energistics™
The Energy Standards Resource Centre

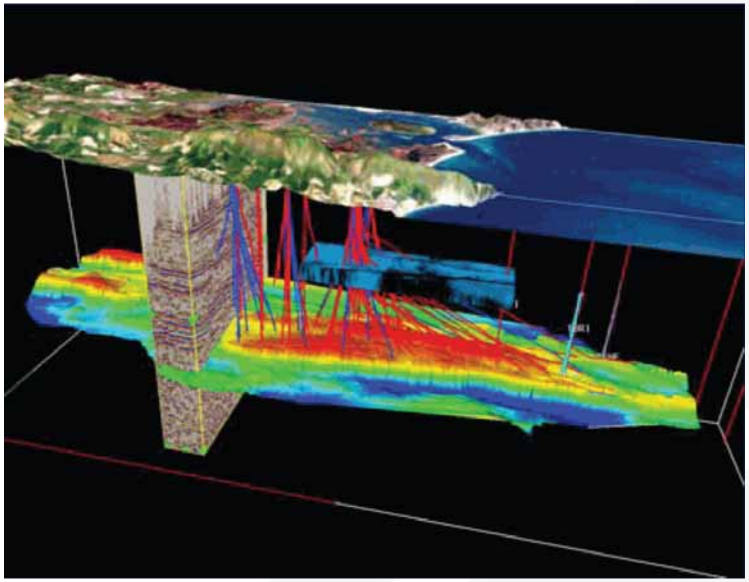
An Overview of RESQML™, the Reservoir and Earth Modeling Data Exchange Standard

Tony Fitzpatrick, Schlumberger

Finding Petroleum Conference, 20th April 2011

Outline

- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



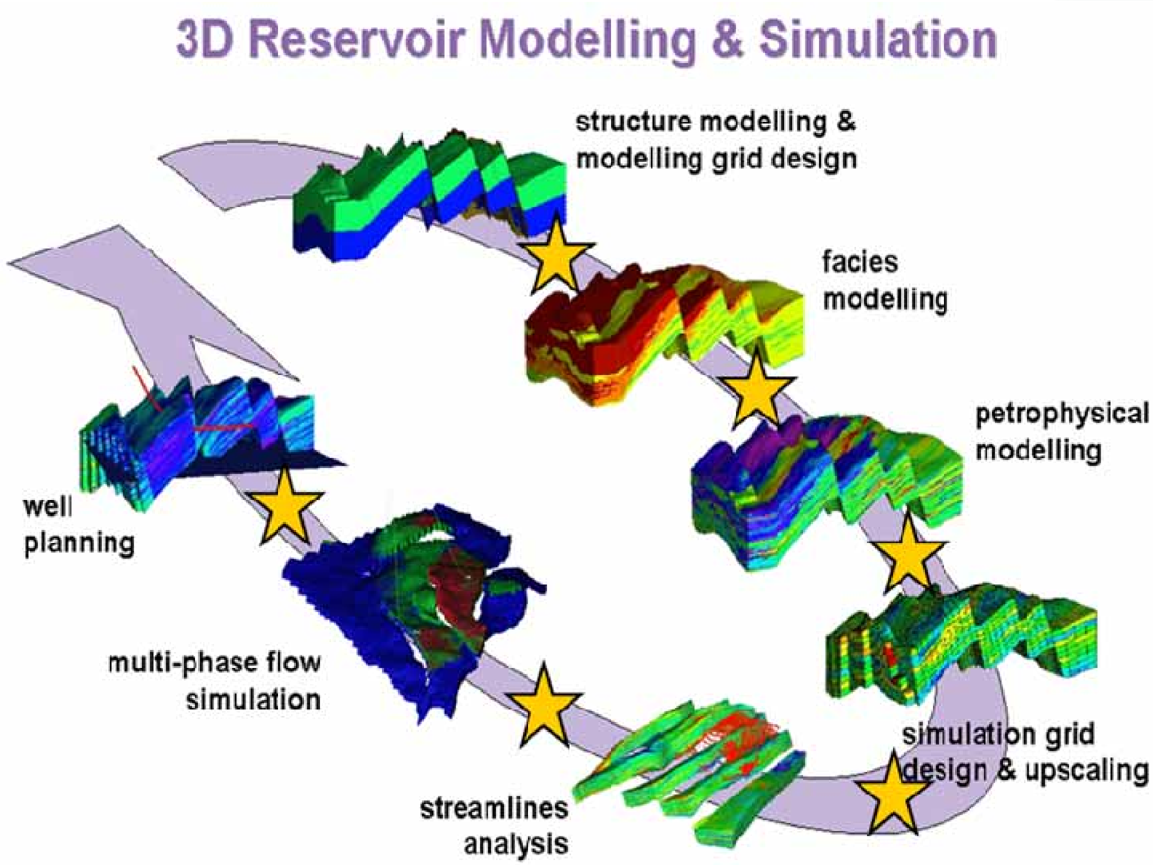
Motivation: Why RESQML?

- Reservoir modeling data standard:
  - To facilitate integrated workflows
  - Multiple applications with multiple vendors across multiple petro-technical domains
    - Robust workflows for the larger vendors
    - Innovation opportunities for the smaller vendors
    - Multiple use cases for the business
  - Business requires increased traceability
    - Meta-data as important as the data
  - Models are bigger and more complex

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

To Facilitate Integrated Workflows

- Multiple petrotechnical domains
- Multiple petrotechnical applications
- Multiple software vendors
- Multiple use cases within the business

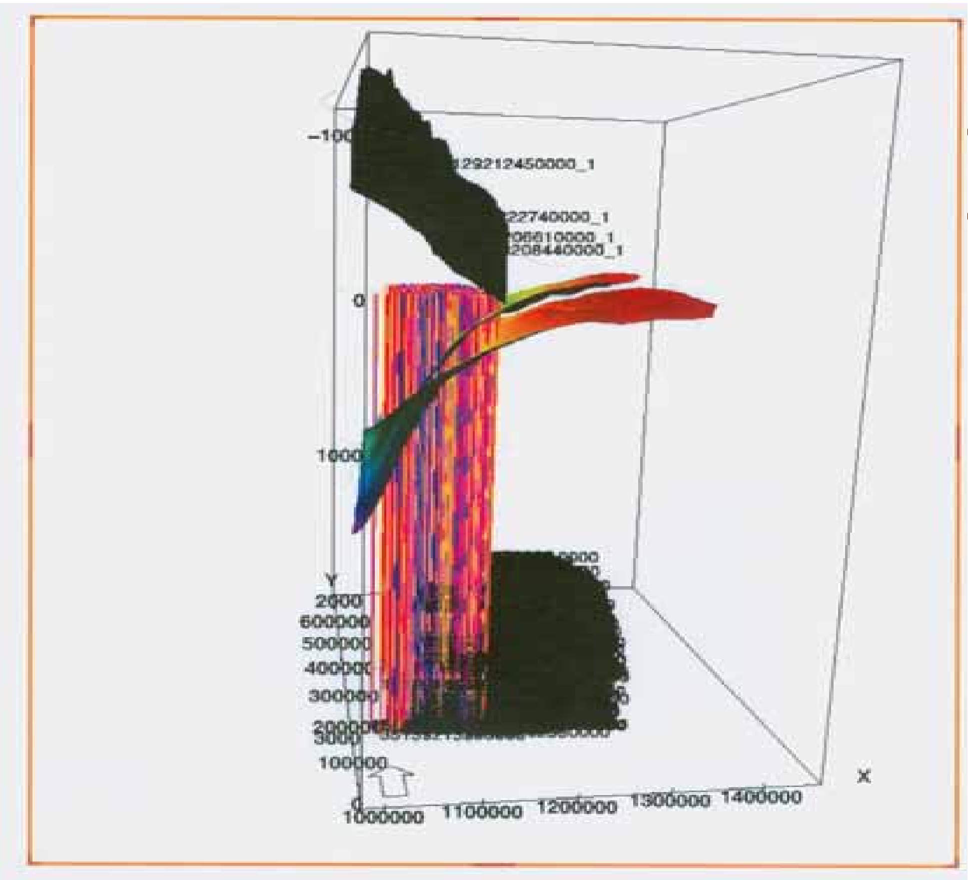


Graphic adapted from Roxar IRAP/RMS

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

To Improve Robustness of Data Transfers

Multi-company, multi-application data transfer

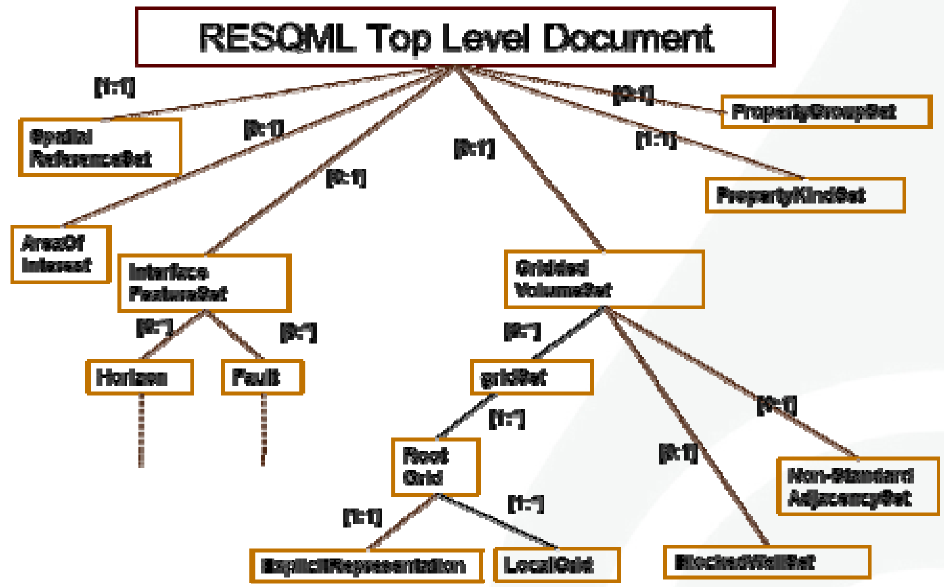


- Horizon data was OK
- Damaged in transfer:
  - Windows/Linux binary file formats
  - Well trajectories lost depth reference
    - 200+ onshore wells
  - 3D Grid inverted in depth / elevation

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

Outline

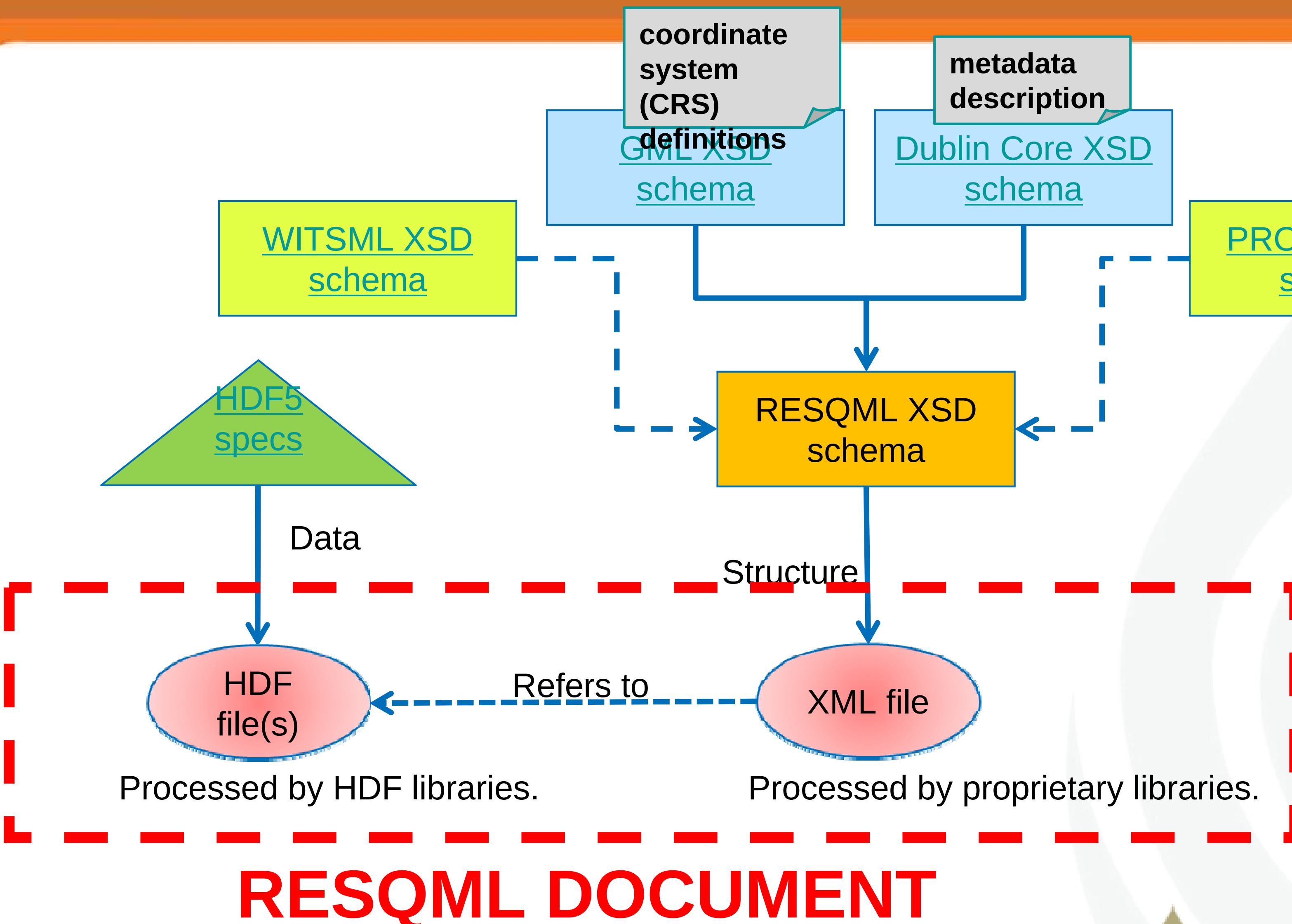
- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



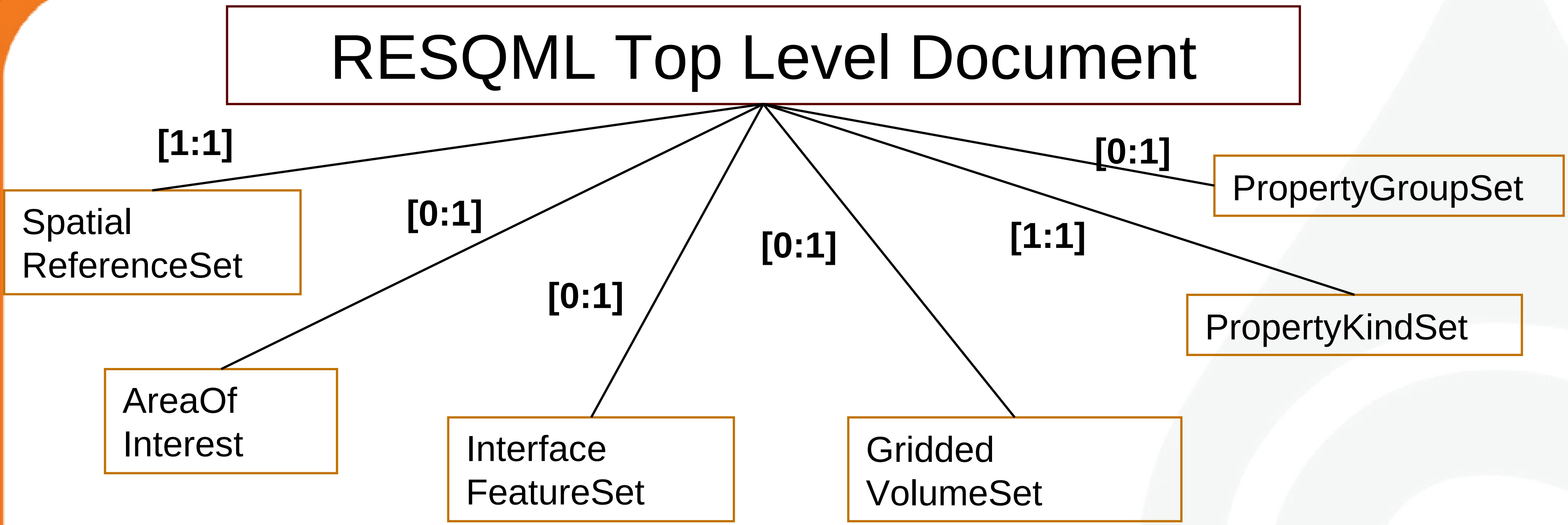
RESQML Document Description

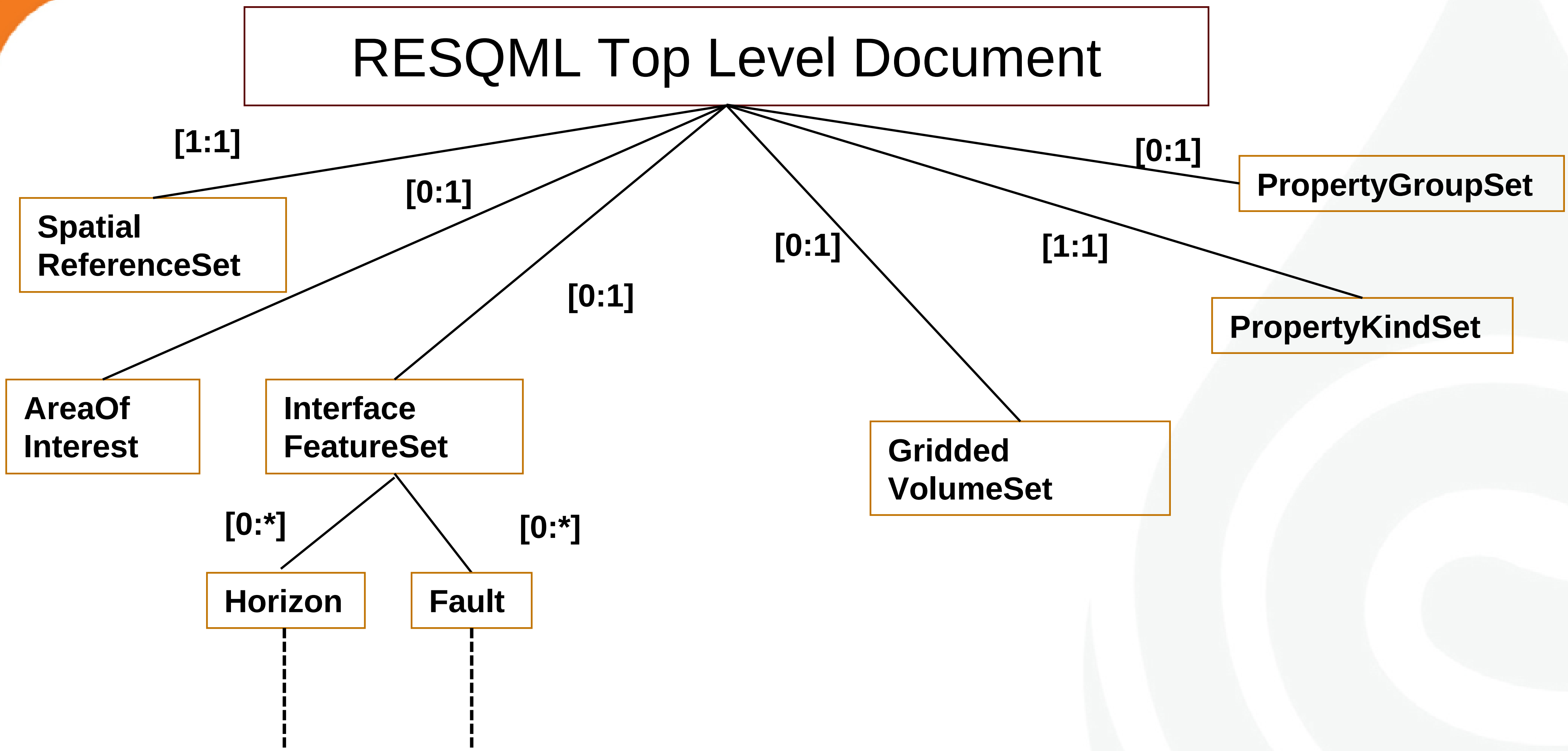
- RESQML XML is the fundamental data file
- HDF5 (Hierarchical Data Format v5) stores the large binary data (optional)
- XSD schema defines the data standard
- EPSG for spatial positioning
- Elements from Dublin Core for meta-data
- WITSML & PRODML

V1.0 Architecture

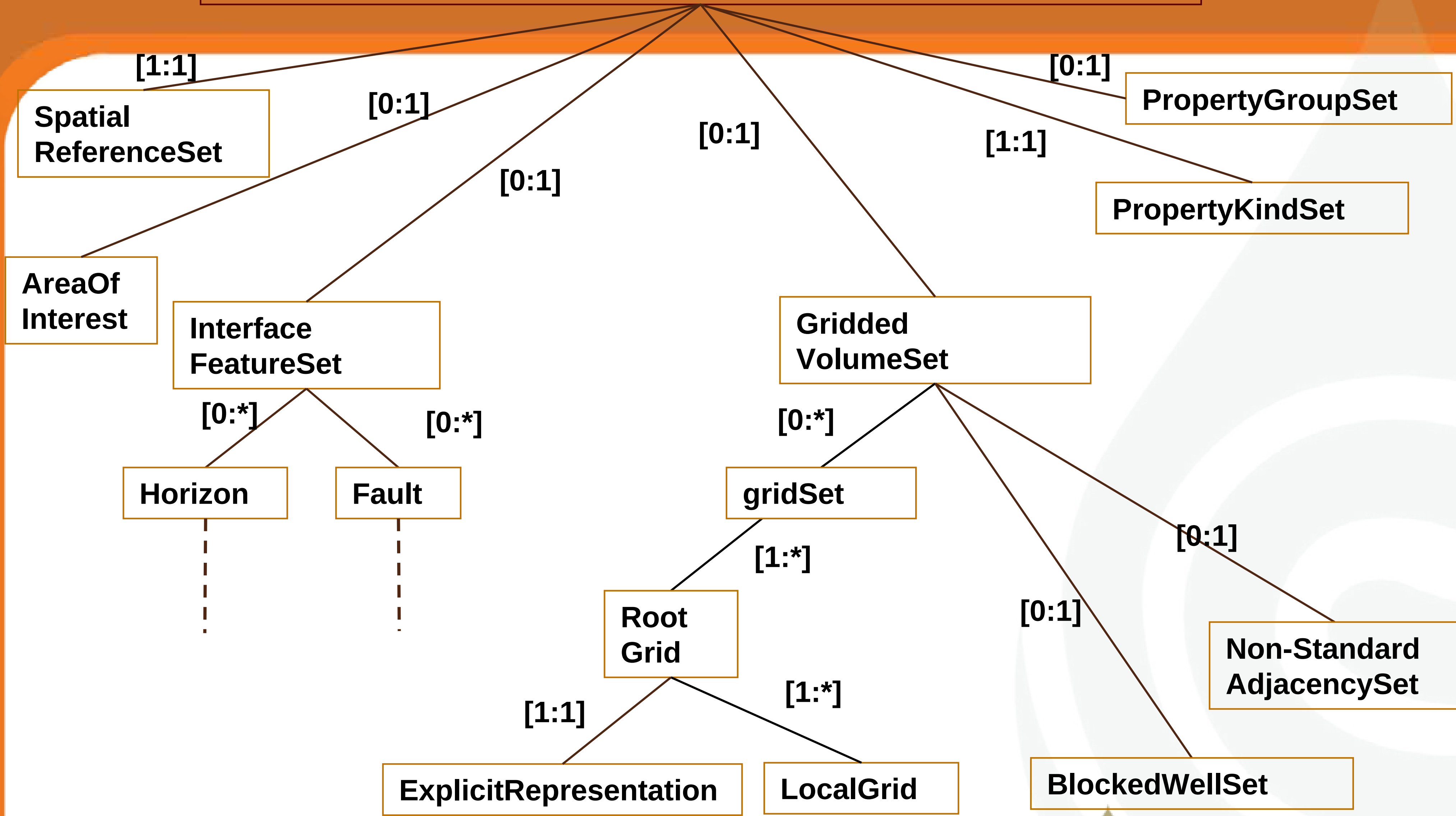


<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre


RESQML Top Level Document
[1:1]
Spatial ReferenceSet
[0:1]
AreaOf Interest
[0:1]
Interface FeatureSet
[0:1]
Gridded VolumeSet
[1:1]
PropertyKindSet
[0:1]
PropertyGroupSet


RESQML Top Level Document
[1:1]
Spatial ReferenceSet
[0:1]
AreaOf Interest
[0:1]
Interface FeatureSet
[0:*]
Horizon
[0:*]
Fault
[0:1]
Gridded VolumeSet
[1:1]
PropertyKindSet
[0:1]
PropertyGroupSet

RESQML Top Level Document



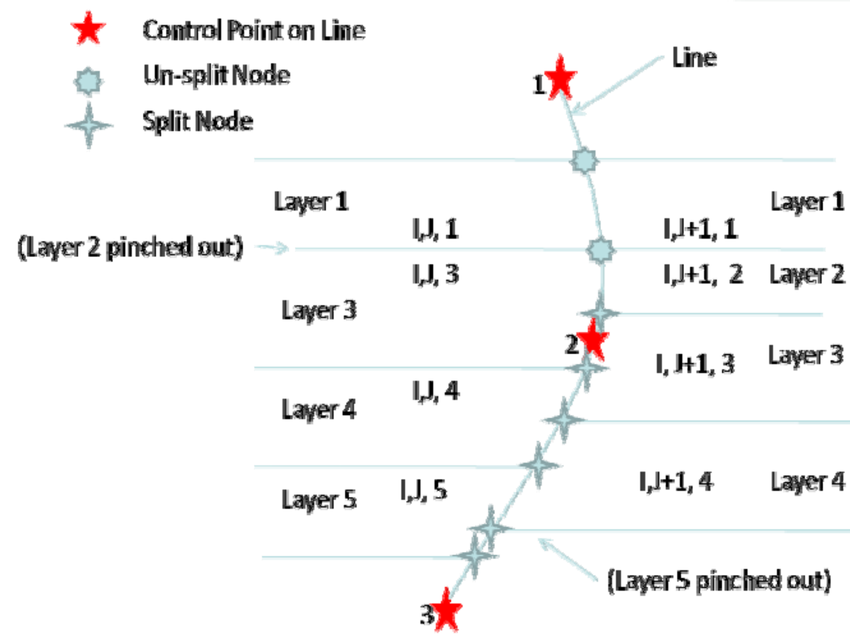
<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

RESQML Document Structure

- Robust yet flexible
  - Spatial Reference Set is required
  - No other document sets are required
- Data Object Traceability
  - Unique GUID’s and Dublin Core meta-data
- Structural data: InterfaceFeatureSet
  - Horizons and Faults
- 3D discretized data: GriddedVolumeSet
  - Grids, Properties, Adjacency, and Wells

Outline

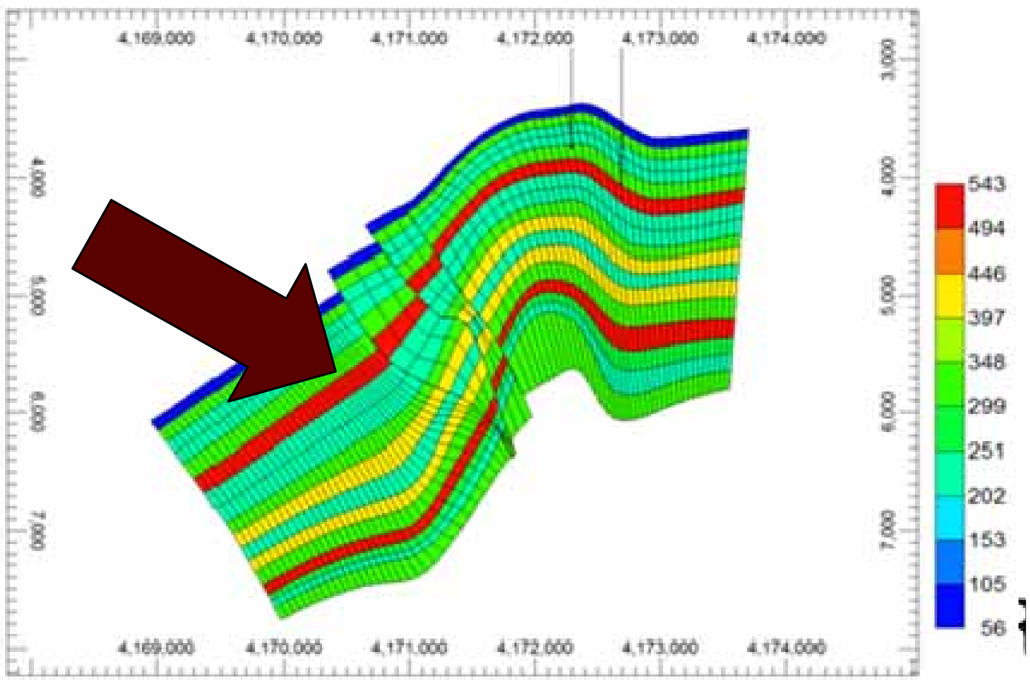
- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



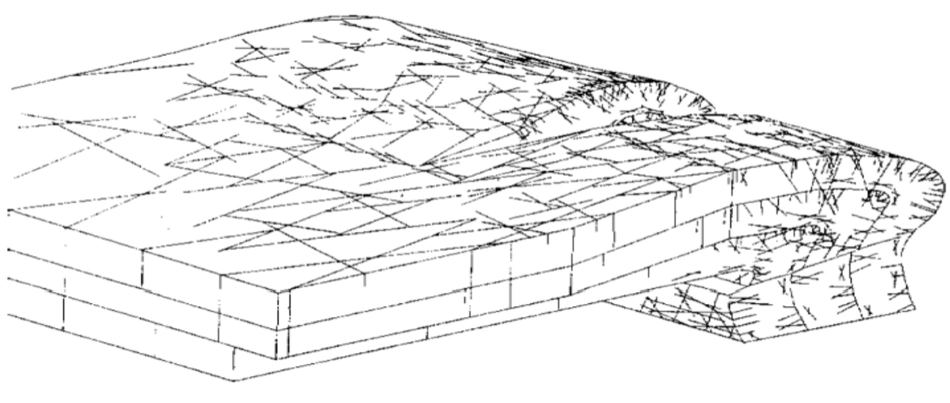
<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

RESQML Corner Point Grid Geometry

- Each cell is defined by its 8 corner nodes
  - Nodes lie on curved coordinate lines to represent complex reservoir structure
- Multiple root grids and local grid refinement



Cupiagua Reservoir



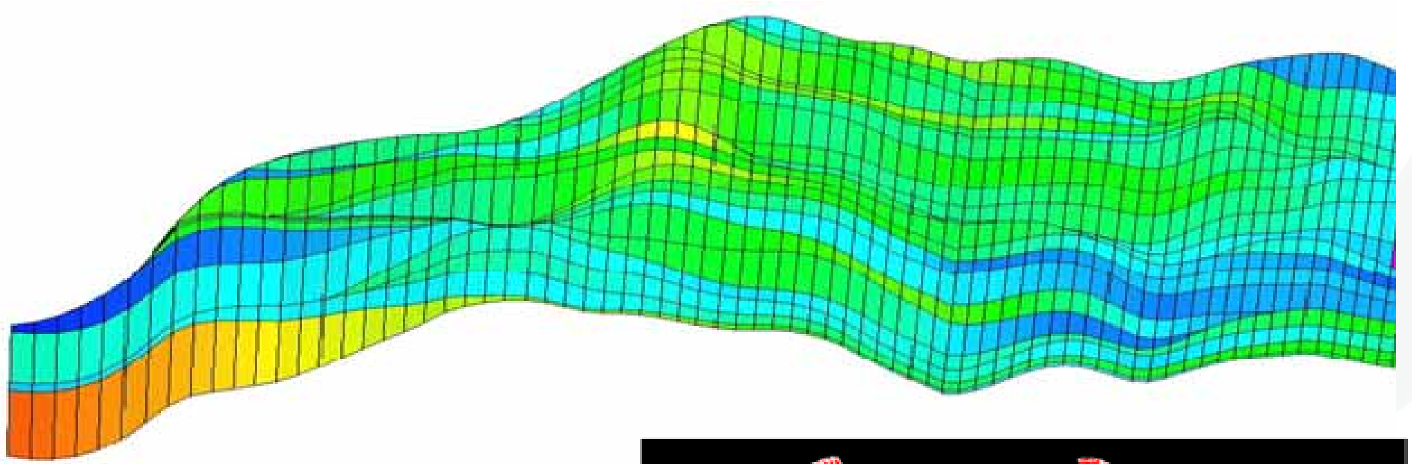
RESQML Corner Point Grid Topology

- Topological indicators are required to describe cell Pinch-out & Standard Adjacency between cells
  - No geometric interpretation required
- Non-Standard Adjacency
  - Required for faulted and local grids
  - Geometry is described by cell face pair lists
  - Properties may be static or dynamic

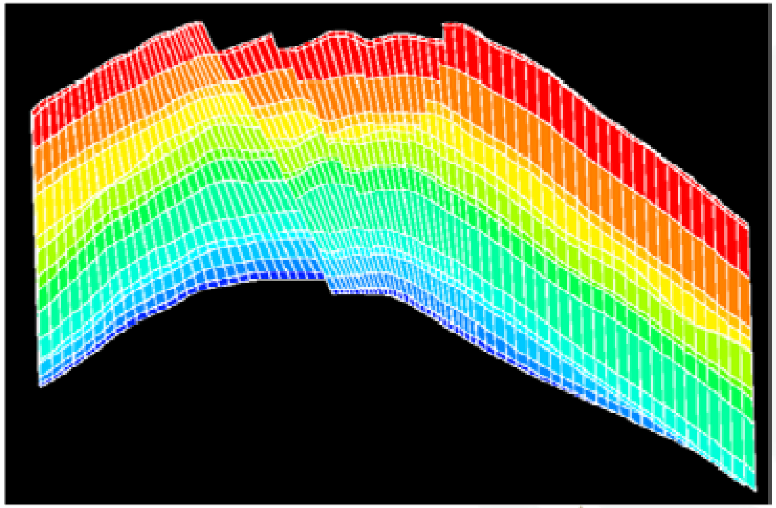
id1	i1	j1	k1	face1	id2	i2	j2	k2	face2

Examples of Complex Topology

- Complex stratigraphy (turbidite reservoir)

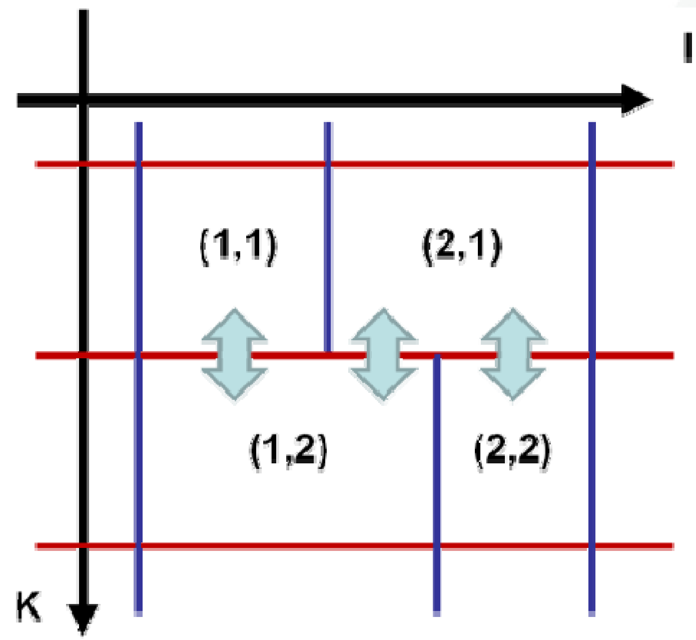


- Complex faulting (Deepwater GOM reservoir)



Outline

- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary

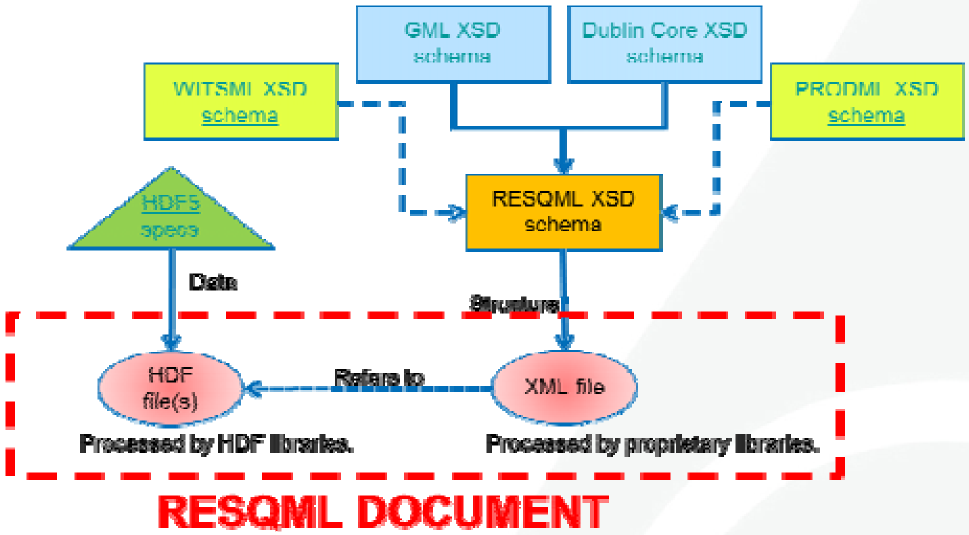


RESQML Property Representation

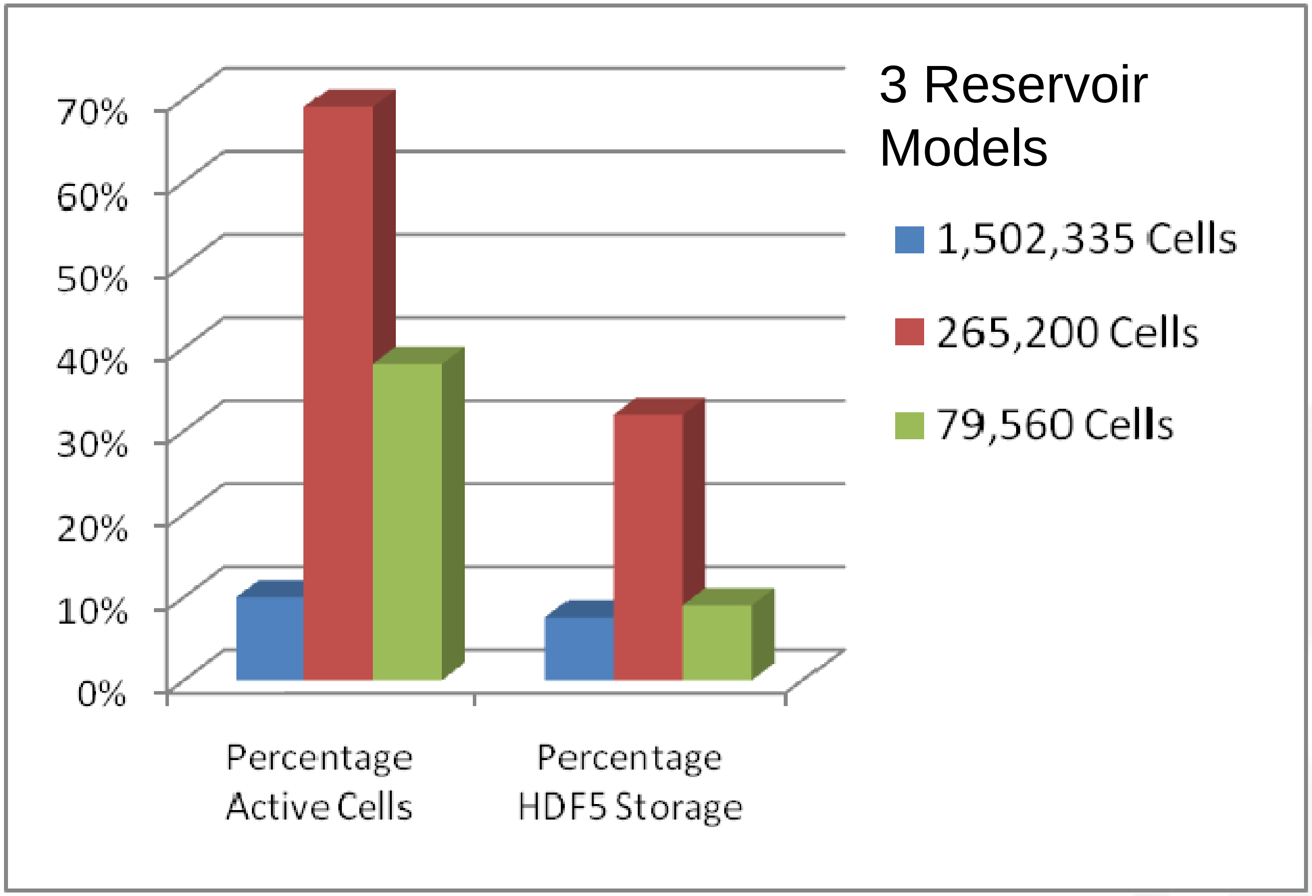
- Gridded Properties
  - Describe geometry and property values separately
  - Supports property groups, e.g., simulation time-steps
- Blocked Wells
  - Geometry: Cell lists ordered by measured depth
  - Properties may be static or dynamic
- Non-Standard Adjacency managed similarly
- HDF5 provides an efficient means of storing data
  - Support for hyper-slabbing to access IJK slabs of data
  - No specific treatment for packing data for inactive cells appears to be necessary

Outline

- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



HDF5 Storage Performance

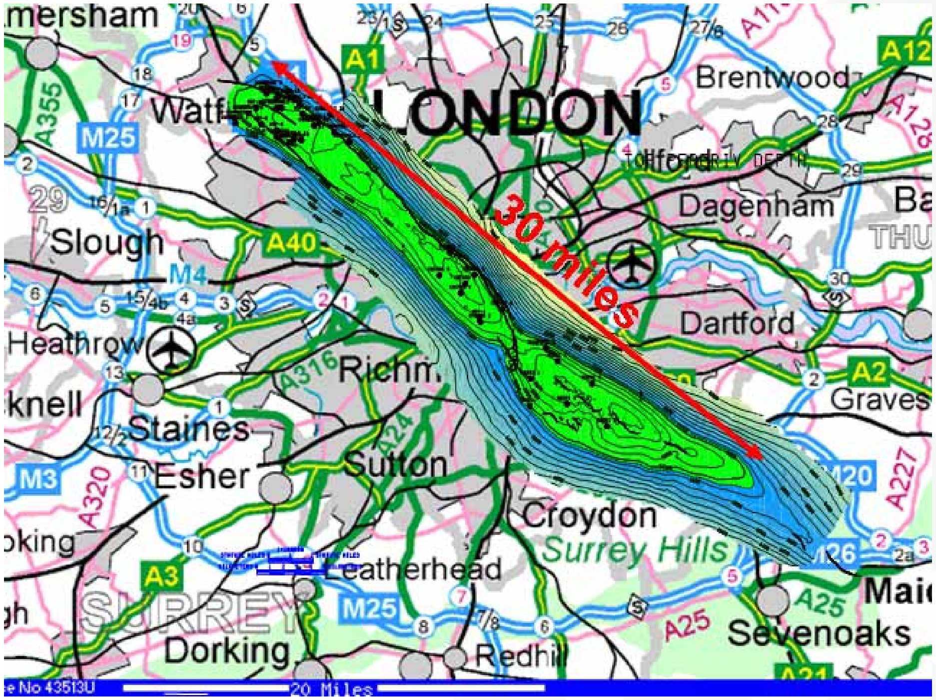


- Comparison of HDF5 storage efficiency with storage for active cells only

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

Outline

- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



Roadmap: Delivery Plan

- RESQML V1
  - Published January 2011
  - Release of RESQML data standard to application vendors
  - 3 ILAB's/year used for development
- Application development during 2010:
  - Inclusion of RESQML V1 in next application development cycle for 2011/2012 (?) release
    - Check with your specific vendors

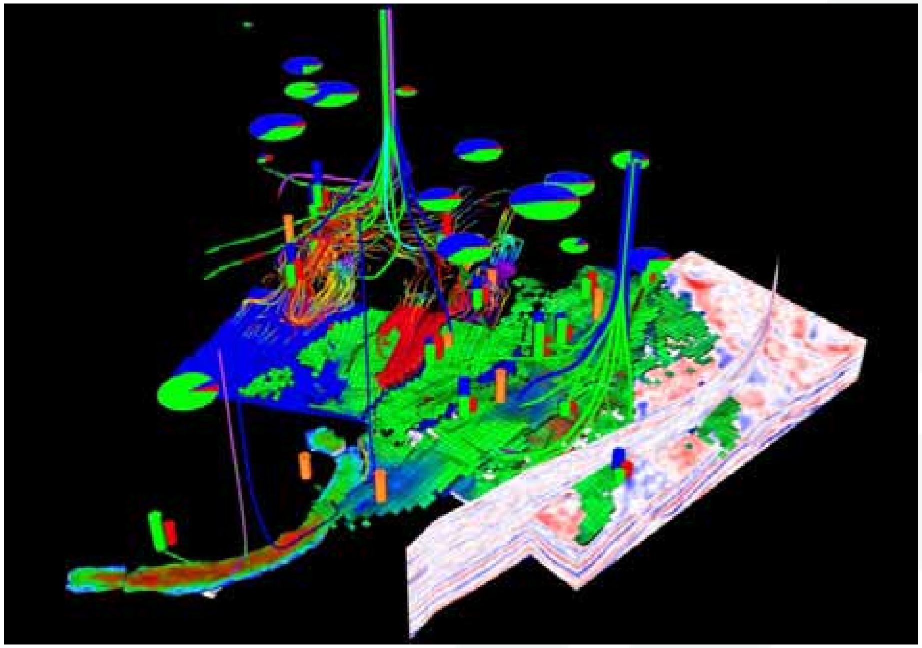
Roadmap: RESQML V2+ Development Plan

- Data objects which store relationships
  - Structural frameworks of horizons + faults
  - Earth models of structure + grid
  - Multiple scenarios, realizations, …
- Additional 3D Grid representations
  - Unstructured or abstract representations for 2D/3D PEBI, XY-OT, streamlines, …
- Simplified and efficient representations
  - XY regular, 3D Seismic, parametric grids, …

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

Outline

- Motivation
- RESQML Document
- Grid Description
- Property Representation
- HDF5 Performance
- Roadmap
- Summary



Summary

- RESQML:
  - Continued requirement for robust data transfers
  - Emphasis on GUID's and metadata for traceability and workflow flexibility
- GRIDS:
  - Corner point cells and coordinate line description for flexibility
  - Introduction of topologic description to remove ambiguities in geometric interpretation
  - Complete replacement for RESCUE features

<WITSML/>™ <PRODML/>™ <RESQML/>™ energistics™ The Energy Standards Resource Centre

RESQML SIG: Member Companies

- Austin GeoModeling
- BP
- Chevron
- Computer Modeling Group
- Dynamic Graphics, Inc.
- Halliburton
- Institut Francais du Petrole
- JOA Oil & Gas BV
- ONGC
- Paradigm
- Pioneer Natural Resources
- Roxar
- Schlumberger
- Shell
- Total
- Transform Software & Services

energistics™ The Energy Standards Resource Centre

TOTAL met en place les standards d'échange de données (open data exchange) d'Energistics pour simplifier les architectures IT et contribuer de façon efficace à l'exploration et à la production de champs de plus en plus complexes.

TOTAL is implementing Energistics open data exchange standards to simplify IT architectures and contribute efficiently to the exploration and production of increasingly complex fields.

Philippe Malzac
Chief Information Officer, E&P, Total

energistics™
The Energy Standards Resource Centre

Resources

- For more information about RESQML and Energistics:

  www.Energistics.org

- SPE135280: Reservoir Modeling: From RESCUE To RESQML™

  Michael J. King, Texas A&M University, Paulo Ballin, BP America, Inc., Chakib Bennis, Institut Français du Pétrole, David Heath, Transform Software, Allan Hiebert, Computer Modeling Group, William McKenzie, Chevron, Jean-Francois Rainaud, Institut Français du Pétrole, Jana Schey, Energistics

- SPE143846: Using RESQML™ for Shared Earth Model Data Exchanges between Commercial Modelling Applications and In-House Developments, Demonstrated on Actual Subsurface Data

  Francis Morandini, Bruno Michel and Philippe Verney, Total; Jean-Francois Rainaud, IFP; Laurent Deny and Jean-Claude Dulac, Paradigm; Tony Fitzpatrick, Schlumberger; Rob Eastick, CMG; Lisa Towery, BP

Thank you!

Questions????