Improving The Reliability Of Reservoir Models Using Diverse Software Workflows*

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Abstract

Reservoir modeling has always involved a broad spectrum of technologies, from seismic interpretation, through well calibration, reservoir characterization, rock and fluid properties using rock physics and geomechanics, leading up to the dynamic simulation of the reservoir's production. Innovative companies are constantly improving the accuracy and reliability of models. While single-platform software suites offer the benefit of efficiency with a seamless workflow execution, they typically require compromises in terms of functionality, and cannot compete with specialized point solutions at every step of a rich workflow and for all the different geological and reservoir challenges encountered by geoscientists and engineers. Workflows that comprise multiple vendor solutions have been a challenge due to the burden of transferring large amounts of data back and forth using ineffective one-on-one connectors, and the loss of information that often occurred through such transactions. That has now changed. The latest industry-developed RESQML data exchange standard from Energistics is comprehensive enough to include all the data of a reservoir modeling and simulation project in a single bundle, complete with ample metadata and a unified indexing of subsurface objects. A software system, whether it is a broad integrated workflow product or a specialized tool, needs only to develop a read and a write interface to this standard format to be able to communicate comprehensively with all other compliant systems. This avoids the need to know any specifics about the other systems and allows data from each step to move through the workflow with complete fidelity. Work on enriching models and reservoir data is incremental over time. New wells are drilled, seismic is reprocessed or new surveys are acquired, and many other activities take place that change the initial model. To manage this efficiently, i.e. to avoid exchanging the whole dataset every time there is a change, the RESQML exchange standard also allows incremental modifications and additions to the initial dataset. A pilot project was successfully conducted in 2018 using a full operator dataset from a Gulf of Mexico offshore field, with a complex workflow involving 6 independent software platforms, seamlessly moving the data between them using the RESQML data exchange format. This live exercise was conducted using two different cloud instances and virtual machines hosting each of the applications.

Improving the Reliability of Reservoir Models Using Diverse Software Workflows

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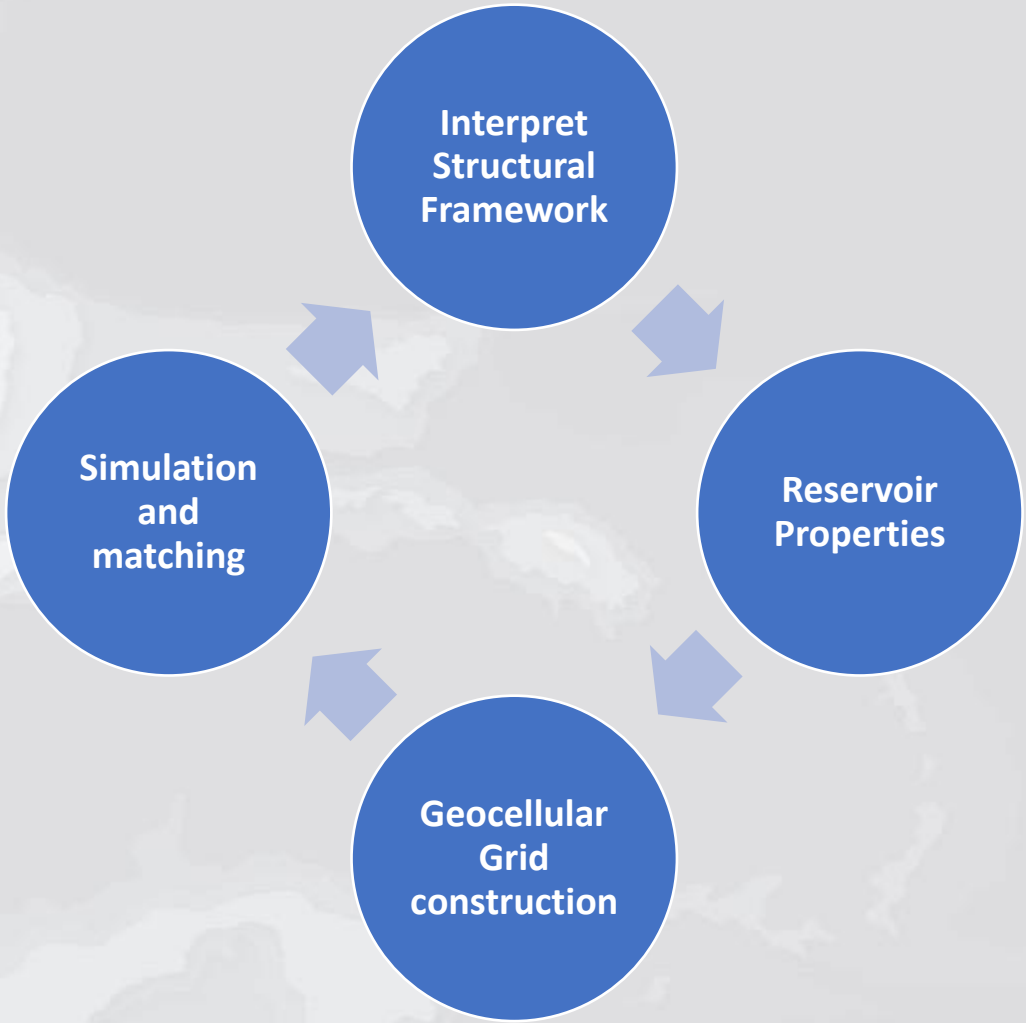
Overview

- Technology-rich cross-discipline workflows
- The need for diversity
- Legacy barriers
- A standards-based solution
- Proof of concept
- Conclusions

Technology-rich cross-discipline workflows

20 to 30 years ago, workflows
were relatively simple and mostly linear
(assembly-line data hand-over)



Technology-rich cross-discipline workflows

10 to 20 years ago, workflows became more multi-disciplinary with new activities bringing new and often more complex data types

Technology-rich cross-discipline workflows

Modern workflows are definitely multi-disciplinary and non-linear, data moves back and forth in iterative loops and is often routed to and from specialty applications

More of everything

- More complex reservoirs and challenges (e.g. EOR)
- More technologies to apply to a dataset
- More data types and larger data volumes for a reservoir project
- More actors (other departments, vendors, consultants, …)

But…

- Same staffing
- Same amount of time to get things done

The need for diversity

- One vendor can't deliver state-of-the-art at all steps
- Workflows include many more iterative or side-step elements
- Many new actors in the geoscience – engineering space
  - Start-ups
  - "Other industry" entrants
  - Use of generic applications (Analytics, AI, ML, ..)
- The cloud has changed metrics, licensing, data location

Diversity requires plug & play

- Peer-based data exchanges or interoperability
- Preservation of application-specific data
- No imposition of workflow sequence
- Proper retention of identity of objects
- Universal approach to reference systems (units, geodetics, etc)
- Simple exchange packaging when applicable

Legacy barriers

- Data transfers using APIs or DevKits
  - Need to learn the particularities of each target system
  - Need to update links every time a new version is released
  - Variable quality and documentation for APIs or DevKits
- Using data files
  - LAS, ASCII grids and others – generates large numbers of files
  - Relationships are lost, references are poorly documented
  - Difficulty keeping track of the completeness of a transfer

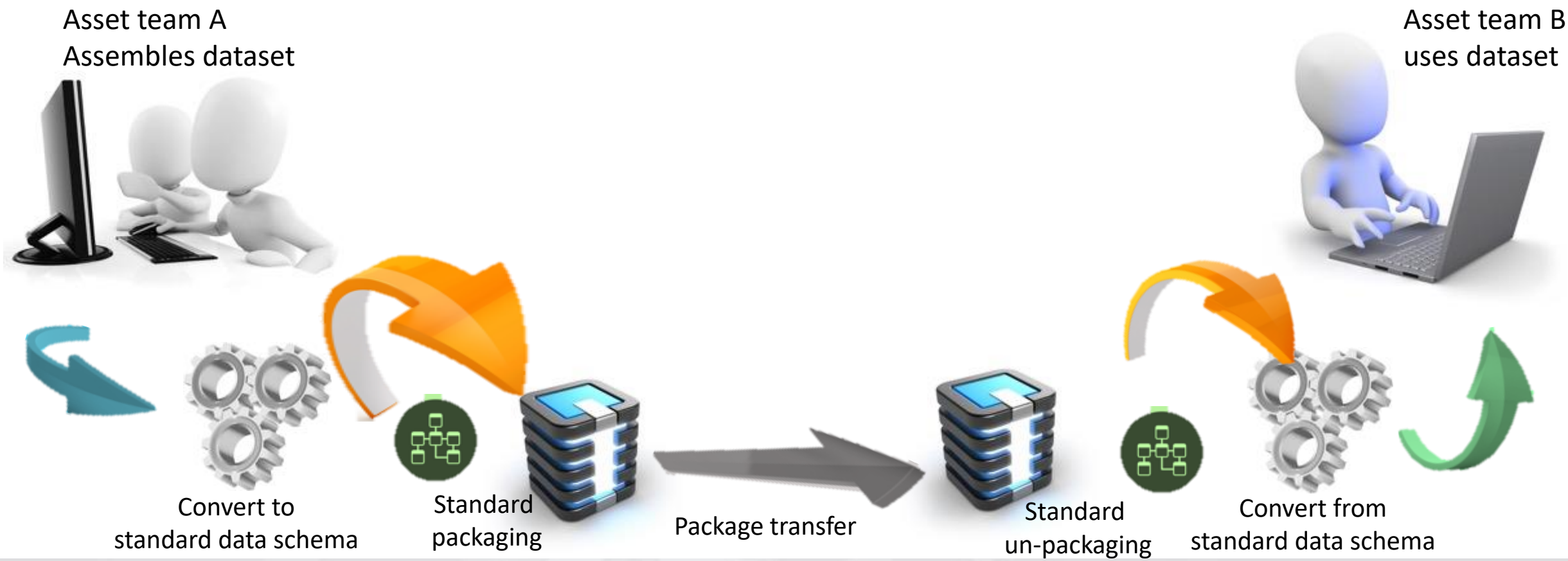
Impact of data exchange difficulties

- Time spent exporting, moving and reading files
- Or, time spent developing testing & maintaining one-to-one links
- Practical impact:
  - An operational limit on the number of software systems in use
  - A barrier to adopting new products, more so from new vendors
  - Difficulty in expanding workflows to new areas of activity

Standards for reservoir datasets

- Part 1: Agree on a standard “superset” data model that …
  - Includes all known representations of commonly used data objects
  - Addresses all modes of reference and relation
  - Labels with a unique ID each instance of a data type to avoid confusion
- Part 2: Leverage a packaging process to simply transfers
  - Keep track of all the components and their relationships
  - Metadata on the project, the files, etc..
  - Specific file for very large data objects (HDF5)

Standard Data Packaging for Transfers

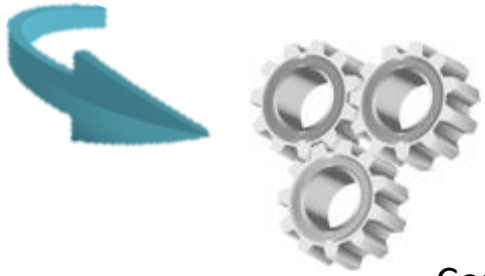


Direct interoperability (in progress)

- Substitute the read of a file written by another software package
- Directly stream in new data from any other compliant package
- Same universality
  - Receive or Send operations include transformations to-from the standard
  - No intermediate file created
  - Suitable for intranet and/or cloud operation
  - Currently testing, release estimated for 2020

Standard Data Packaging for Transfers

Asset team A
Assembles dataset



Convert to
standard data schema

Transfer

Asset team B
uses dataset

Convert from
standard data schema

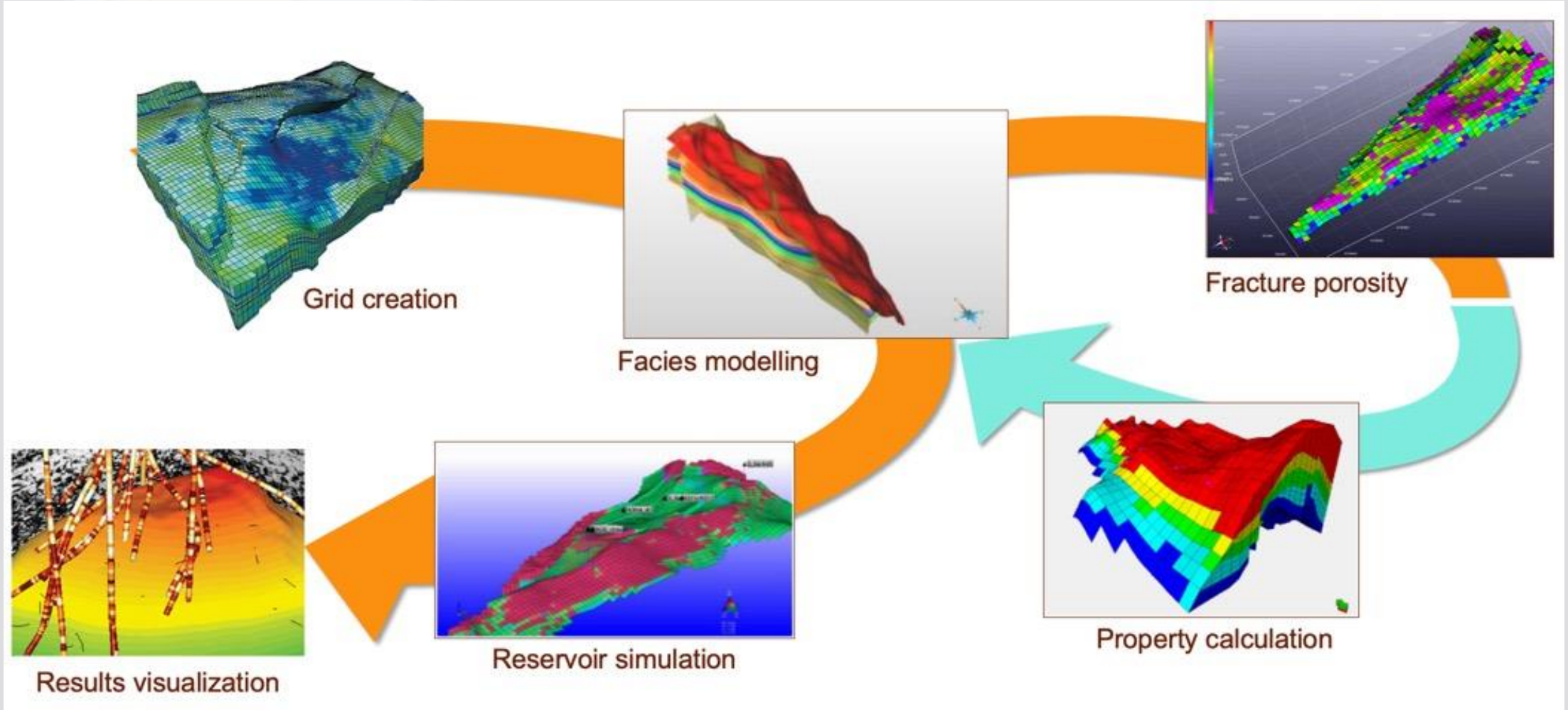
A live demo as proof of concept

- Goal: show viability of standardized file transfers
- Dataset: complete dataset of GoM field in the cloud
- Software: 6 commercial packages
- Workflow: enrich reservoir model, simulate and display

Note: each software system could have performed much larger parts of workflow

Workflow schematic

[Performed live at SEG 2018 in 45 minutes, exchanges of partial or whole dataset lasting 3-5 minutes each]



Execution of the PoC demo

- Each application read the transfer package
- A transformation or editing of the data was performed
- The new version of the package was exported
- One step involved transfer to a separate cloud and back
- In all, the demonstration lasted 45 minutes
- Any step could have been skipped or substituted

Conclusions

- Standardization of data transfers increases technology diversity
- Increased collaboration de-risks decisions
- Data verification workloads are reduced
- A standard file is future-proof, datasets can always be re-used

Thank You

Questions are welcome

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