how to manage information about UML and Code Tools. The UML FD file is included to work with some of the data modeling tools. It is located in your Program files, ArcGIS directory in the Code Tools Mixed Tools. The .bills for the Code Tools example are versions of the same files as the .fd file and need to be copied in the same folder together with it.

Supporting files:
- Good Data for Geodatabase - FDF - 116 KB
- Geometry for the Geodatabase - KDF - 221 KB
- Managing ArcGIS Layer Connection Properties - PDF - 465 KB
- ERSI Reference in the Geodatabase - PDF - 360 KB
- Enterprise Schemes - PDF - 89 KB
- How to Import ArcView FDs to the Geodatabase - KDF - 334 KB
- How to Create a Specification for a Microsoft Repository Database or MIF files - FDF - 23 KB
- How to use the 5th version of FDF - 294 KB
Geodatabase Diagrammer
Create graphical representation of geodatabase
Geodatabase Designer

Import / Export Geodatabase Schema

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**Geodatabase Designer v2 (9.x)**

**Download**

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**Summary**

*SOURCE CODE INCLUDED*

Welcome to Geodatabase Designer v2.0.

**Author:** GeoScriptGuy

**File Name:** GeodatabaseDesigner.zip

**Language:** Visual Basic

**Last Modified:** Jul 21, 2005

**Software:** ArcGIS Desktop

**File Size:** 755K

**Downloads:** 3482

**Description:**

This application provides tools to export and import geodatabase schemas using XML. After installation, please view demonstration videos from the start menu. For enhanced functionality, you can use the provided tools to export and import geodatabase schemas using XML.

Please report any bugs using the “Contact Author” hyperlink above.
For More Information

• **ESRI Virtual Campus**
  - Using CASE Tools (for ArcEditor and ArcInfo)
  - Creating, Editing, and Managing Geodatabases for ArcGIS 9
  - Creating and Editing Geodatabase Features

• **ESRI Instructor - Led Training**
  - Modeling Geodatabases Using CASE Tools
  - Geodatabase Design Concepts
  - Building Geodatabases I
  - Building Geodatabases II
For More Information

- **ArcGIS Data Models Web site**
  [http://support.esri.com/datamodels](http://support.esri.com/datamodels)

- **Sample Case Study**
  - within ArcGIS Data Models > Petroleum

- **PPDM Spatial main website**
  - linked from ArcGIS Data Models > Petroleum
  [www.ppdm.org/standards/spatial](http://www.ppdm.org/standards/spatial)

- **PPDM Lite workflow**
  [www.ppdm.org/standards/spatial/ppdm_lite.html](http://www.ppdm.org/standards/spatial/ppdm_lite.html)

- **PPDM Lite online documentation**