ESRI Data Modeling for Petroleum

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(Peter Boorman)

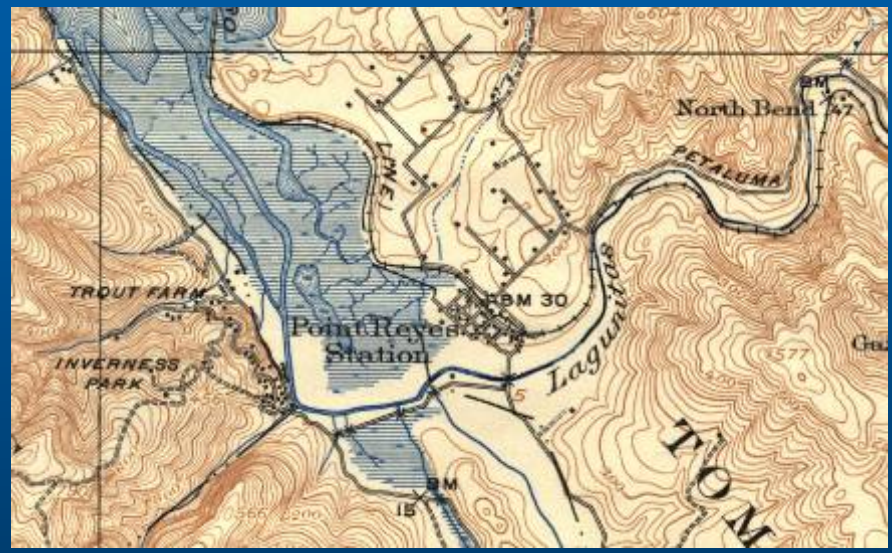
Overview

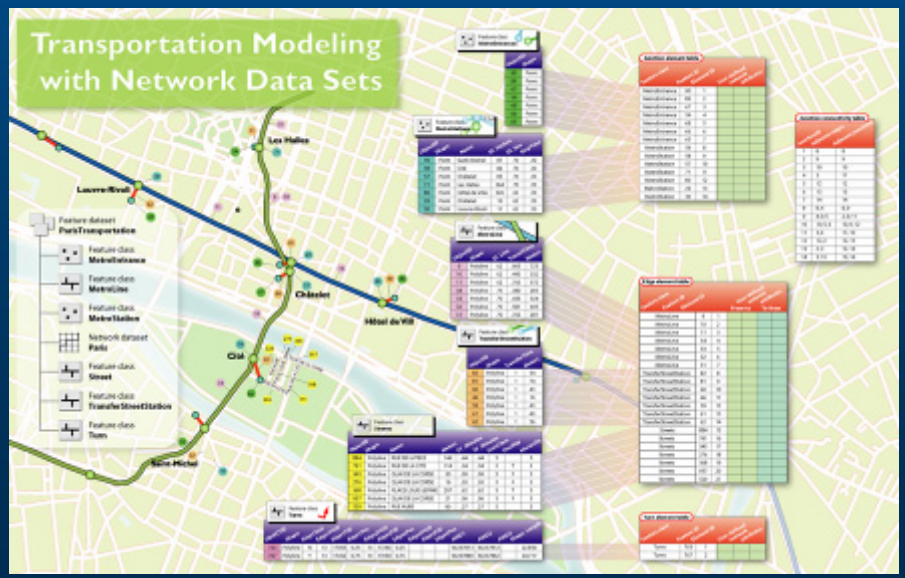
- Topics
  - Data model concepts with focus on Petroleum
  - Basic data model implementations
  - 3D applications specific to petroleum
- Goals
  - Review corporate data holdings
  - Get you started with ESRI data modeling for petroleum
  - Review and define specific elements of the PPDM data model

Models and reality

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

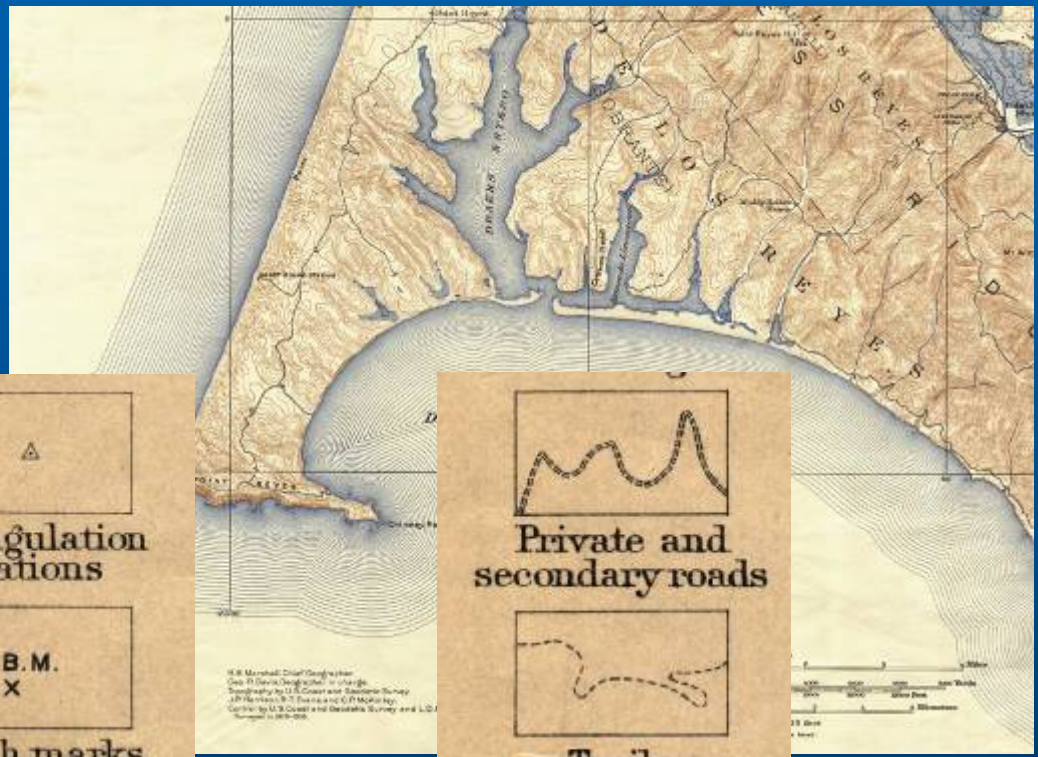
A map is a scale model of geographic reality

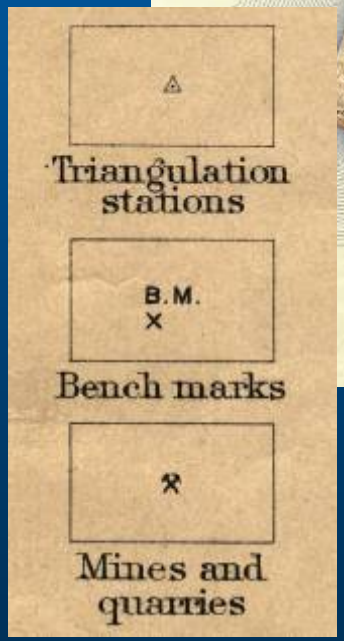




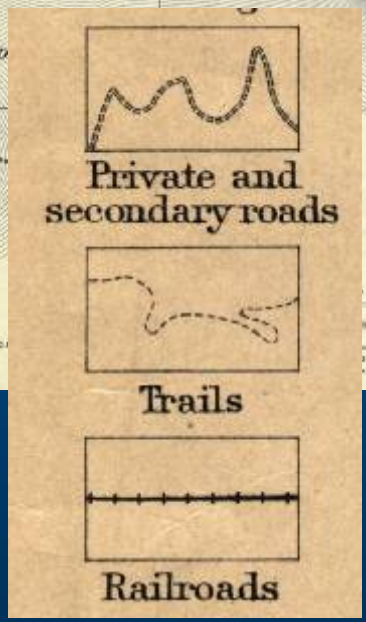
A GIS data model is a set of representation objects, such as points, lines, polygons, and rasters, capturing the behavior of a system, such as network flow.

Map features drawn as points, lines, and areas

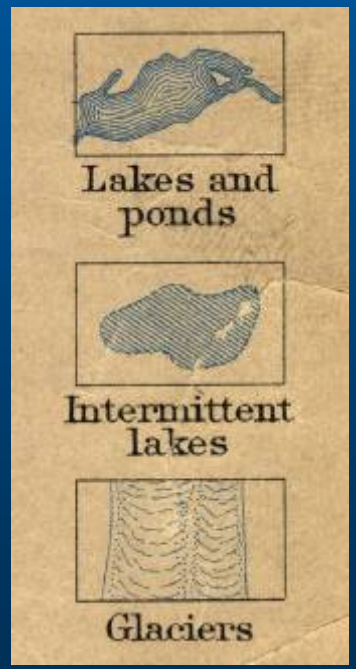




Small objects are drawn as points

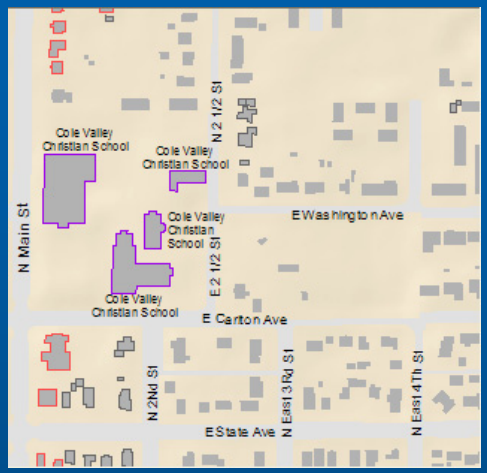


Objects long but not wide are drawn as lines



Objects with extent are drawn as areas

Map scale determines representation

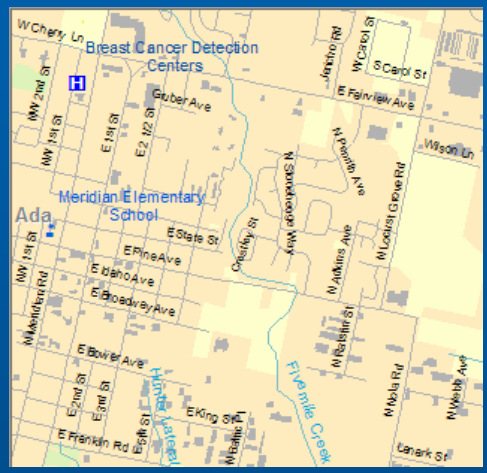


1 : 5,000

Buildings are polygons

Roads drawn by curb lines

All road names are labeled

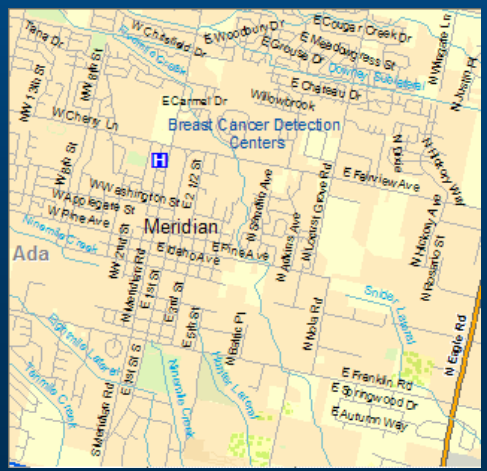


1 : 25,000

Only prominent buildings drawn

Roads drawn by centerlines

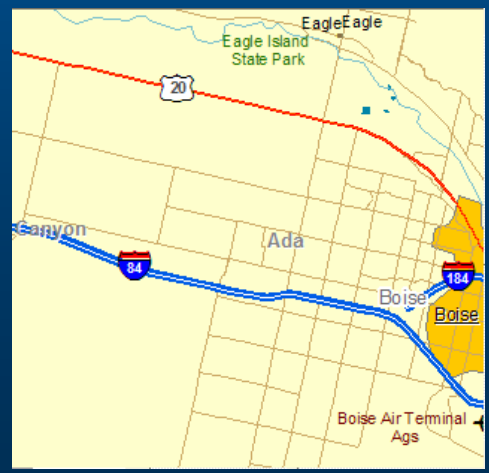
Selective labeling of roads



1 : 50,000

Important buildings drawn as landmark symbols and labels

Minor roads filtered out



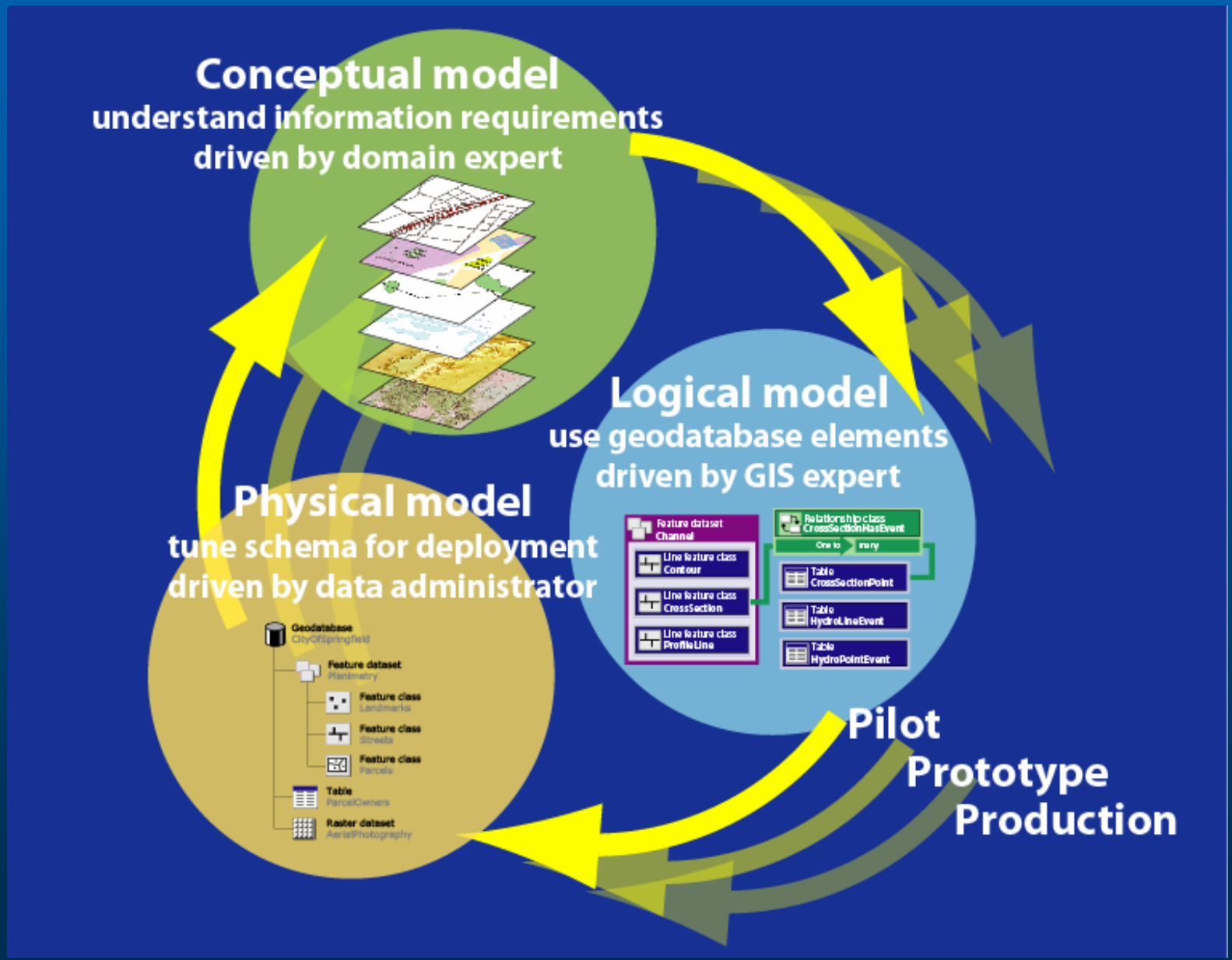
1 : 250,000

Built areas become aggregated into polygons

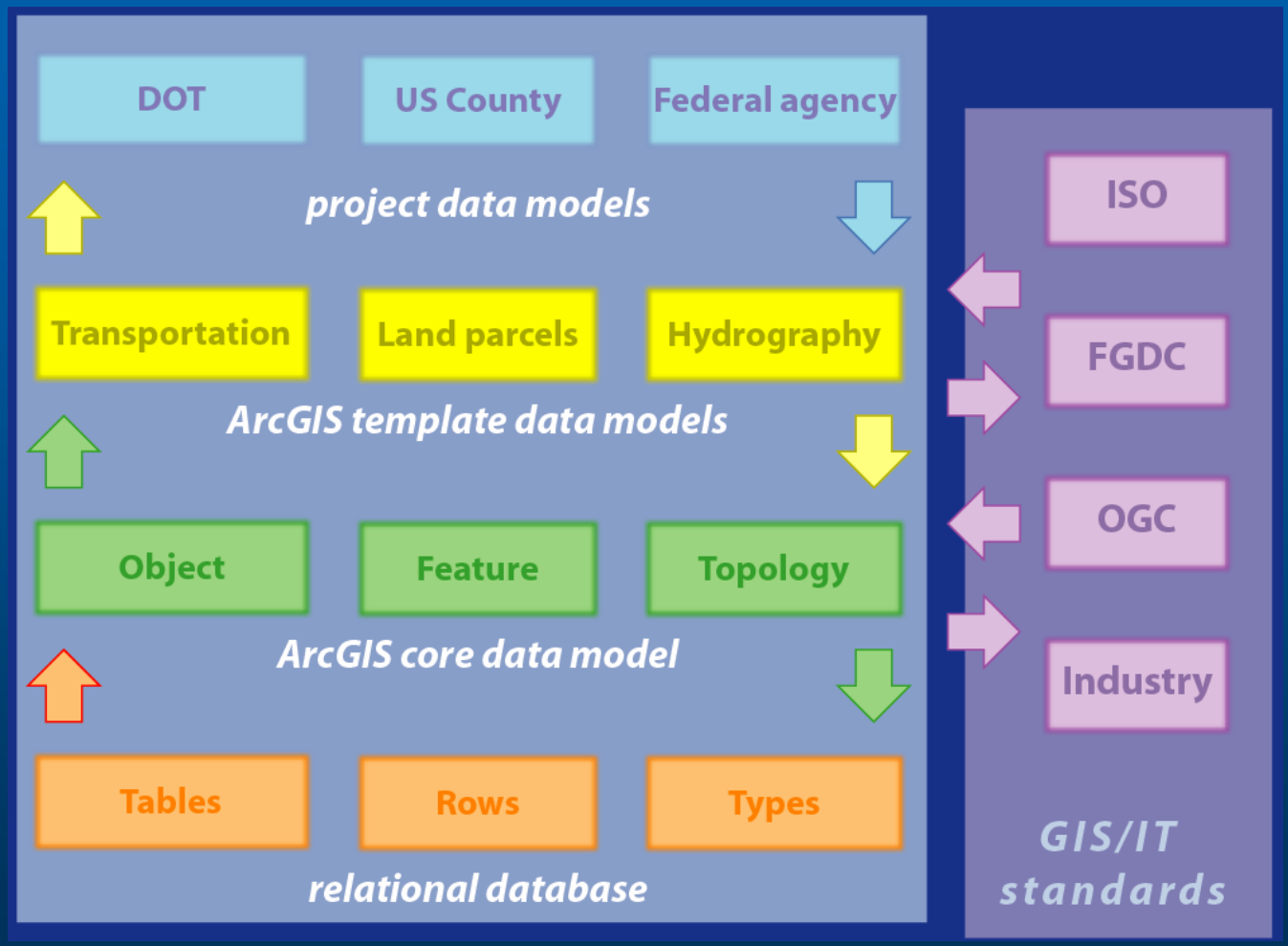
Only major roads displayed

Key places labeled

The Data Modeling Cycle



Levels of data models

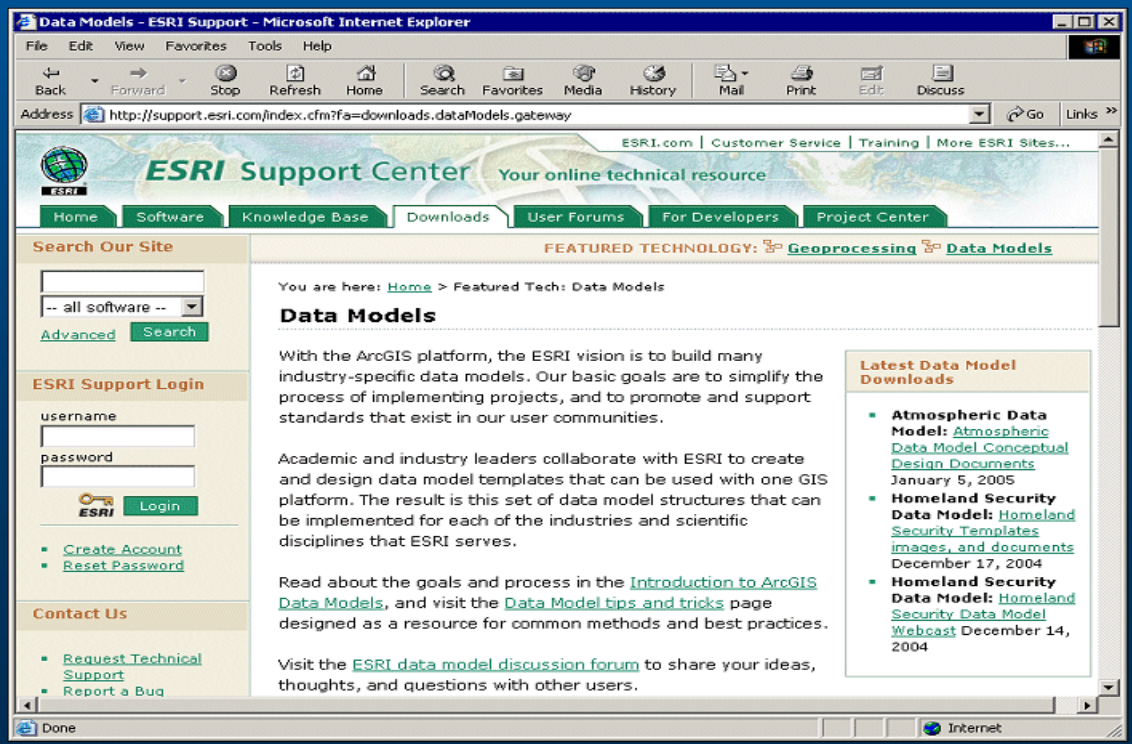


Data Models that ESRI Produces

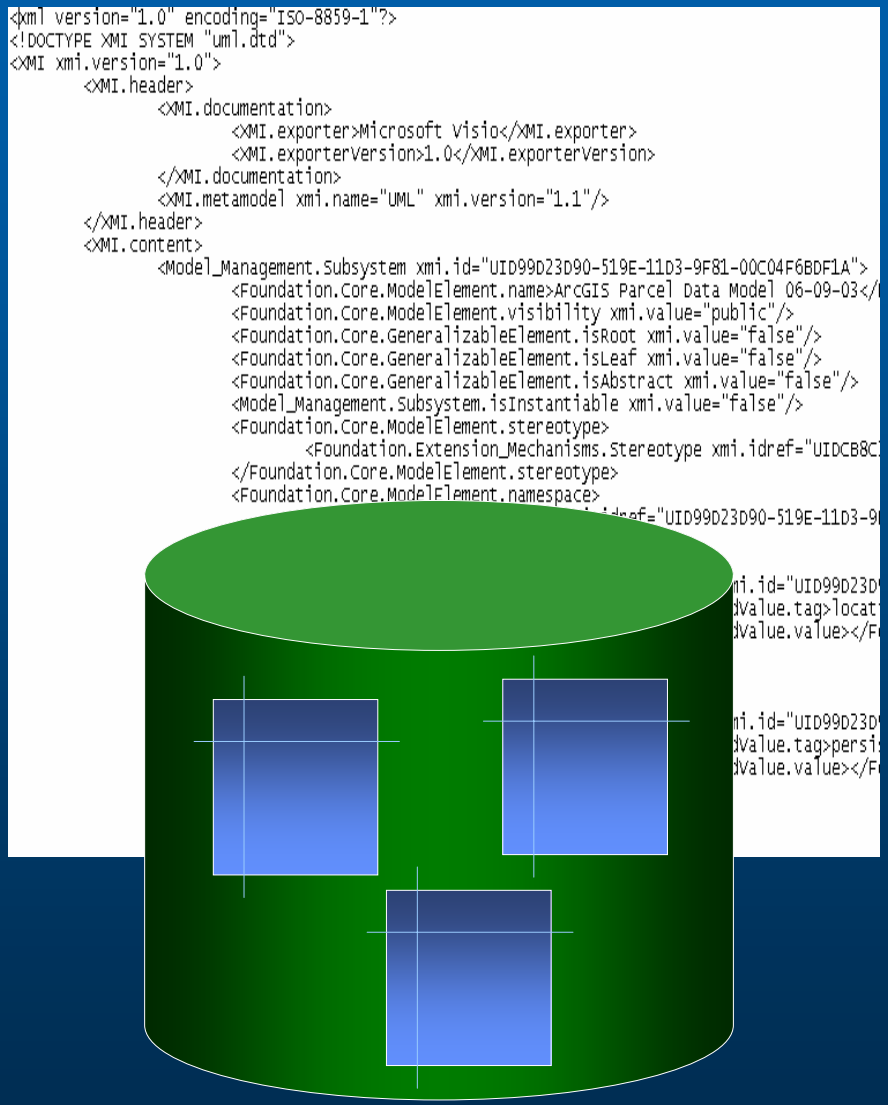
Created and owned by user groups and industries

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?

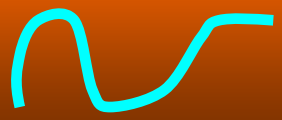


- In the GIS it is a list of the names of contents and rules stored in the Geodatabase.
- Organized approach of grouping knowledge.
- The concepts and actions that can be revised and used to create a database.

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

Text	Date	Geometry
Oil	03 27 95	

Field type

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

Spatial store methods

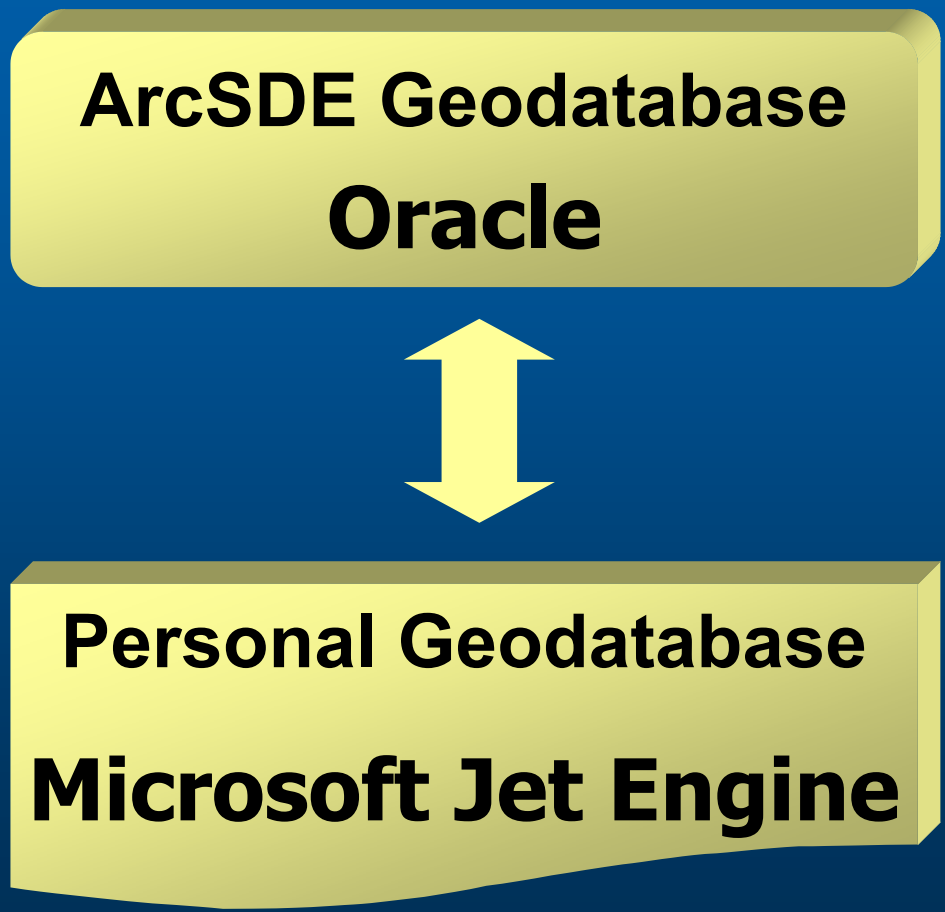
ESRI ArcSDE

Binary Schema - BLOB or Long Raw

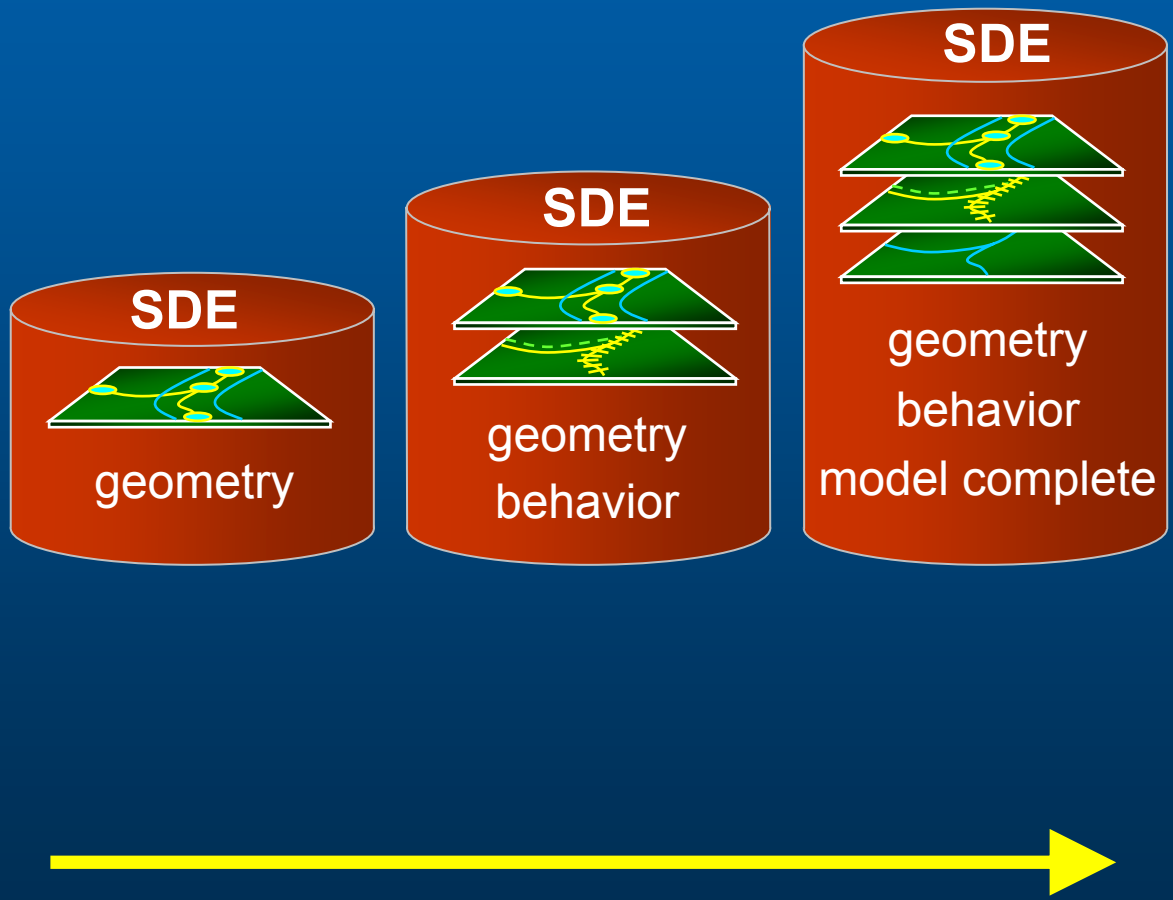
Oracle Spatial

Geometry Type - SDO_Geometry

The Geodatabase



Industry Transition



Benefits of Spatial

Improved Data Management

SHARED!

Connectivity

Master store

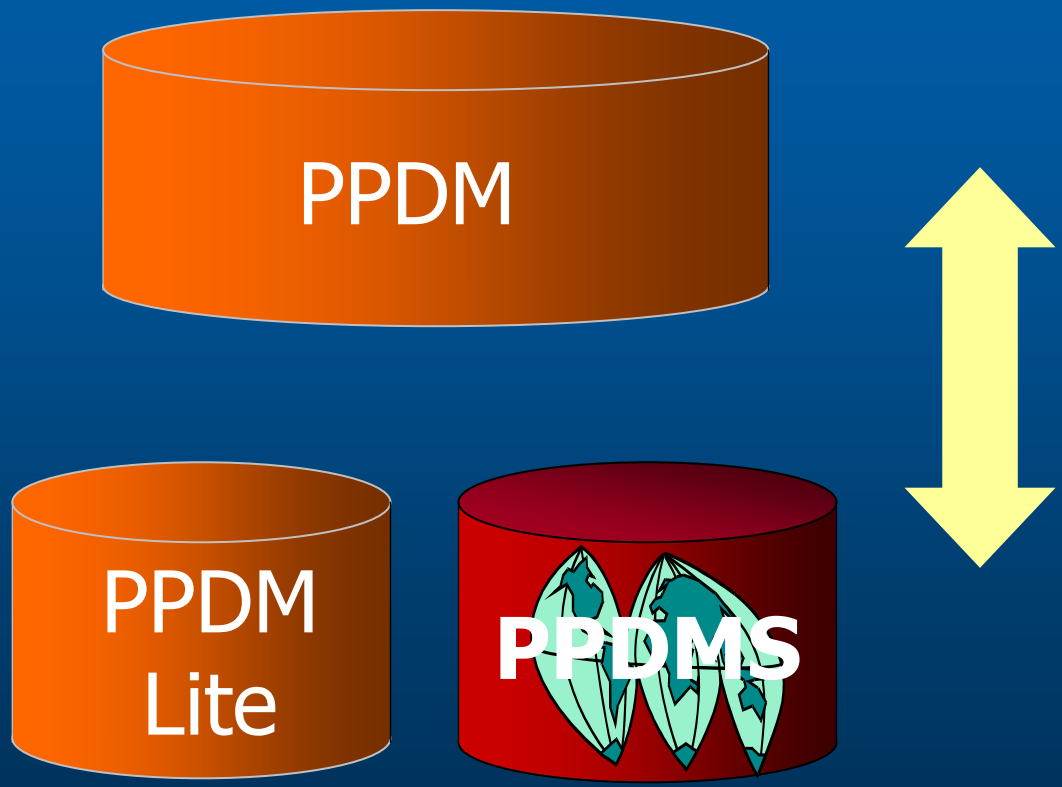
85% Oil and Gas
Is spatial

Spatial Analysis

Seamless

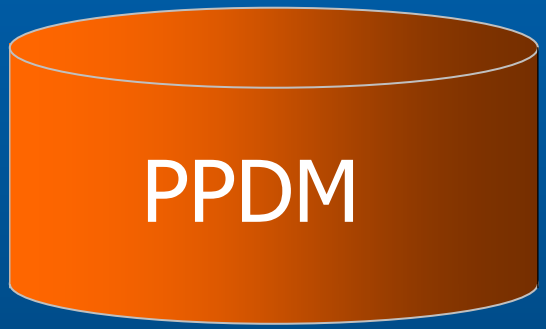
Advanced Business Applications

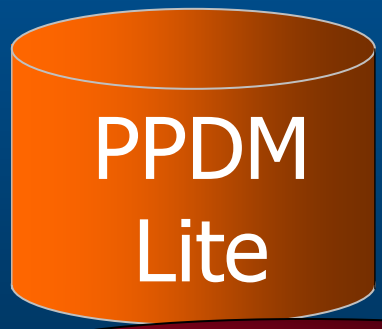
PPDM Spatial

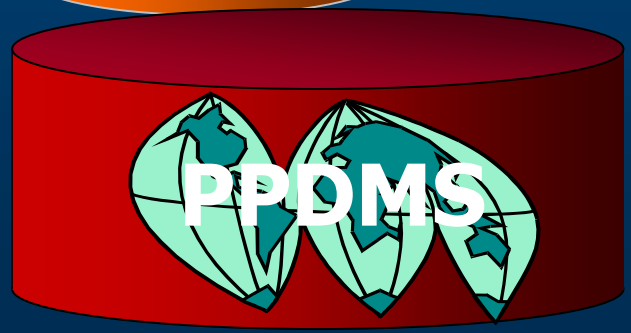


PPDM Spatial

Spatial 5

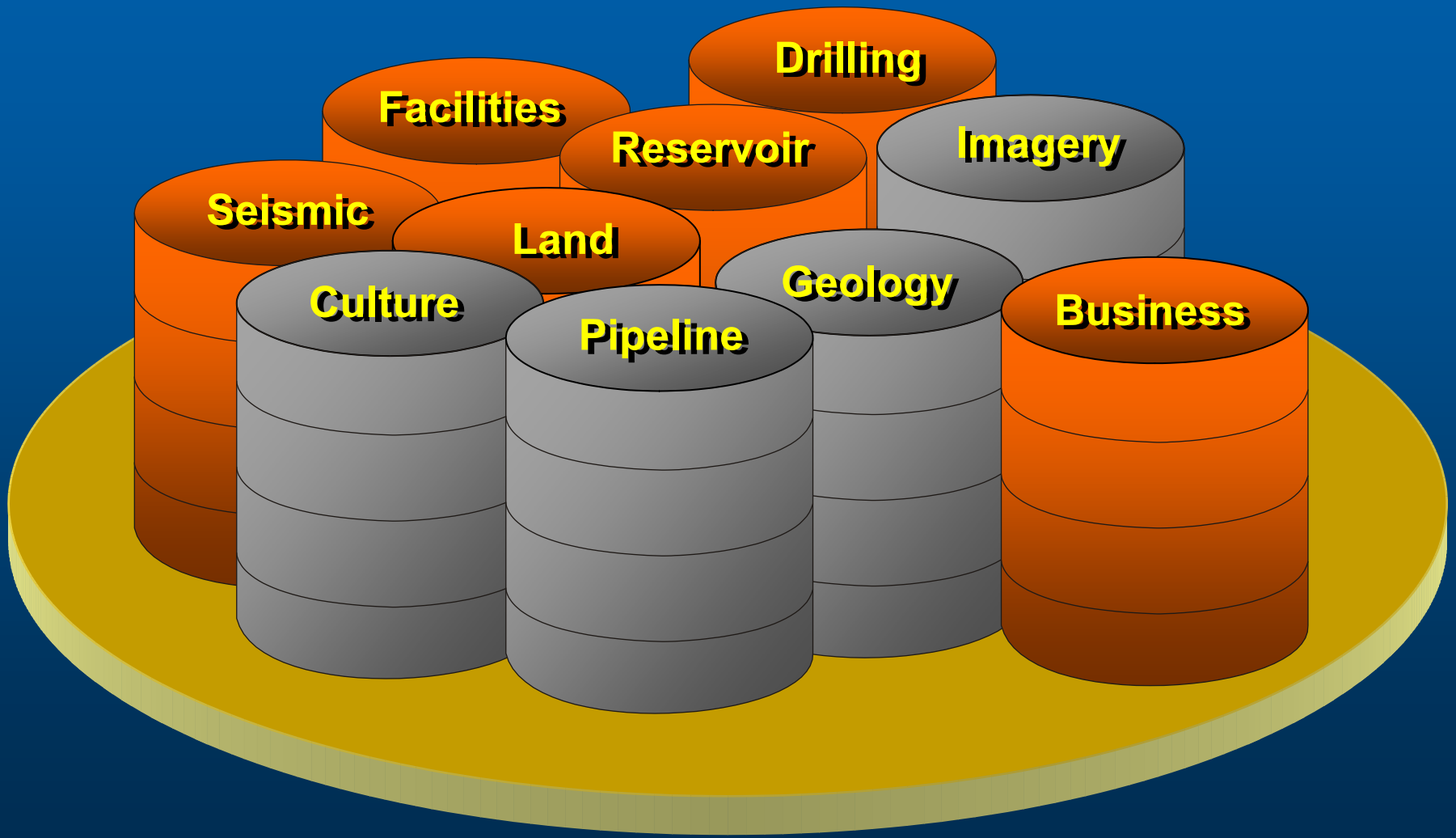






Culture
Geology
Environment
Pipeline
Imagery
Forestry

Digital Earth Model



Considerations

Technical

Spatial as a component of the corporate technical backbone

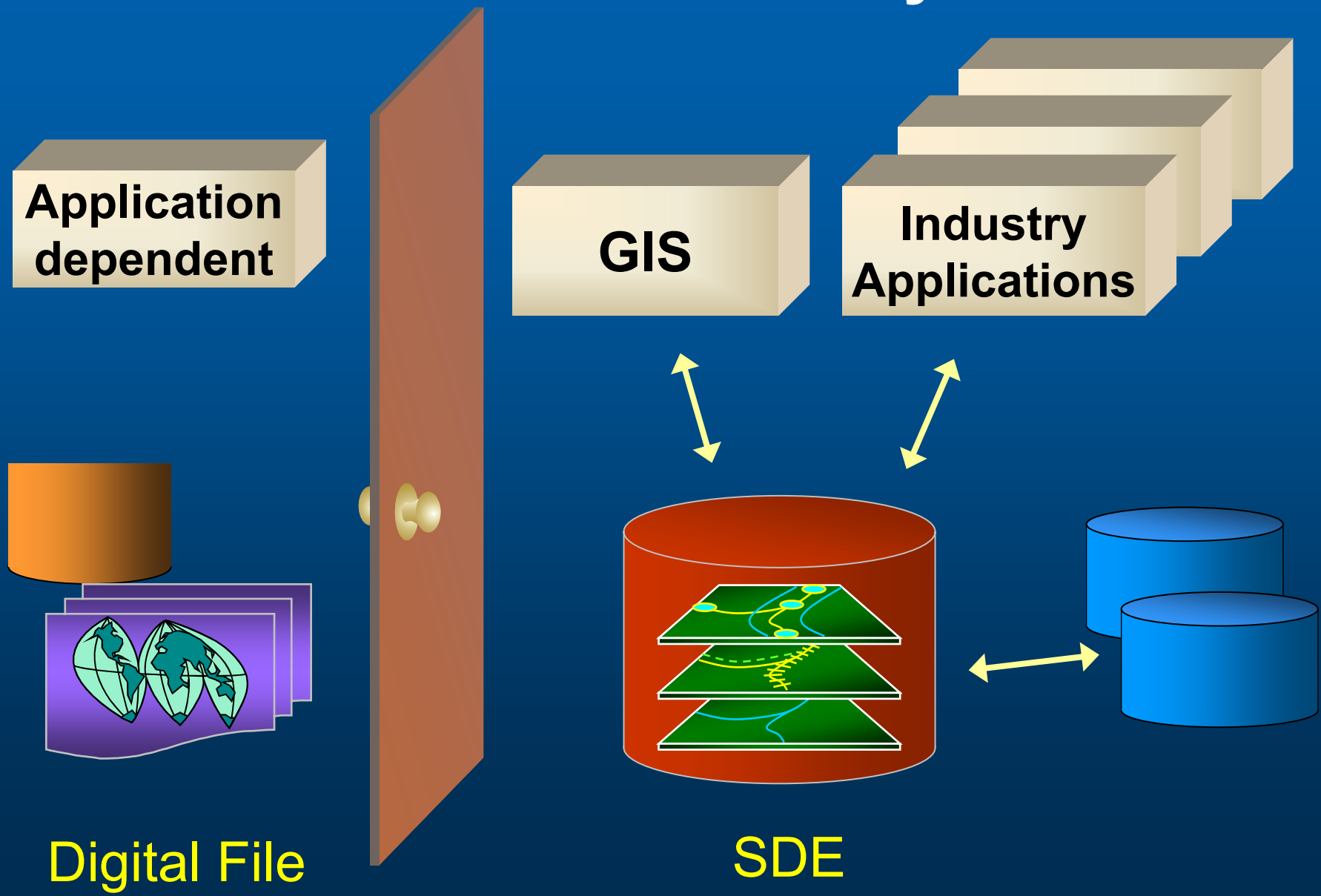
People

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



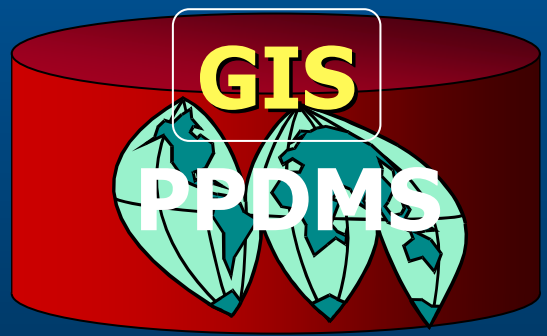
Shared application use

Wood Mackenzie Pathfinder

GeoQuest Smartview

Petrosys

Trango



Web GIS

IHS

GIS

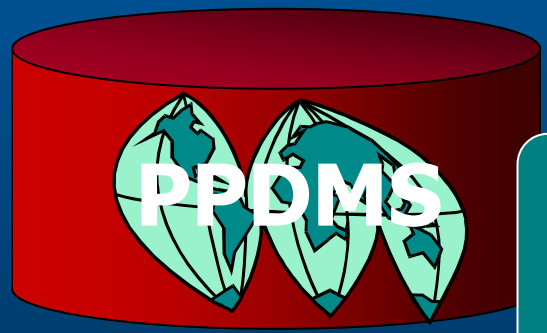
Landmark
PowerExplorer

More coming !

SDE hubs (data vendors, bps)

IHS Canada

IHS International



GIS
Web GIS

Partners

Wood Mackenzie

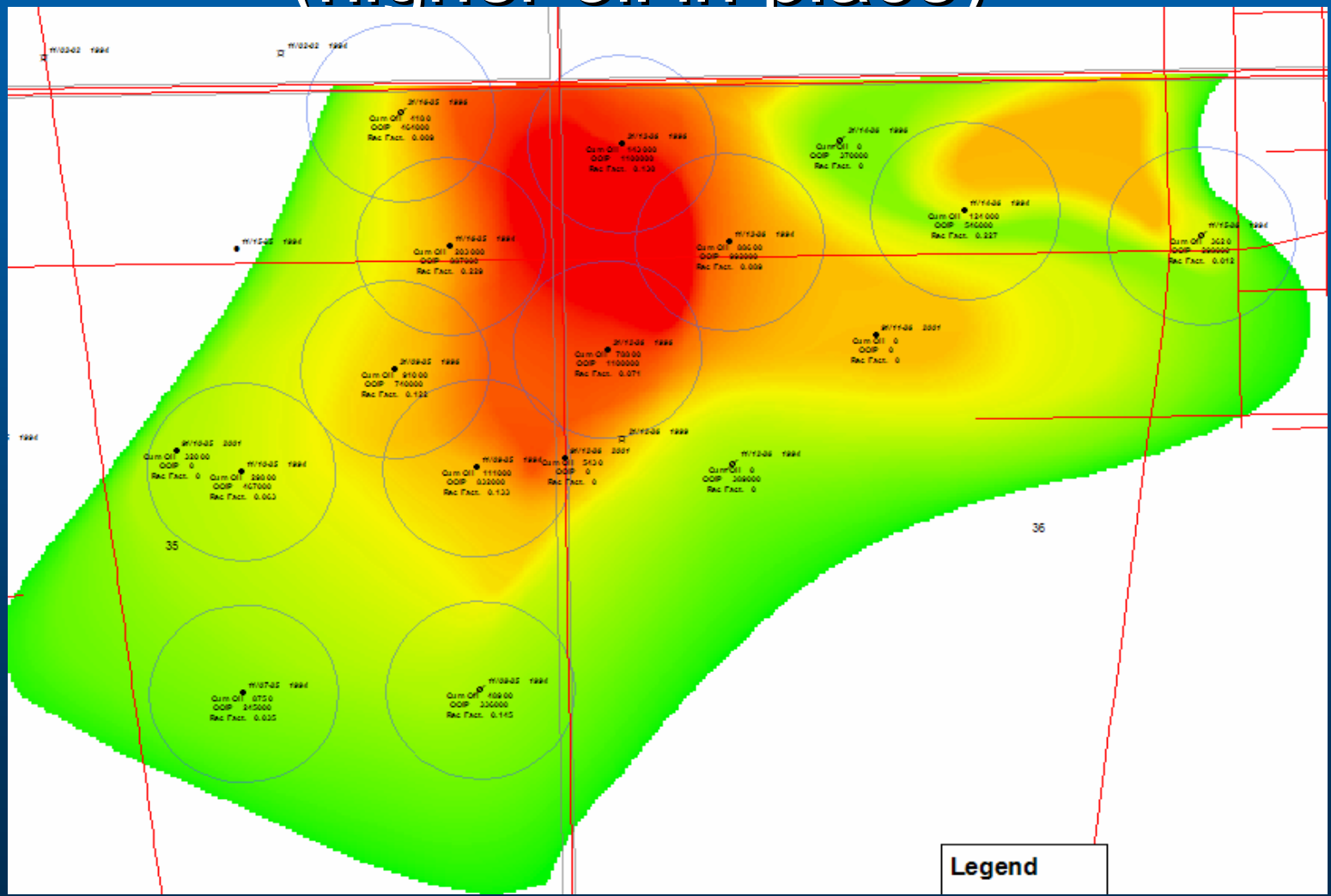
New processes –not typically available in the standalone database

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

Spatial query

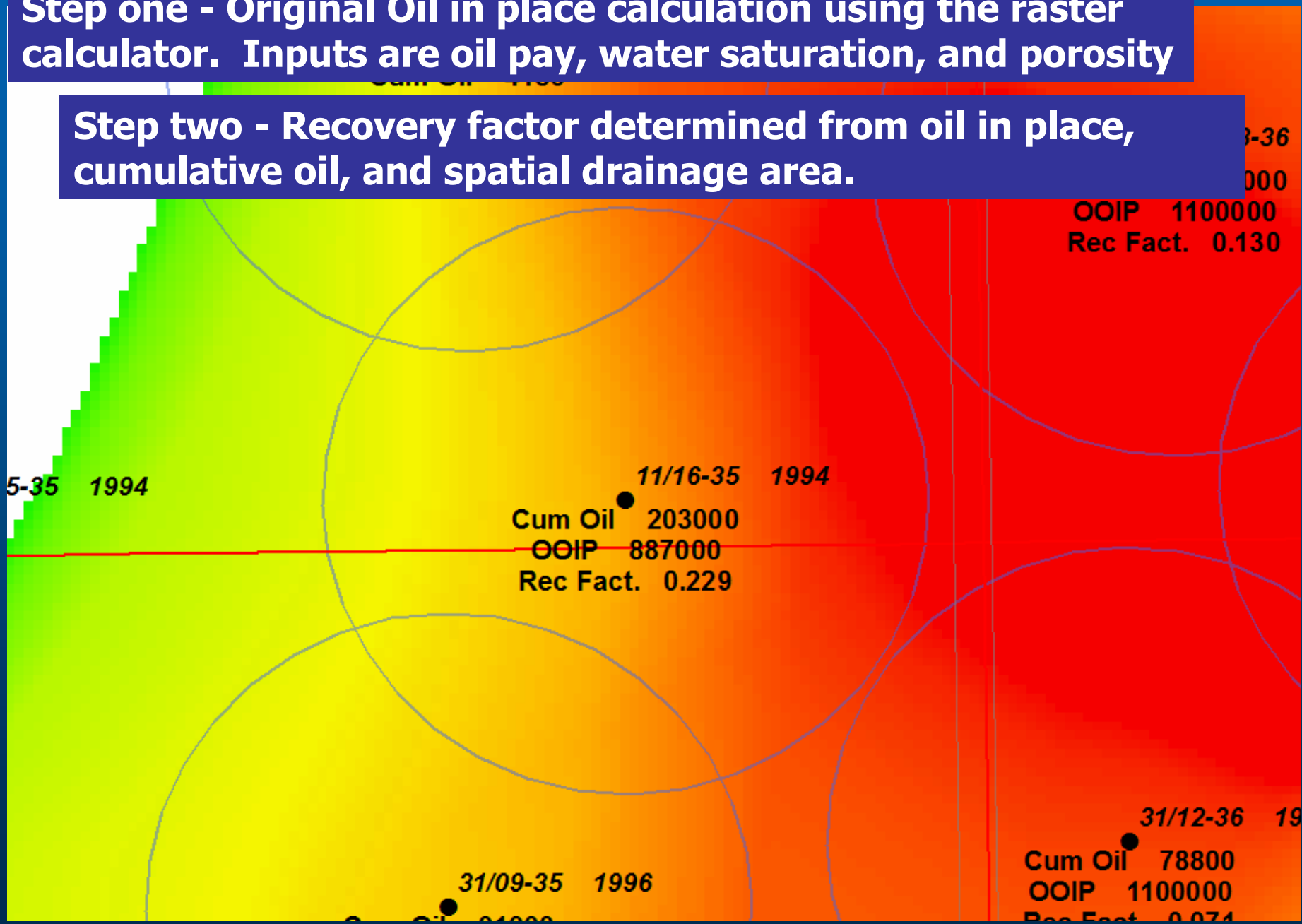
- Determine the daily production for all wells connected to a specific pipeline within a specific township range
- Determine the average reserves for all pools wholly or partially within a specific lease
- Others?

Spatial Analysis Recovery factor (higher oil in place)



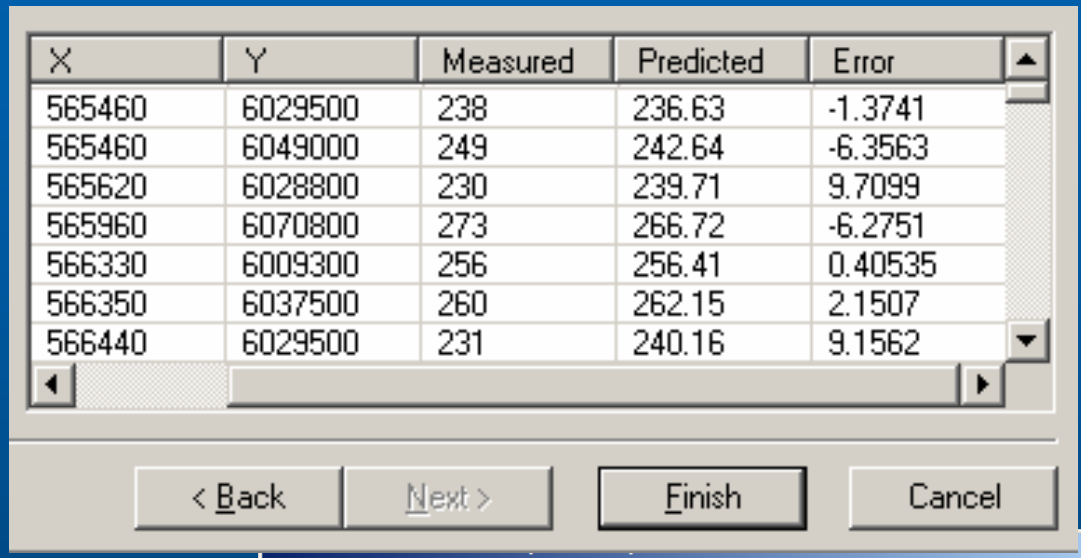
Step one - Original Oil in place calculation using the raster calculator. Inputs are oil pay, water saturation, and porosity

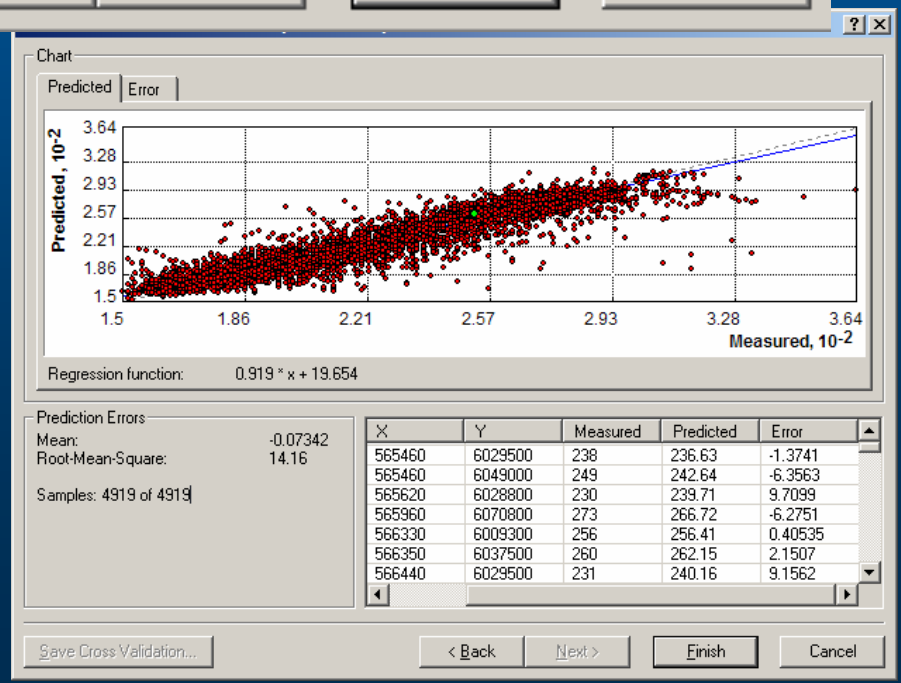
Step two - Recovery factor determined from oil in place, cumulative oil, and spatial drainage area.



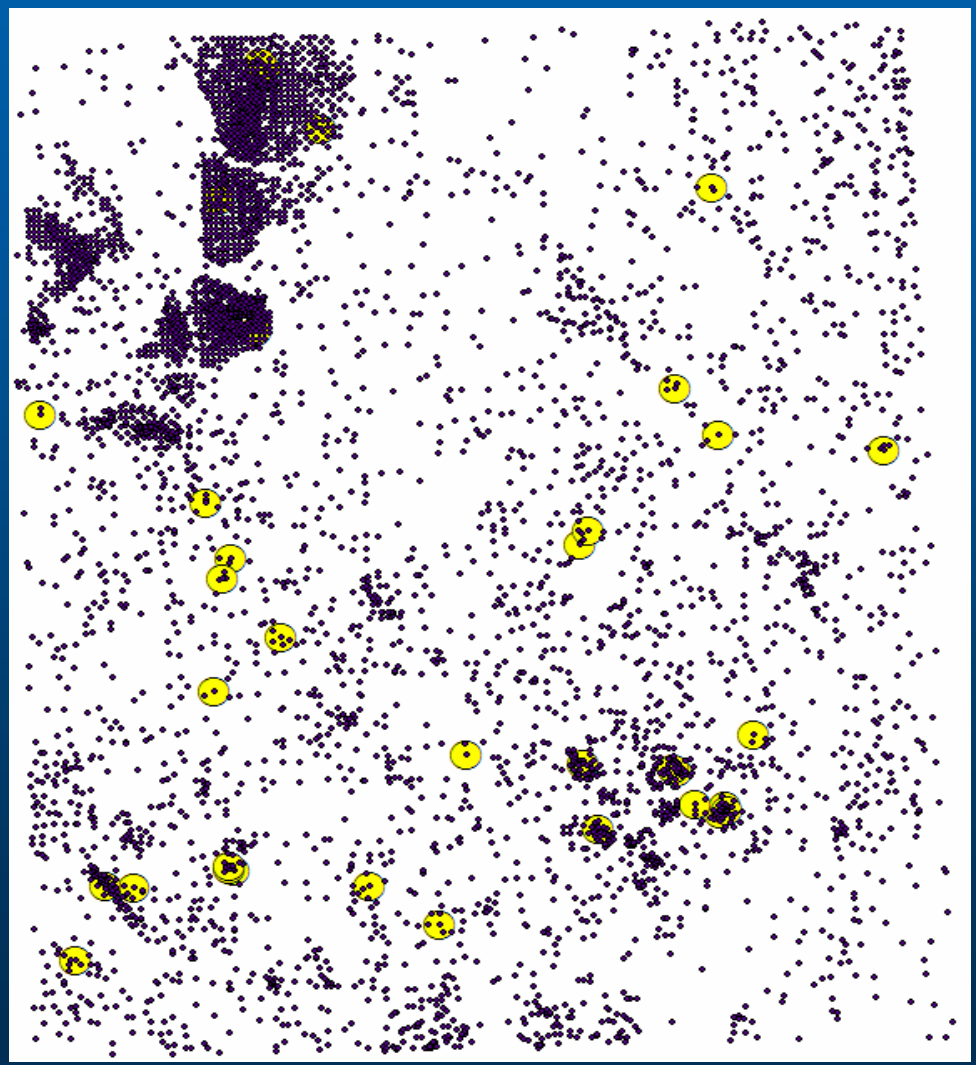
Spatial interpolation

- Predict value for each point



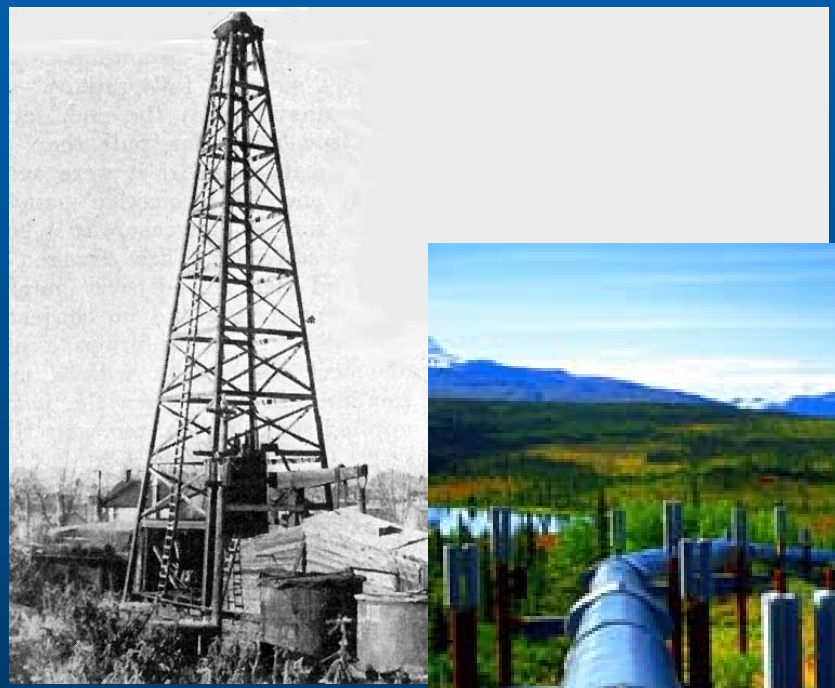


Compare predicted to published

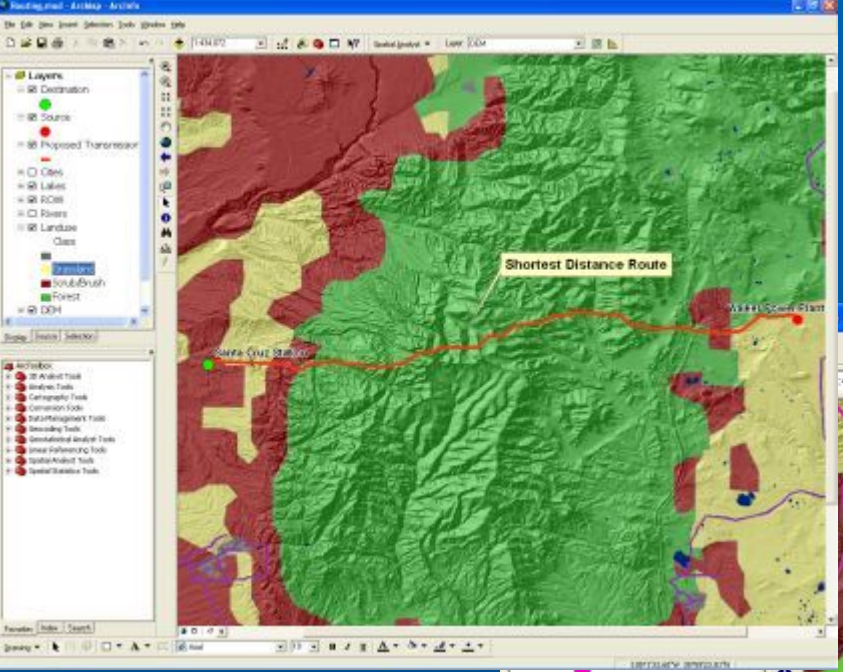


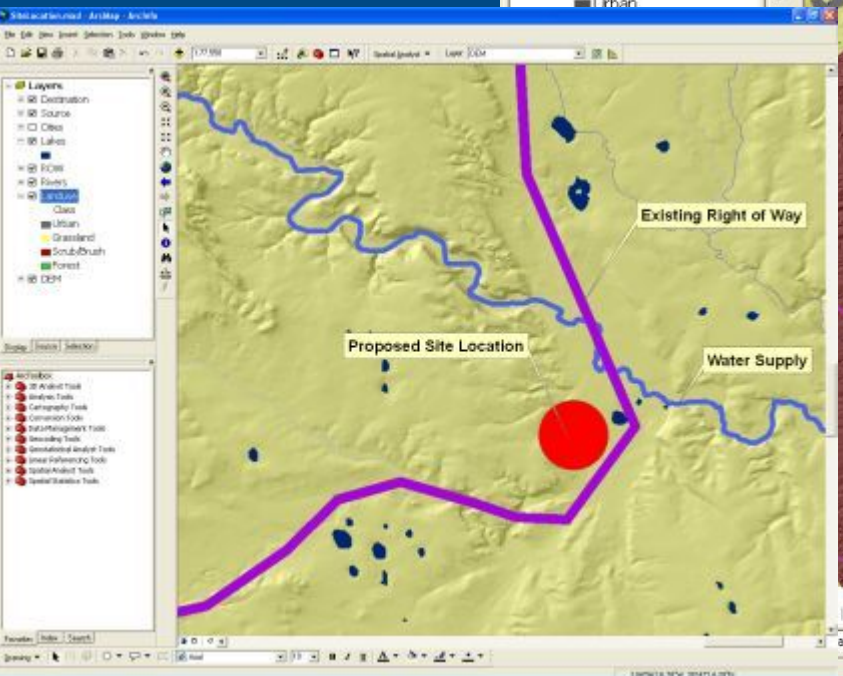
- Look at all errors say > -50
- Yellow are wells that production did not meet expectations
- Engineering calculations in a spatial context

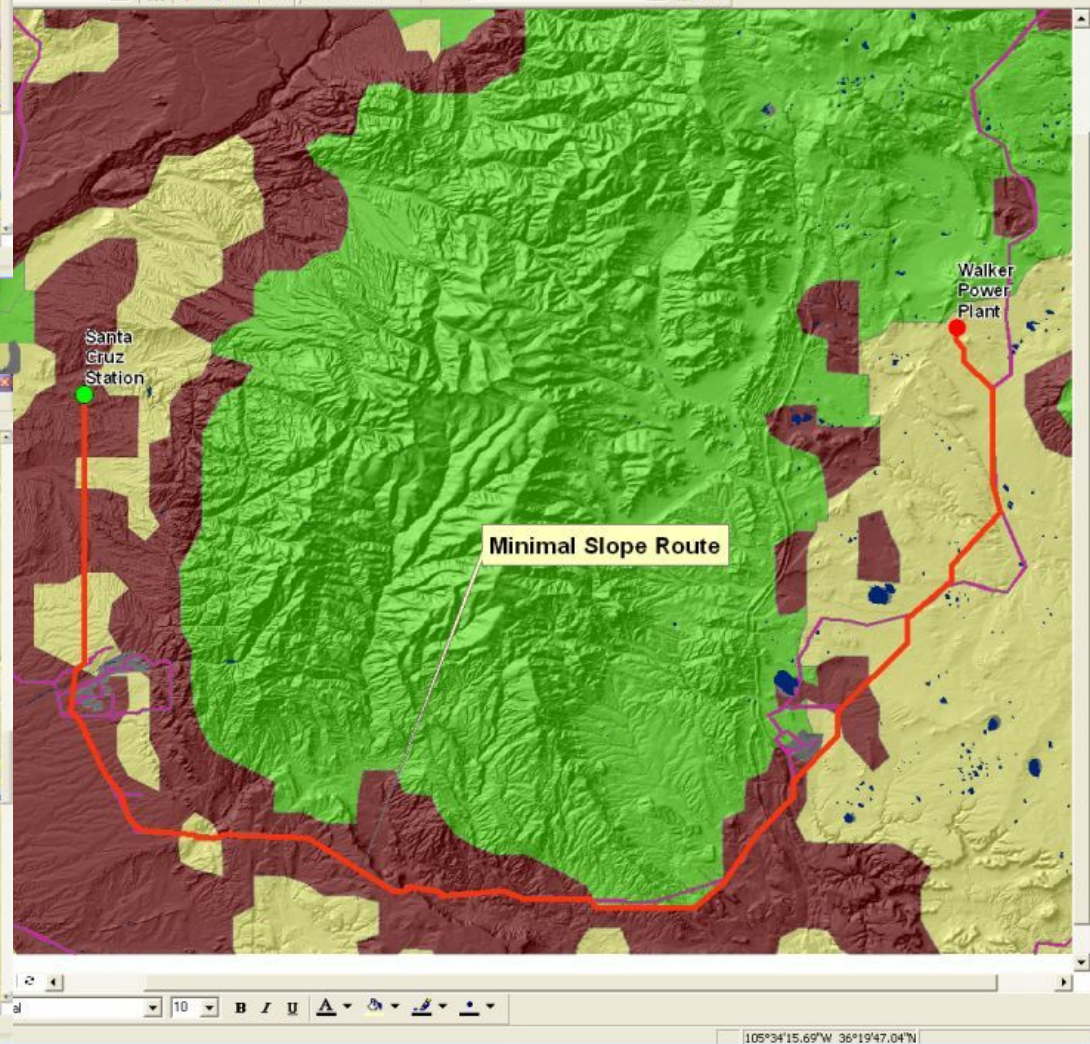
Pipeline routing



Pipeline Routing



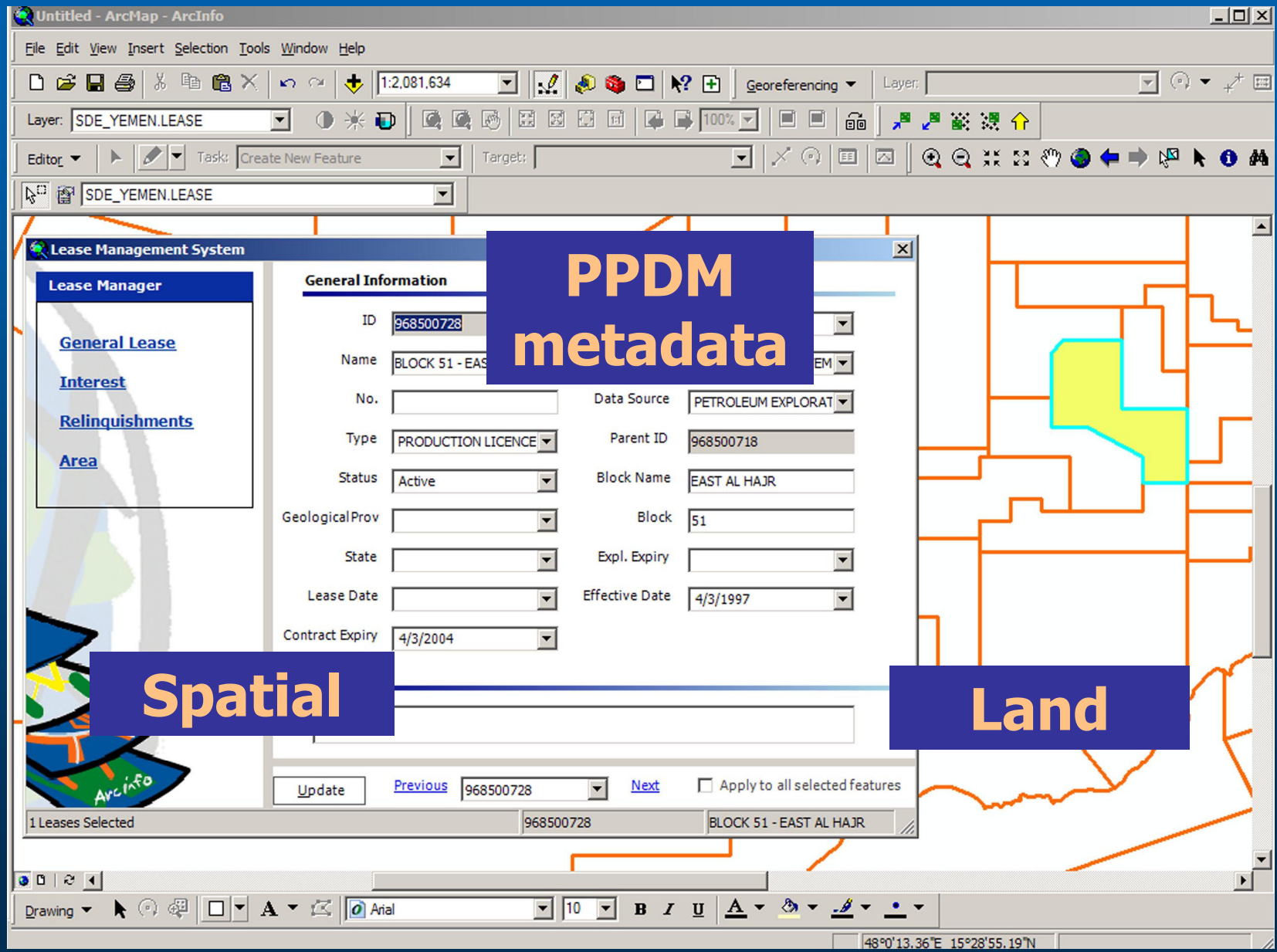




Incorporate data edits through PPDM Spatial transactions

- 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



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

Technical Information Library

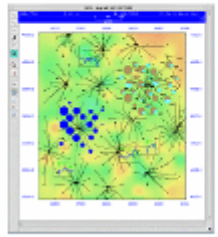
DECISION HISTORY

Date	Issue	Decision	Signed –off
May 21 1991	Farm-out Pinto well	Offers to Esso	Larry Redman

Access to any application.

KNOWLEDGE

Project activity	Author	Results	Comments
Porosity study	Jan White	Bello Fm. info.	Good flow characteristics.



Database, or
File, or
Mindshare

Access to any application.

FINANCIAL SUMMARY

Year	G&A	Capital	Total	To date	Balance
1995	$100	$200	$300	$272	$28

Year	$AFE	AFE description	Actual
1995	$20	Drill Pinto 5	$18

Access to any application.

PERSONNEL

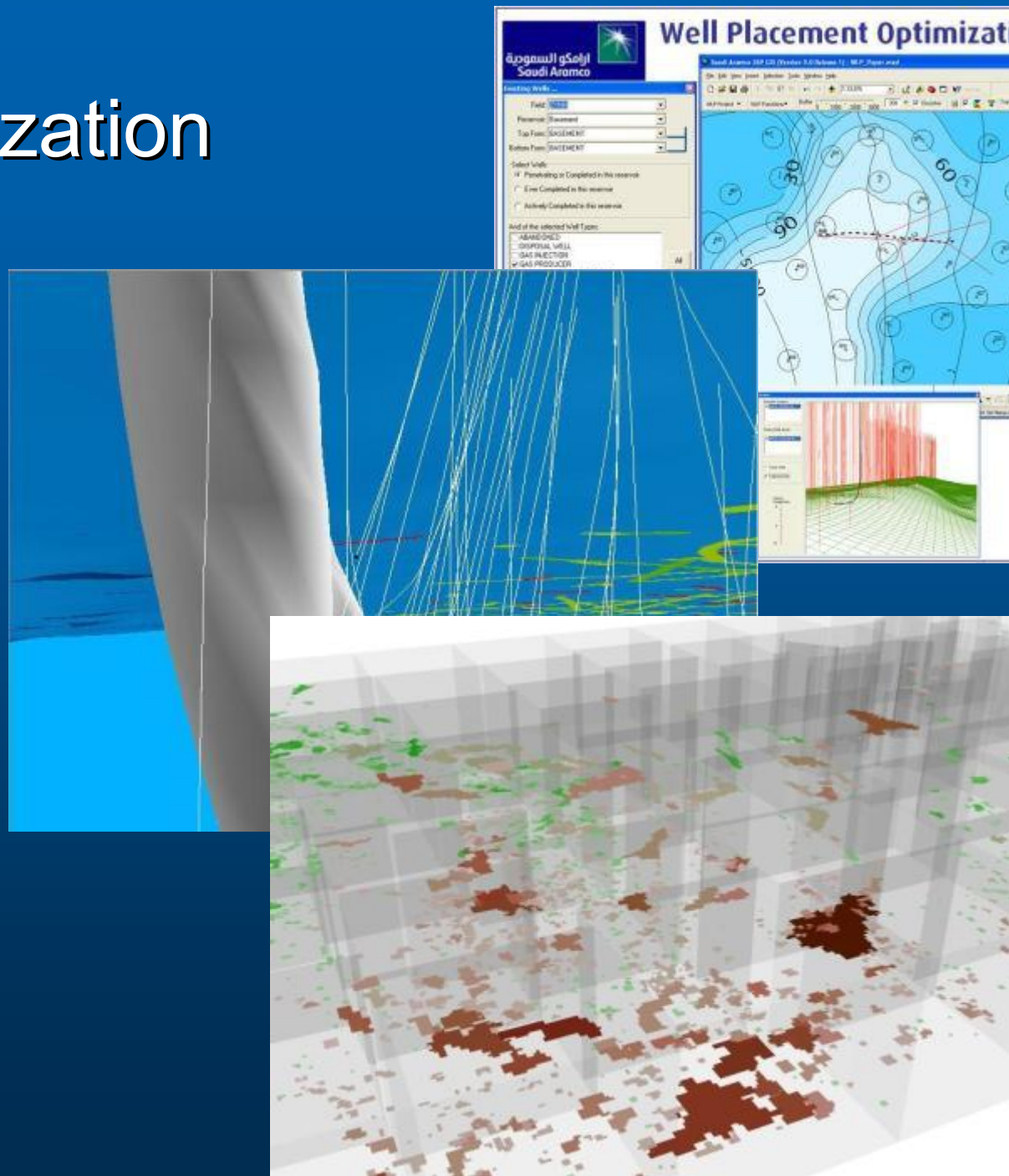
Personnel	Role	Date Start	Date Finish	Activity summary
Bill Brown	Geologist	June 1992	June 1995	Exploration on Pasto block.

Access to any application.

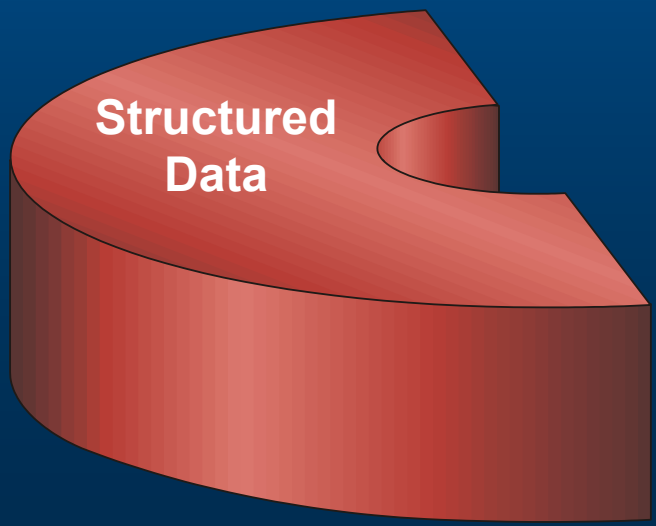
Visualization

3D Visualization

- 3D display
- Grids
- Wellbores
- Etc.



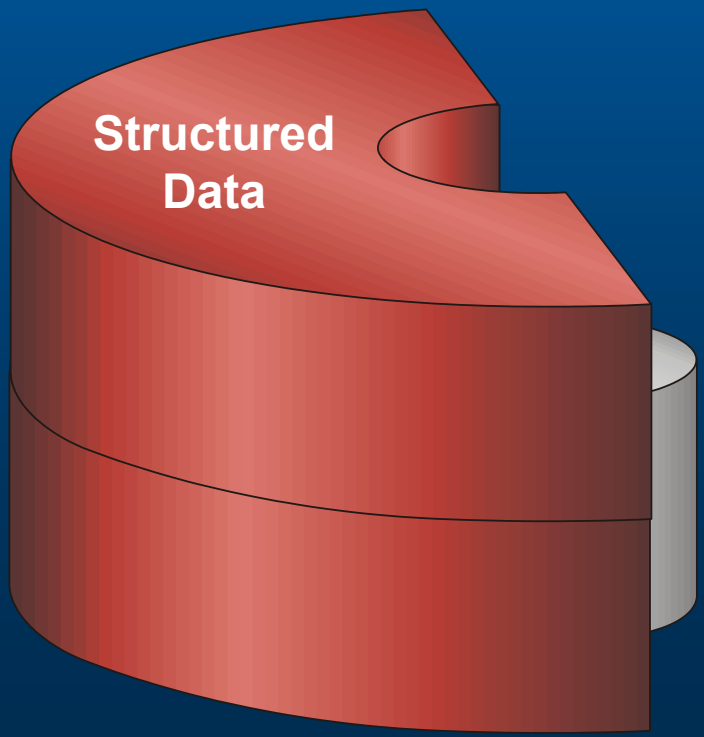
Building Blocks



Wells
Seismic
Lease
Production
Reserves

Building Blocks

Culture
Geology
Environment
Pipeline
Transportation
Project



Wells
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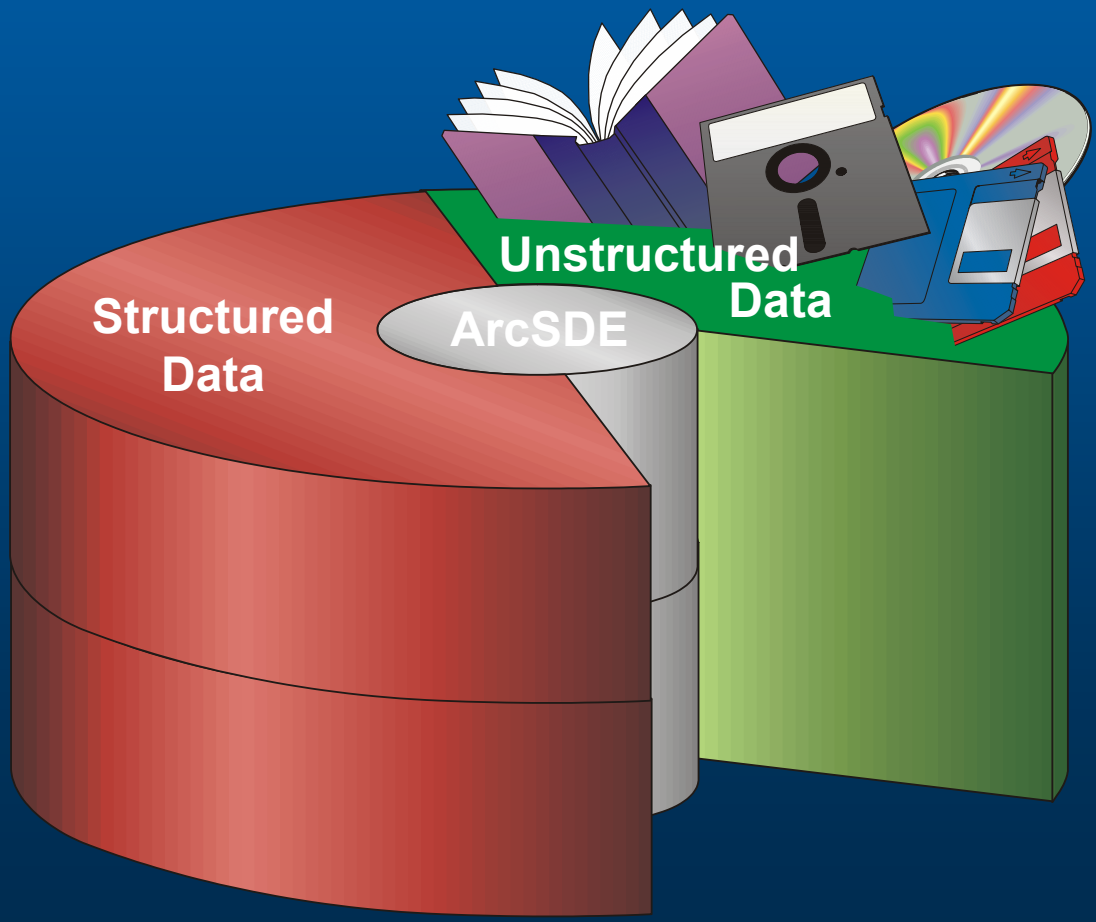

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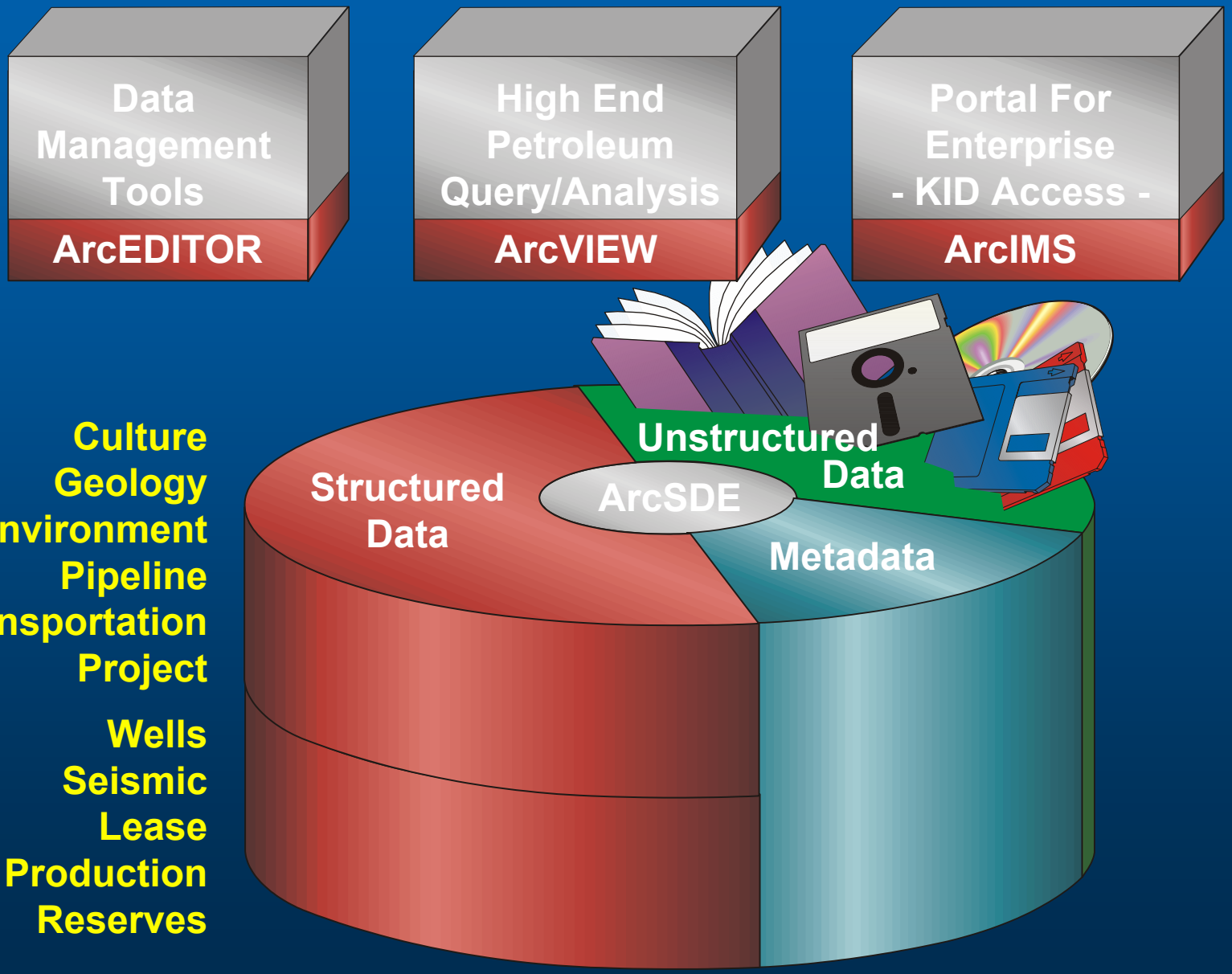
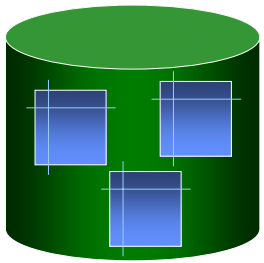
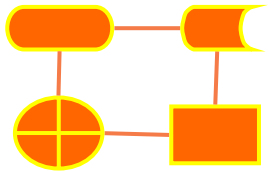


How Do I Use a Logical Template?

- You may only need a small part of the over all schema and template to match your data



Physical Model
Database Schema
Business Rules



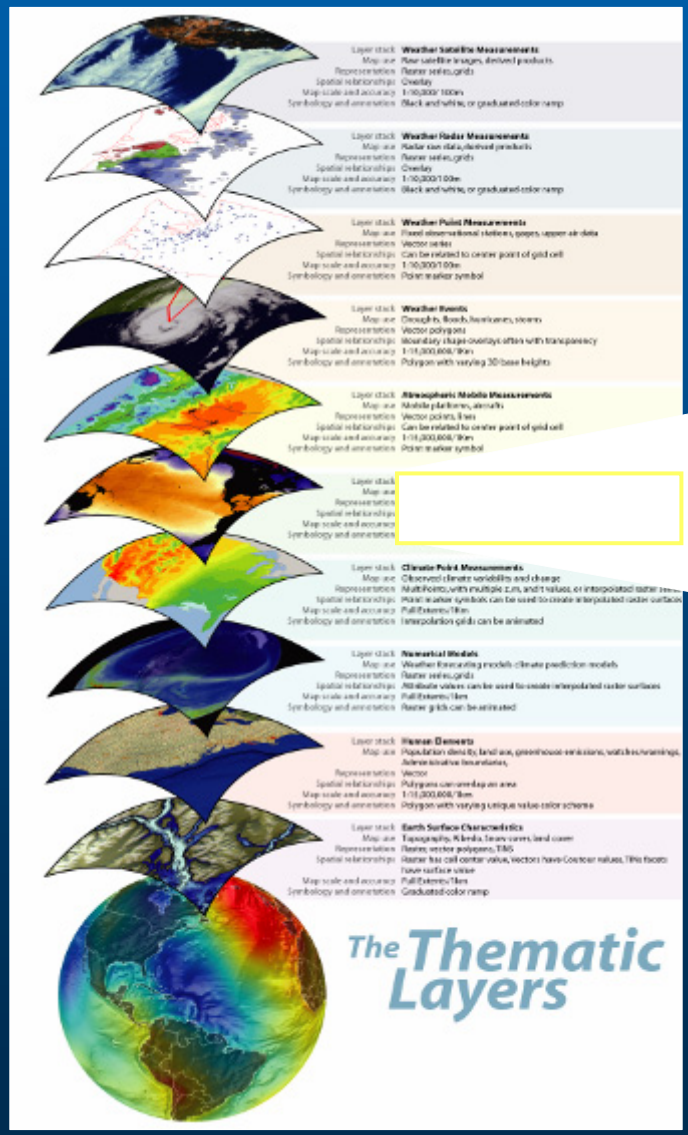
Conceptual Model
Sketches, Flow Diagrams, etc.

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

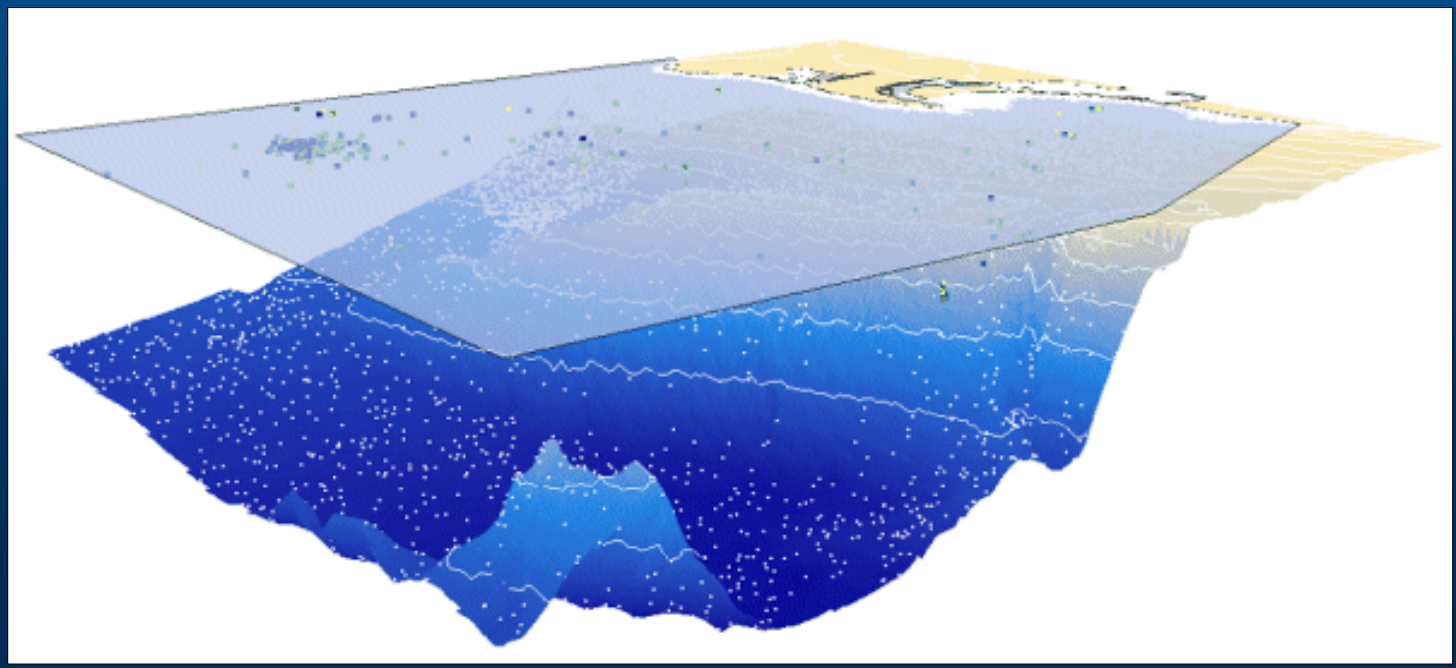
Thematic groupings of data sets



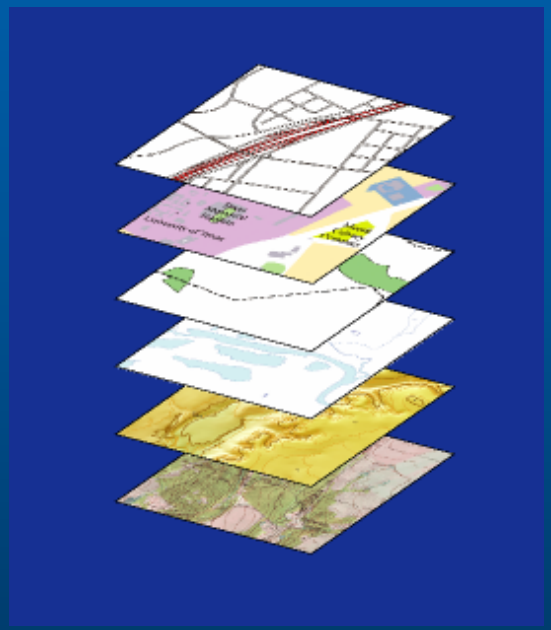
Atmospheric Boundaries
Weather fronts, temperature boundaries
Vector polygons, lines
Multiple time series polygons can be merged and animated
1:15,000,000/1Km
High/Low pressure front lines and cones of intensity,can be animated

Identify the Key Layers

- Based on your information requirements
- Example: Marine data model
  - Bathymetry
  - Soundings
  - Contours
  - Points



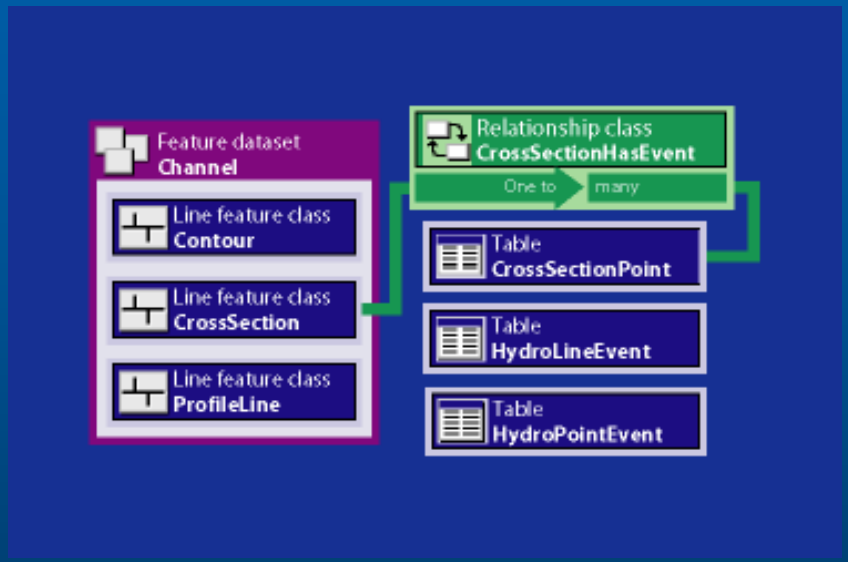
Ten Steps to Designing Geodatabases



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.

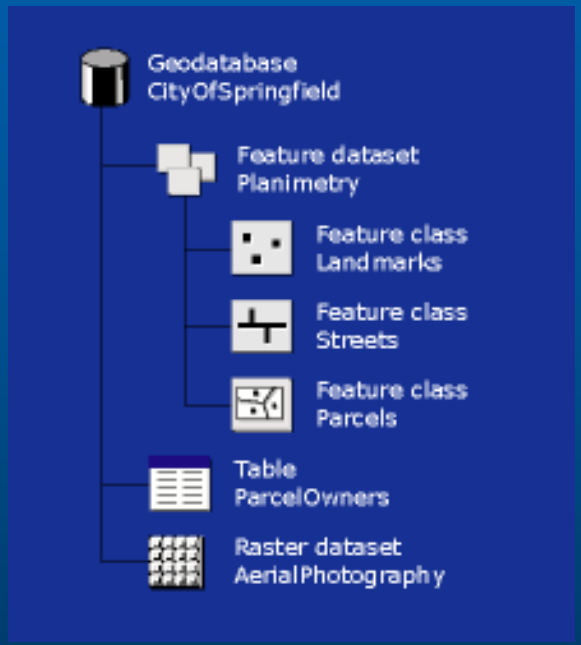
Ten Steps to Designing Geodatabases



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.

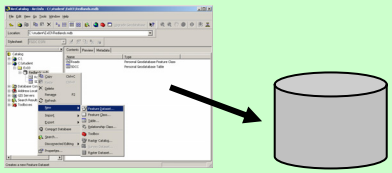
Data Model Implementation

Four ways to build geodatabase schema

Database design

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

1 Create schema with ArcCatalog wizards



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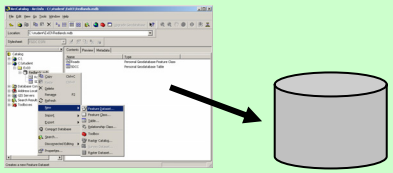
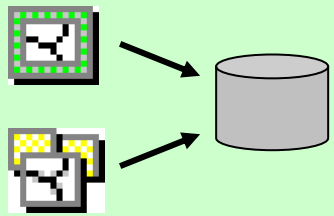


2 Import existing data



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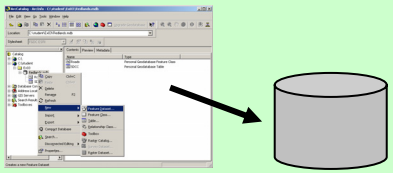

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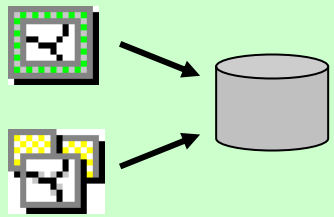
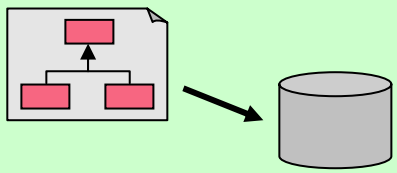


3 Create schema with CASE tools



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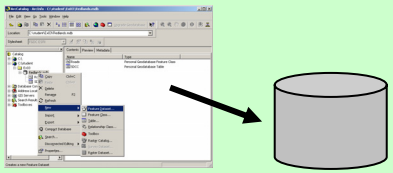

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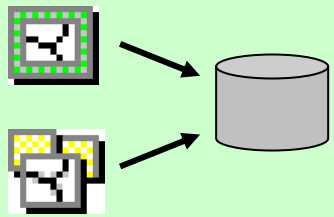

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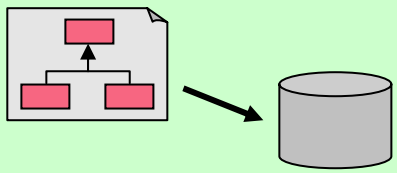
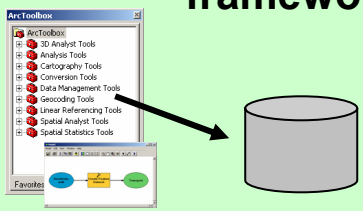


4 Create schema in geoprocessing framework



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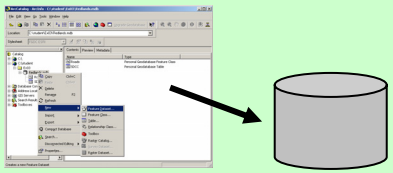

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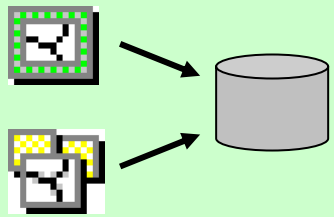

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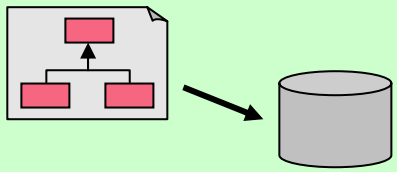

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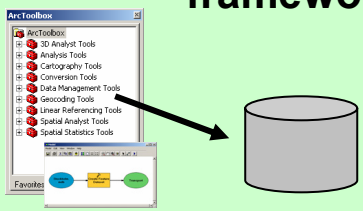

Set relationships
Set rules

- Domains
- Connectivity
- Relationships
- Topology

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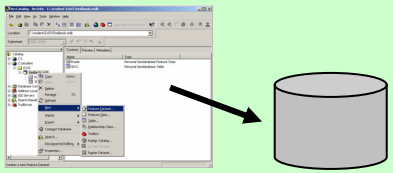

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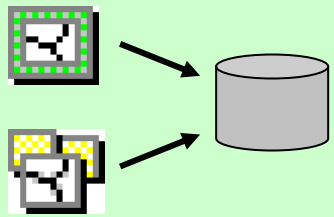

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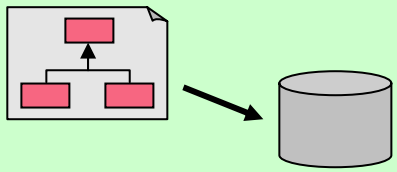

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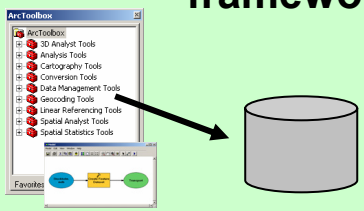

Set relationships
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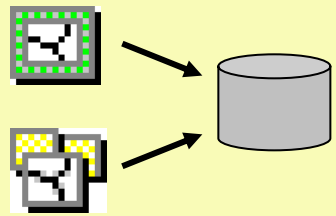
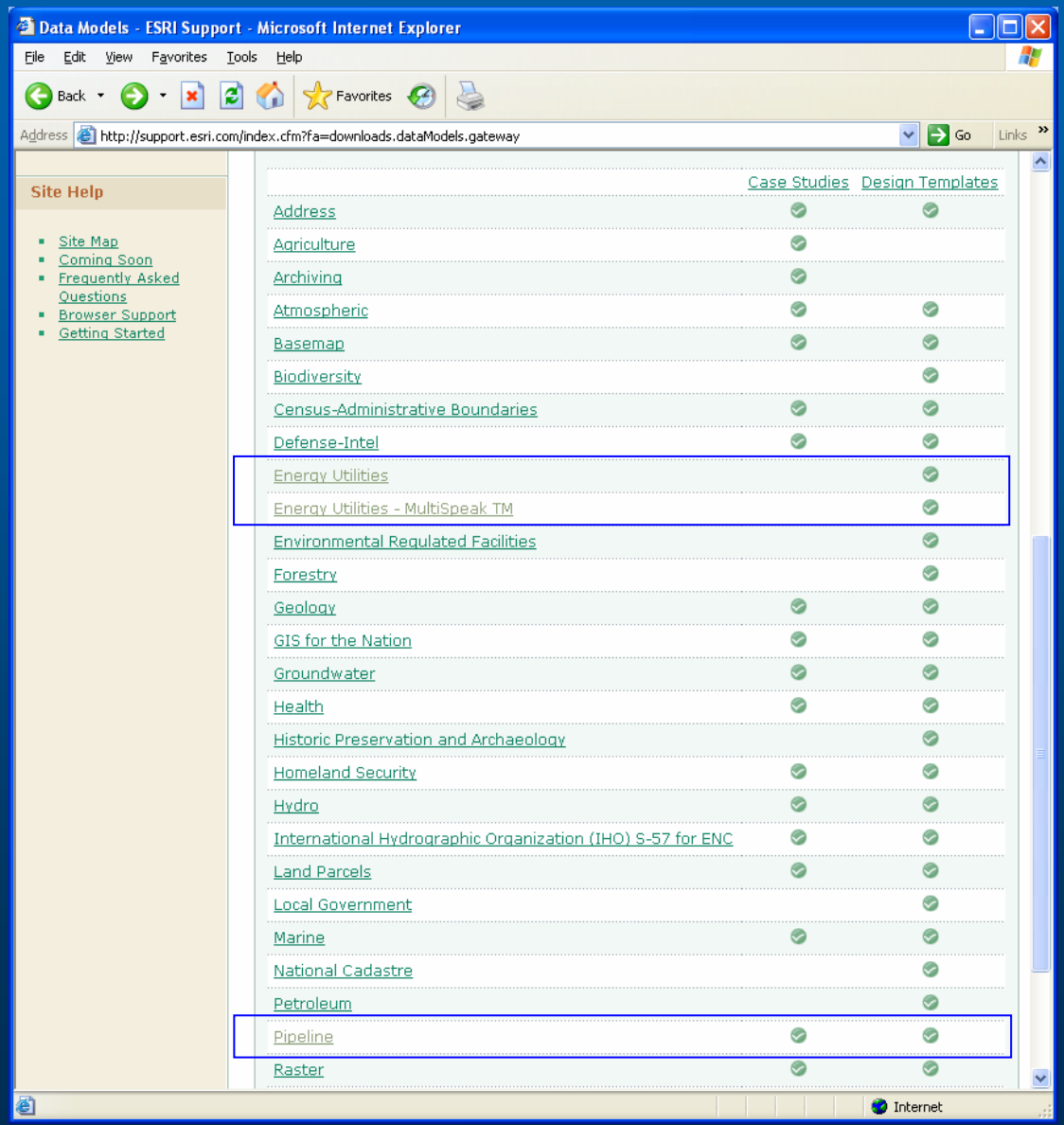
Load data



Data Model Templates

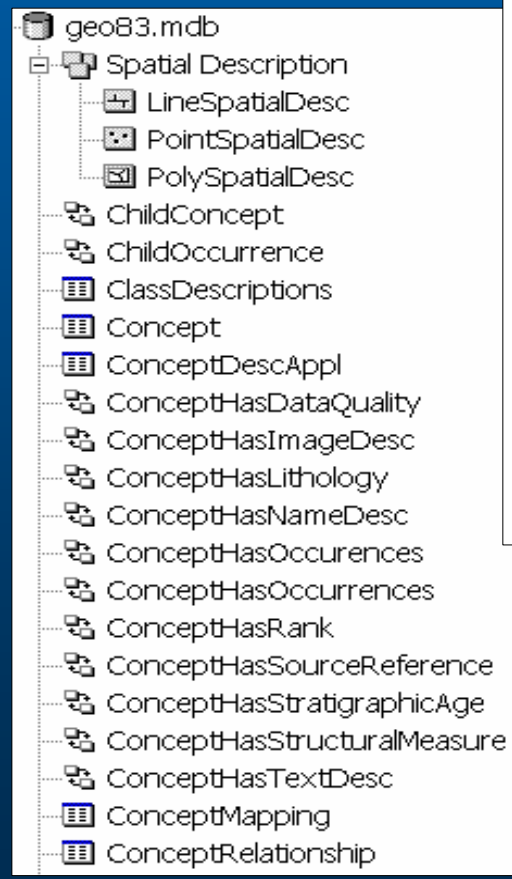
Petroleum Data Model Templates

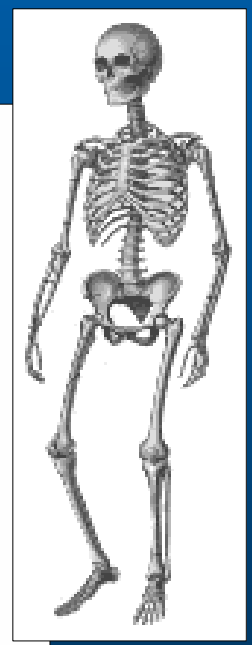


- PPDM
- PPDM Lite
- Pipeline and well data
- Exploration, Conservation

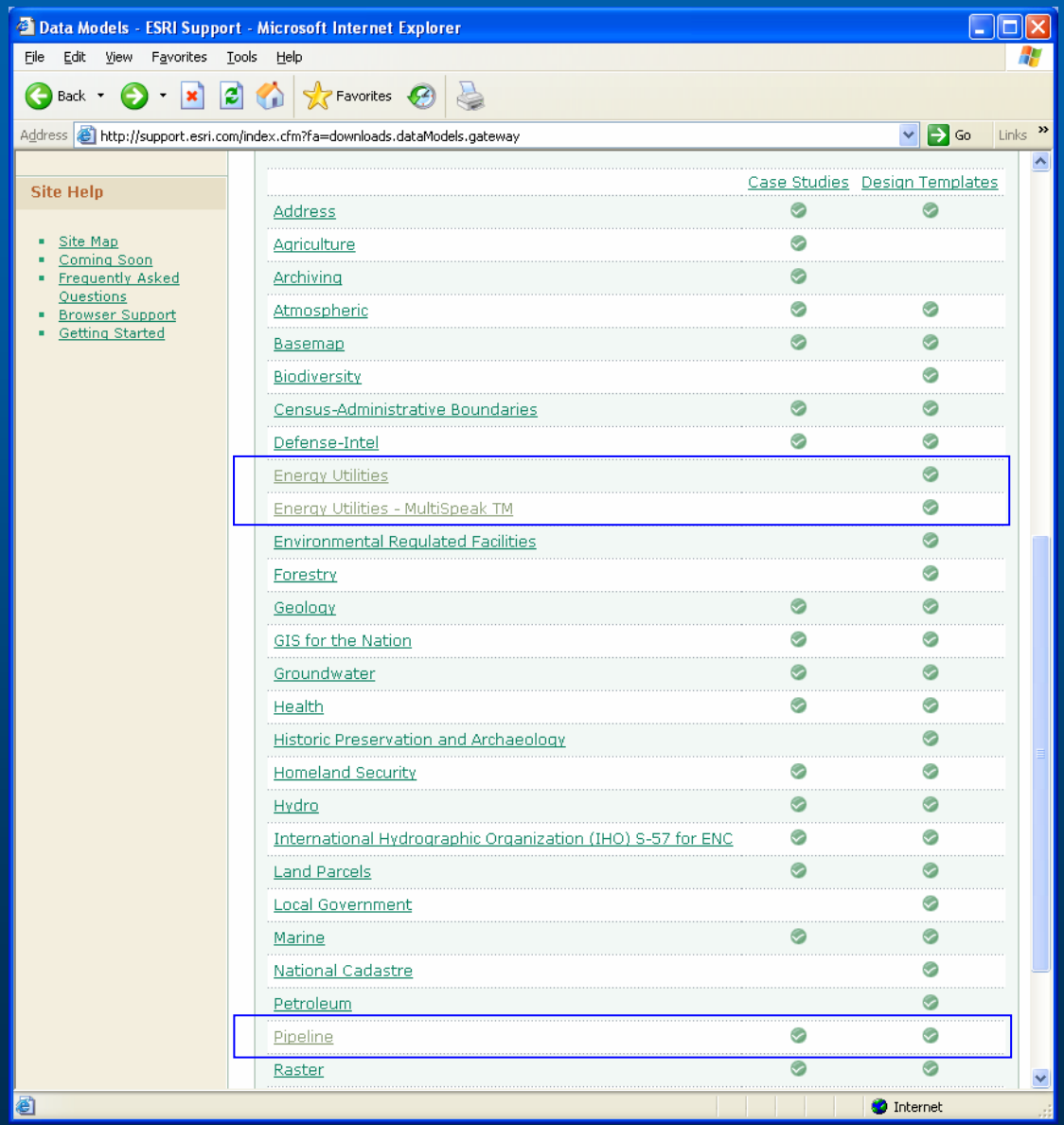
What's in a Data Model Template?

- A pre-designed schema of Objects
- Feature classes
- Tables
- Relationships
- Domains
- Subtypes



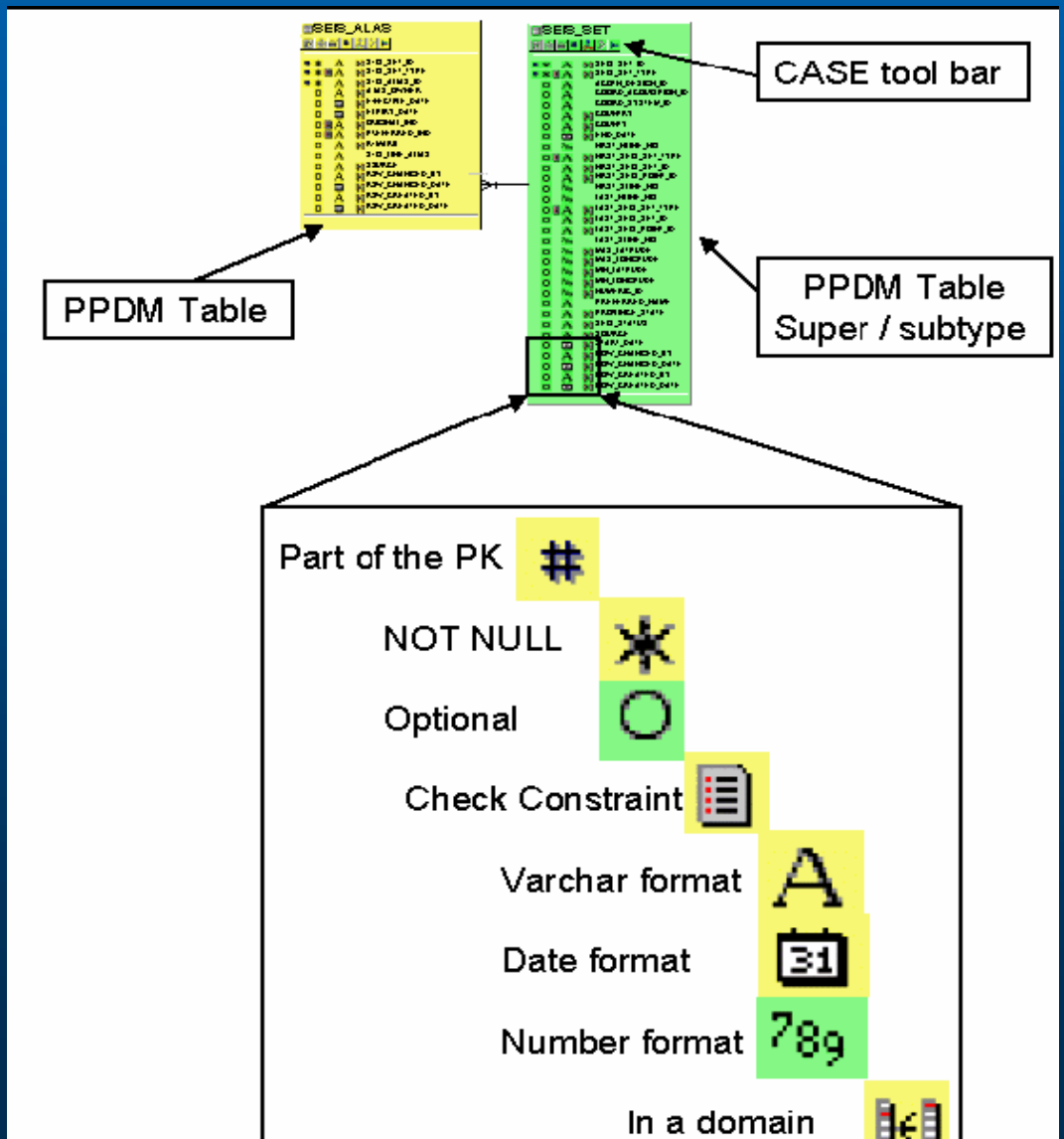


Electric & Gas Data Model Templates



- Electric Distribution
  - ArcFM
  - MultiSpeak
- Electric Transmission
- Gas Distribution
- Gas Pipeline

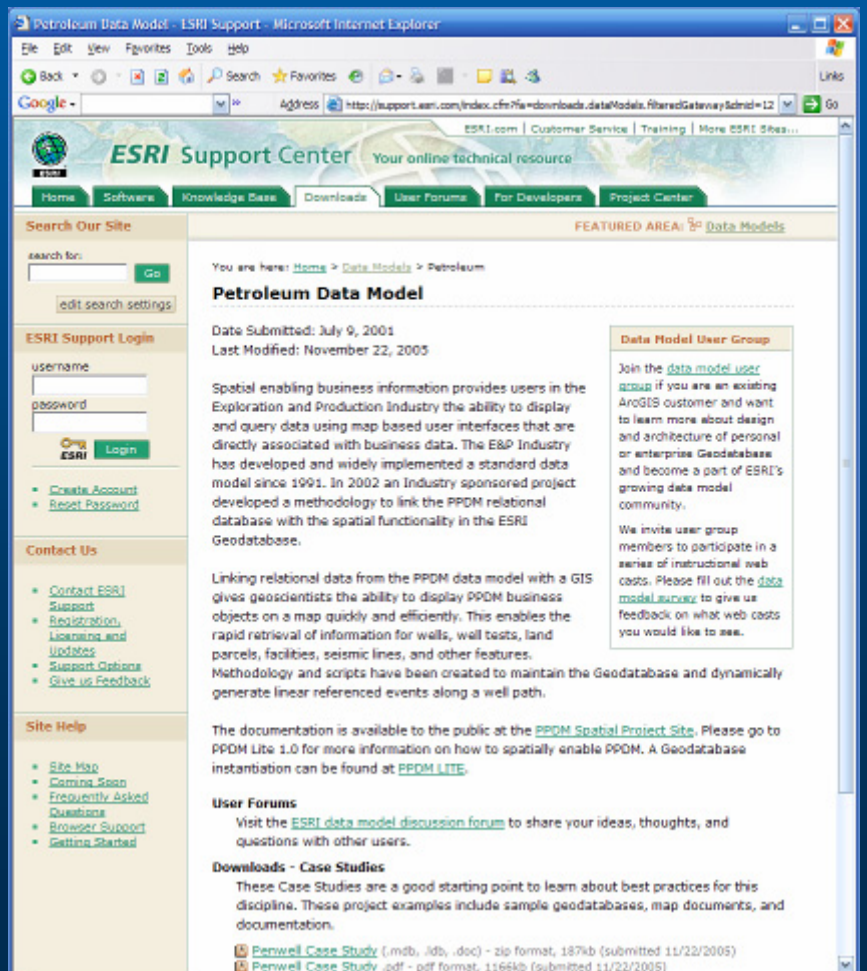
Which template to use?



Typical Model Template Layout

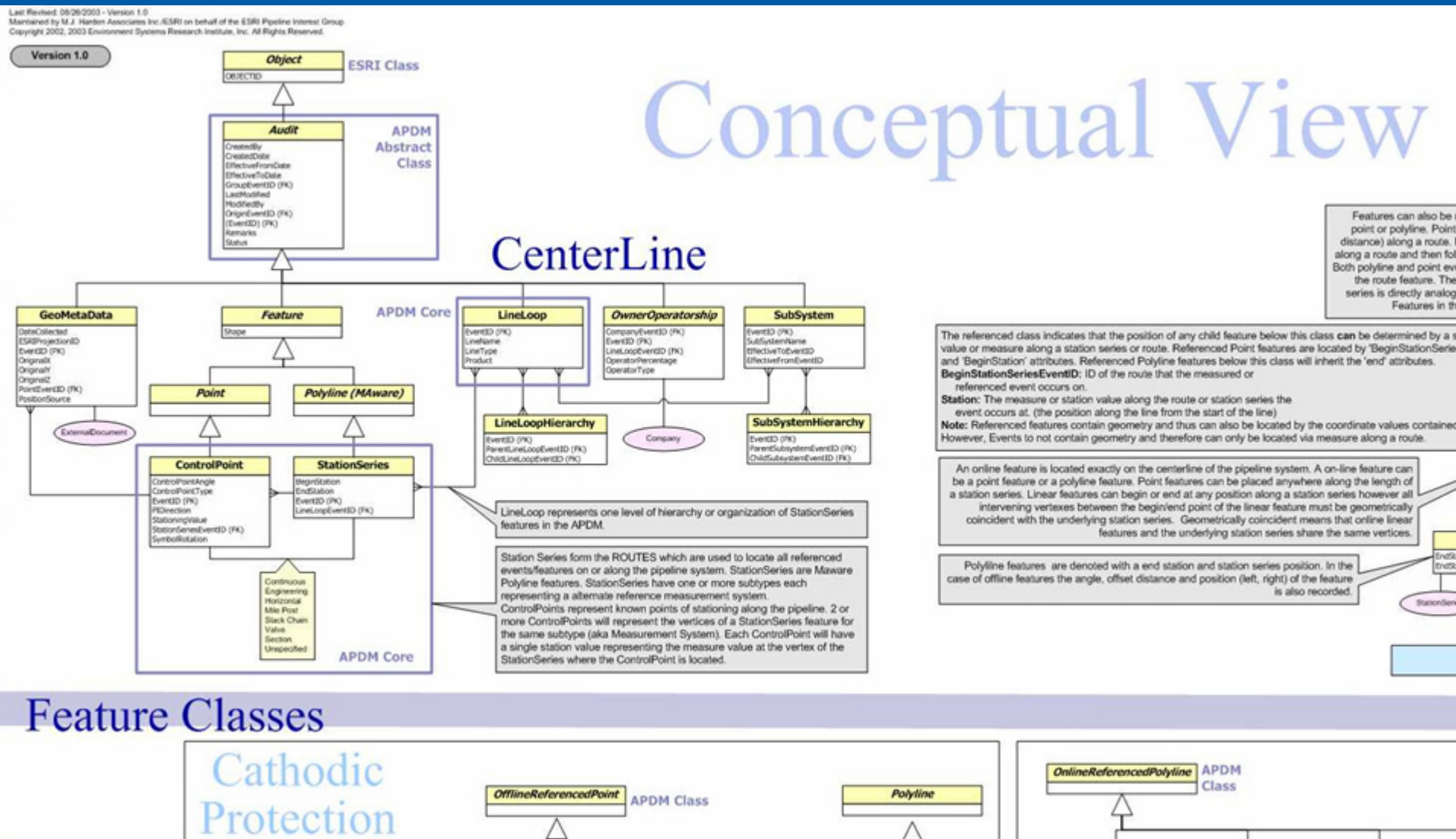
- Points, lines, polygons
  - Well Classes
  - Pipelines
  - Basemap surfaces
  - Linear referencing

Petroleum Templates and Resources



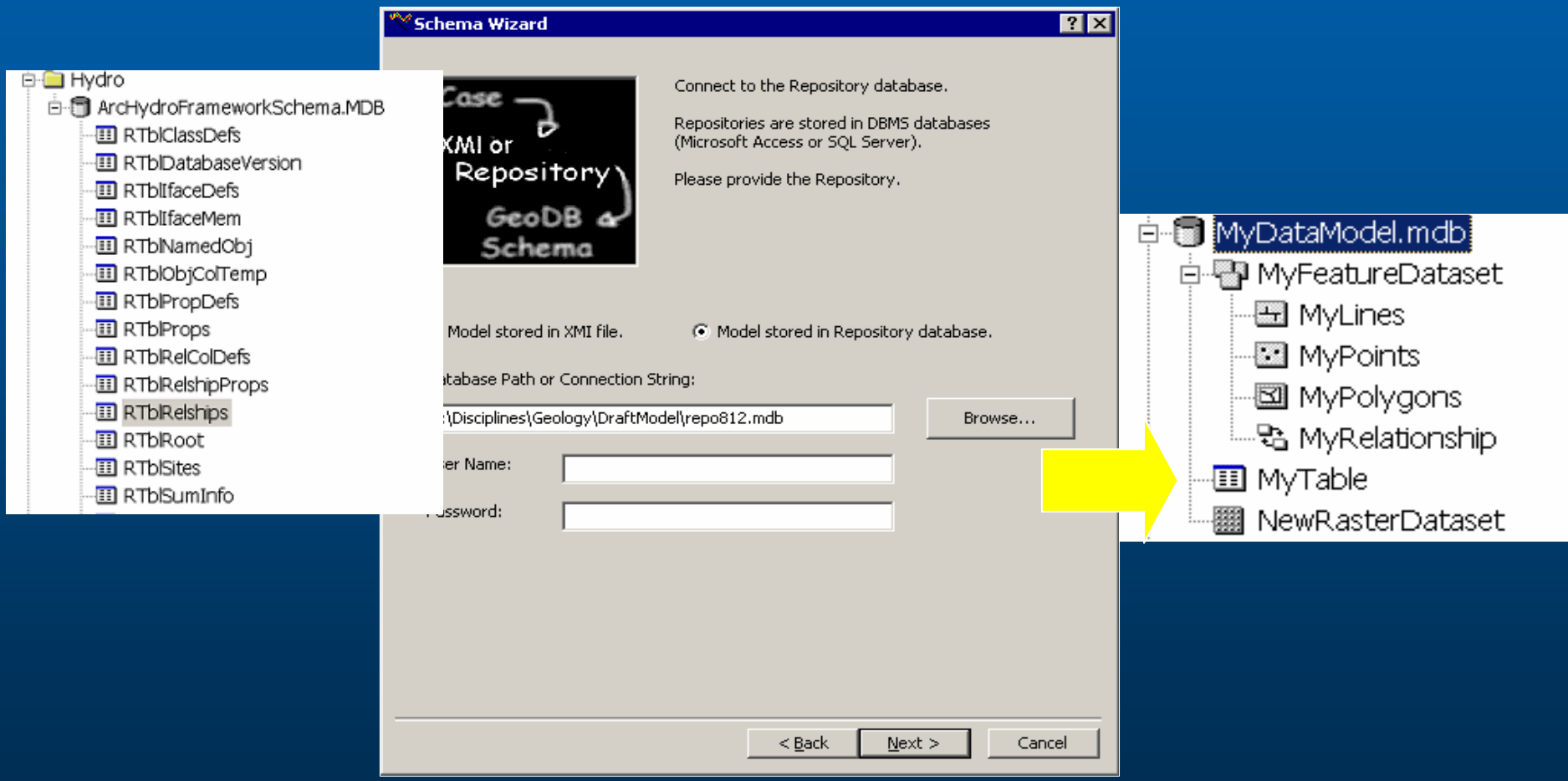
- Logical Models
  - Visio Format
  - GIF Image
- Reference Books
- Tips & Tricks Link

Logical Design Template (APDM)



Using a Design Template

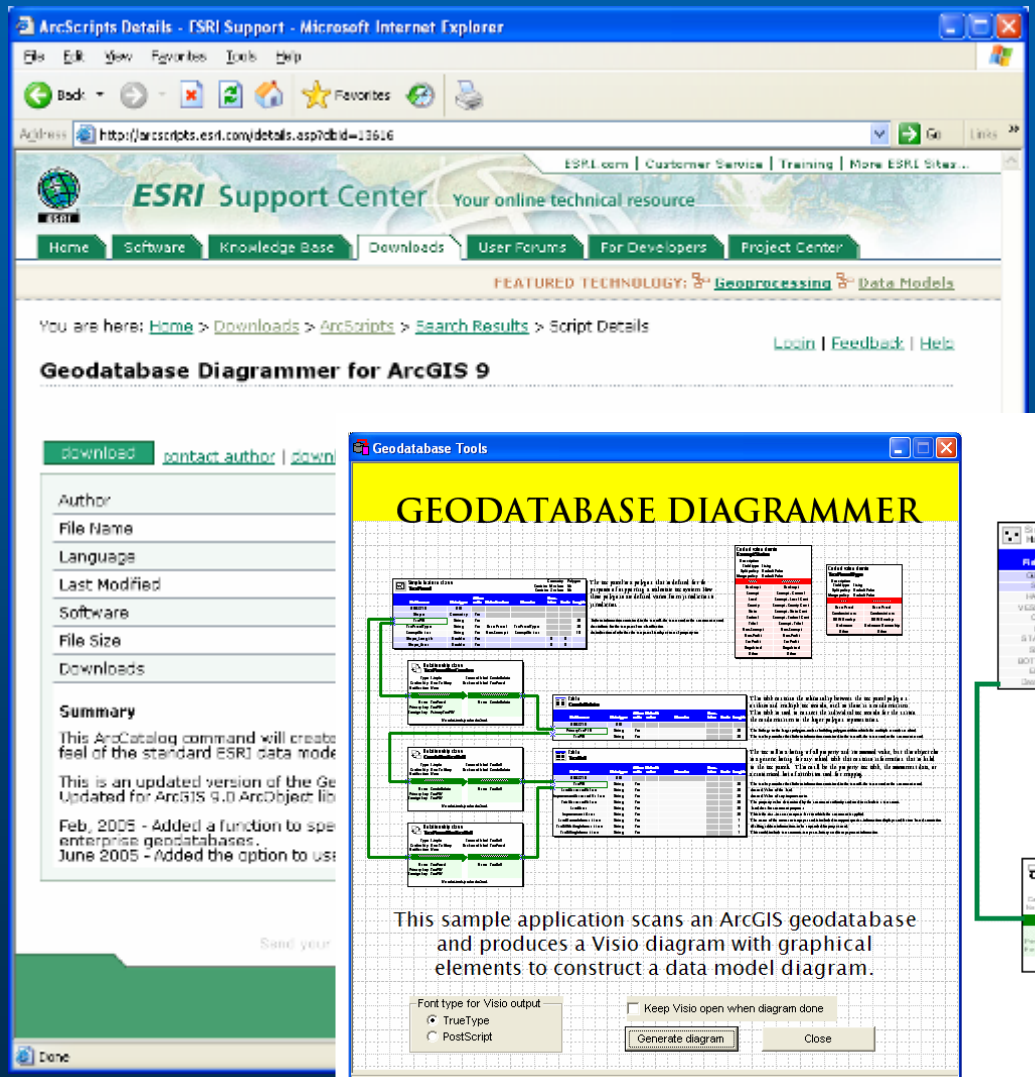
Schema Wizard reads repository or template to create a geodatabase

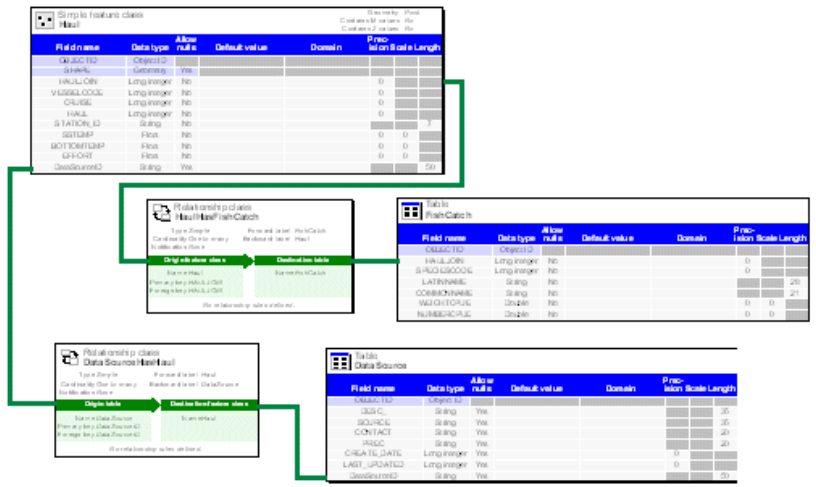


Some Tips and Tricks Online

Geodatabase Diagrammer

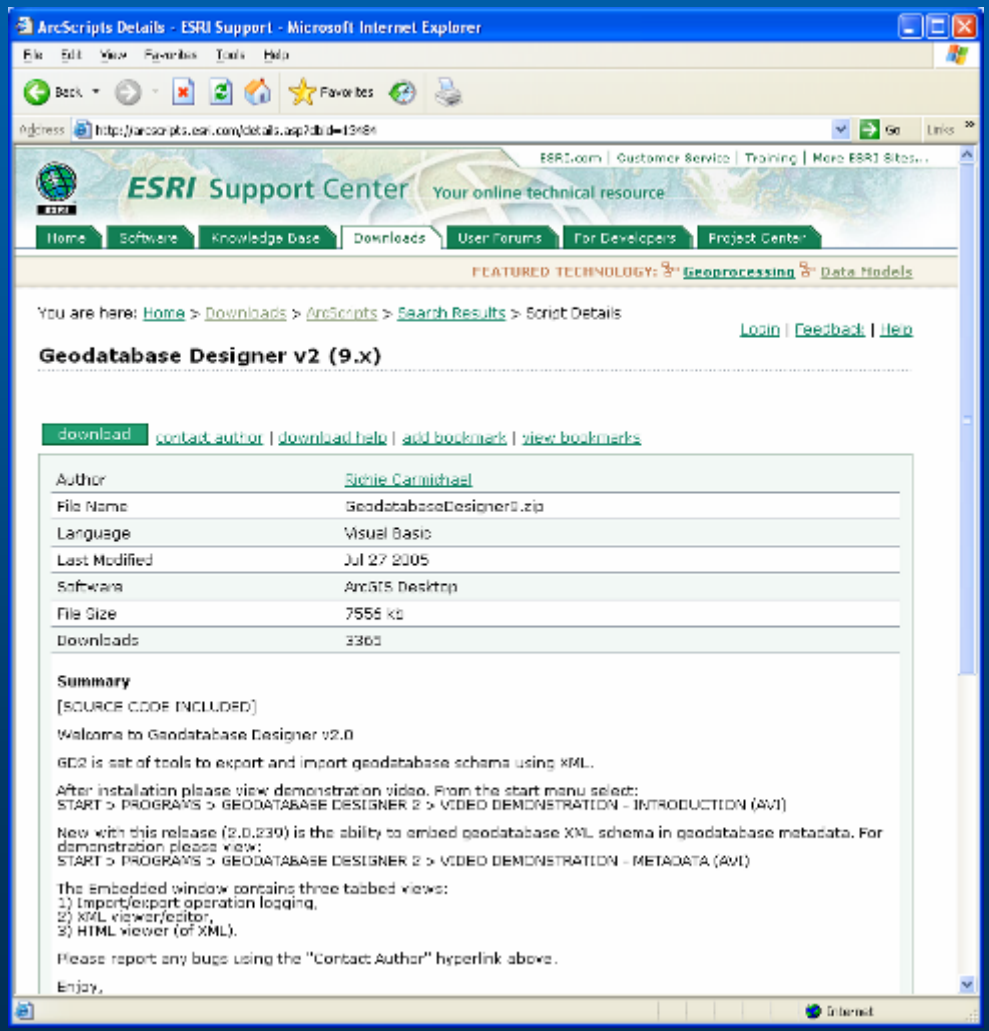
Create graphical representation of geodatabase





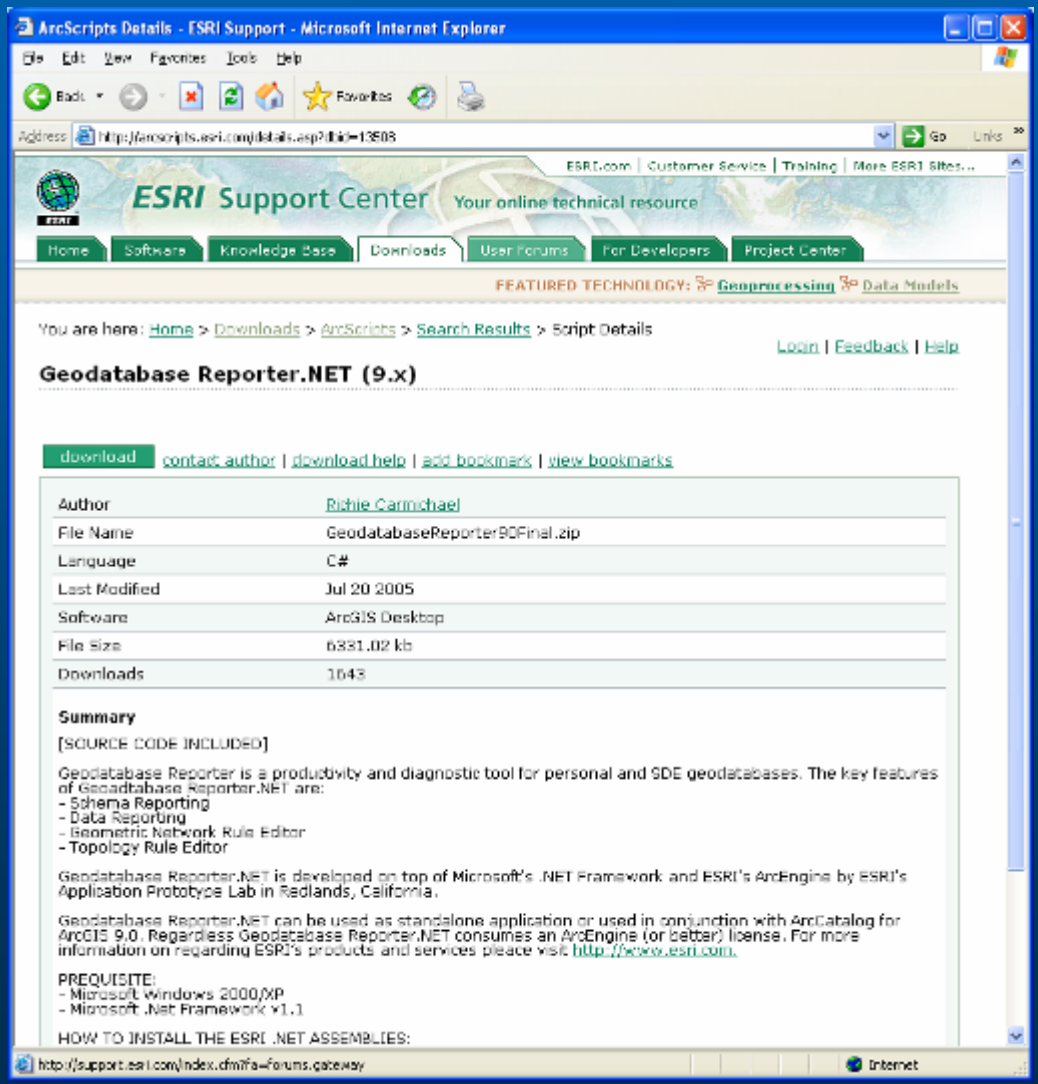
Geodatabase Designer

Import / Export Geodatabase Schema



Geodatabase Reporter

Create hyperlinked HTML reports of geodatabase



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
- Sample Case Study
  - within ArcGIS Data Models > Petroleum
- PPDM Spatial main website
  - linked from ArcGIS Data Models > Petroleum
    www.ppdm.org/standards/spatial
- PPDM Lite workflow
  www.ppdm.org/standards/spatial/ppdm_lite.html
- PPDM Lite online documentation
  www.ppdm.org/standards/model/lite_v1/documentation/html/index.html