Big Data Analytics for the Subsurface:
enabling better reservoir management

Dr Duncan Irving, Teradata Oil and Gas Practice Lead

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Agenda

Big Data and Analytics

The current landscape

Big Data Analytics approaches

1. Discovery Analytics
2. Operational Analytics

What is all the hype about Big Data?

The subsurface has always given us big data, right?

Big Volume ≠ Big Data

- "**Big data** is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization." (Gartner, 2012)
- Subsurface data has ***low value density*** **–** there is a lot of data to filter out
- **but** when ***combined*** with other data types and business processes, the reservoir domain presents a Big Data problem

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Question: How do we get more value from our data?

- Our data managers are highly skilled "librarians"
- Our application databases signpost the books, **not the data in the books**
- Data integration can only occur after complex and often one-off transformation
- Application workflows are inflexible and compartmentalised
- It is a long journey from the data to the decision

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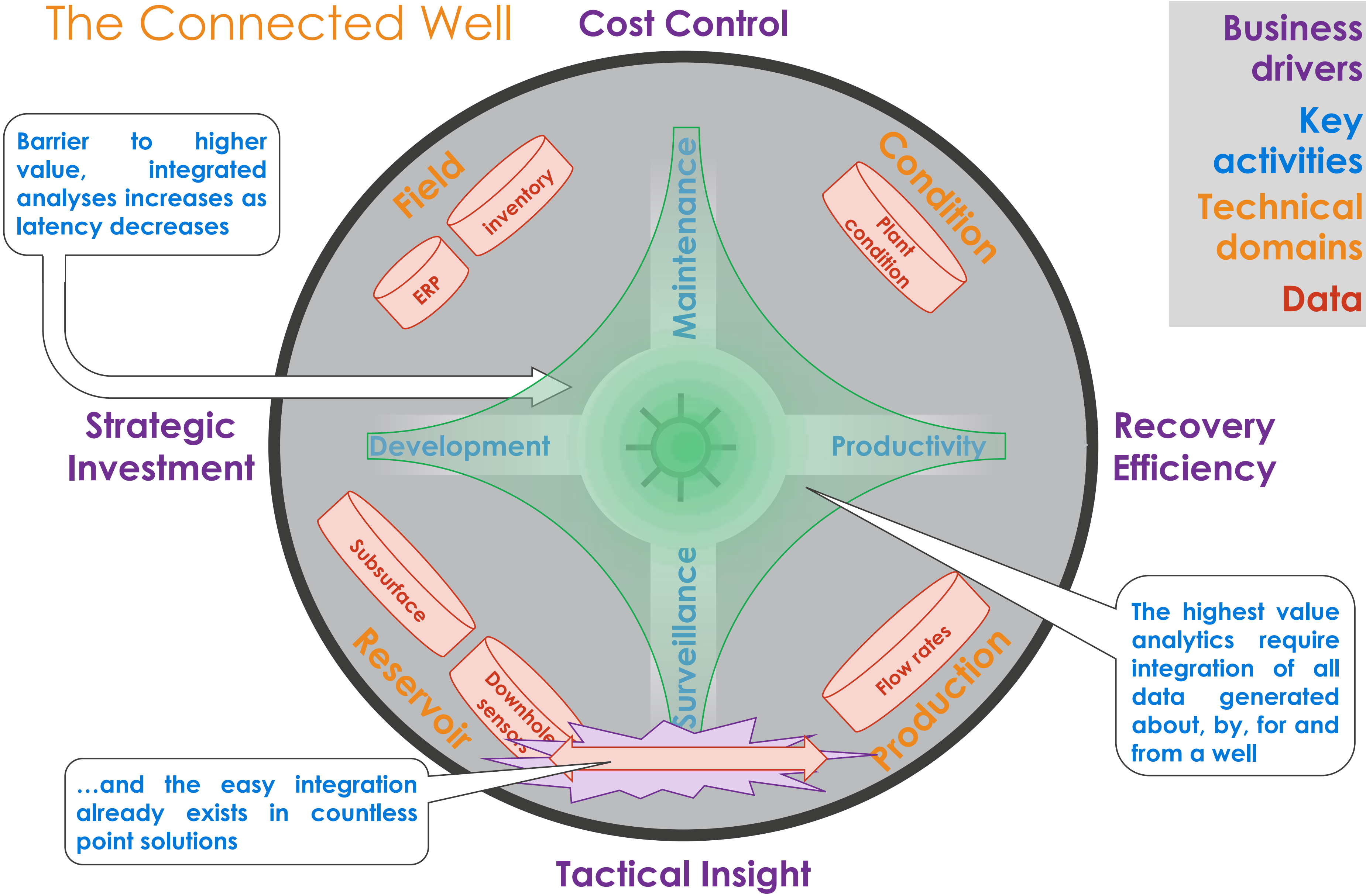
The Connected Well



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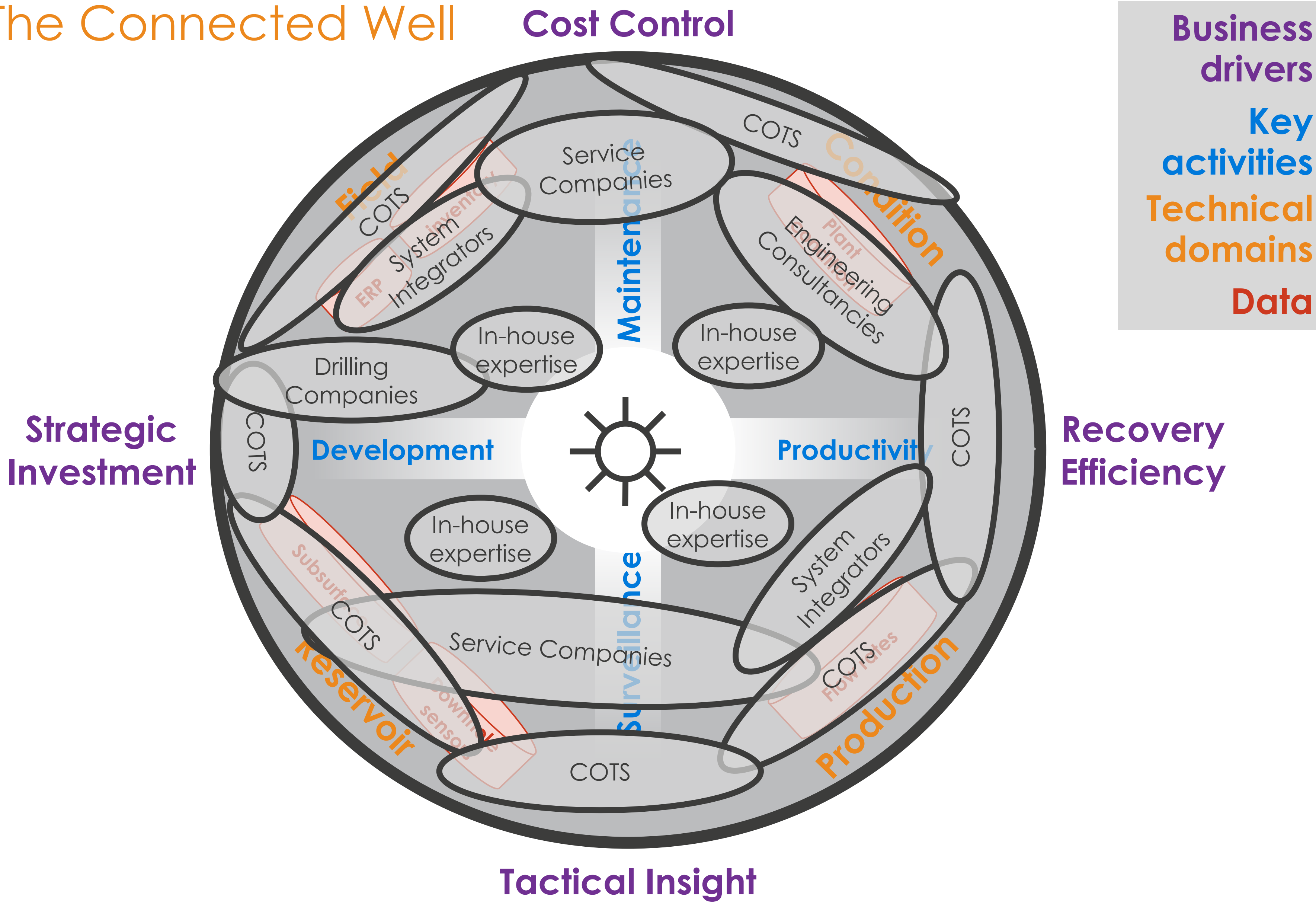
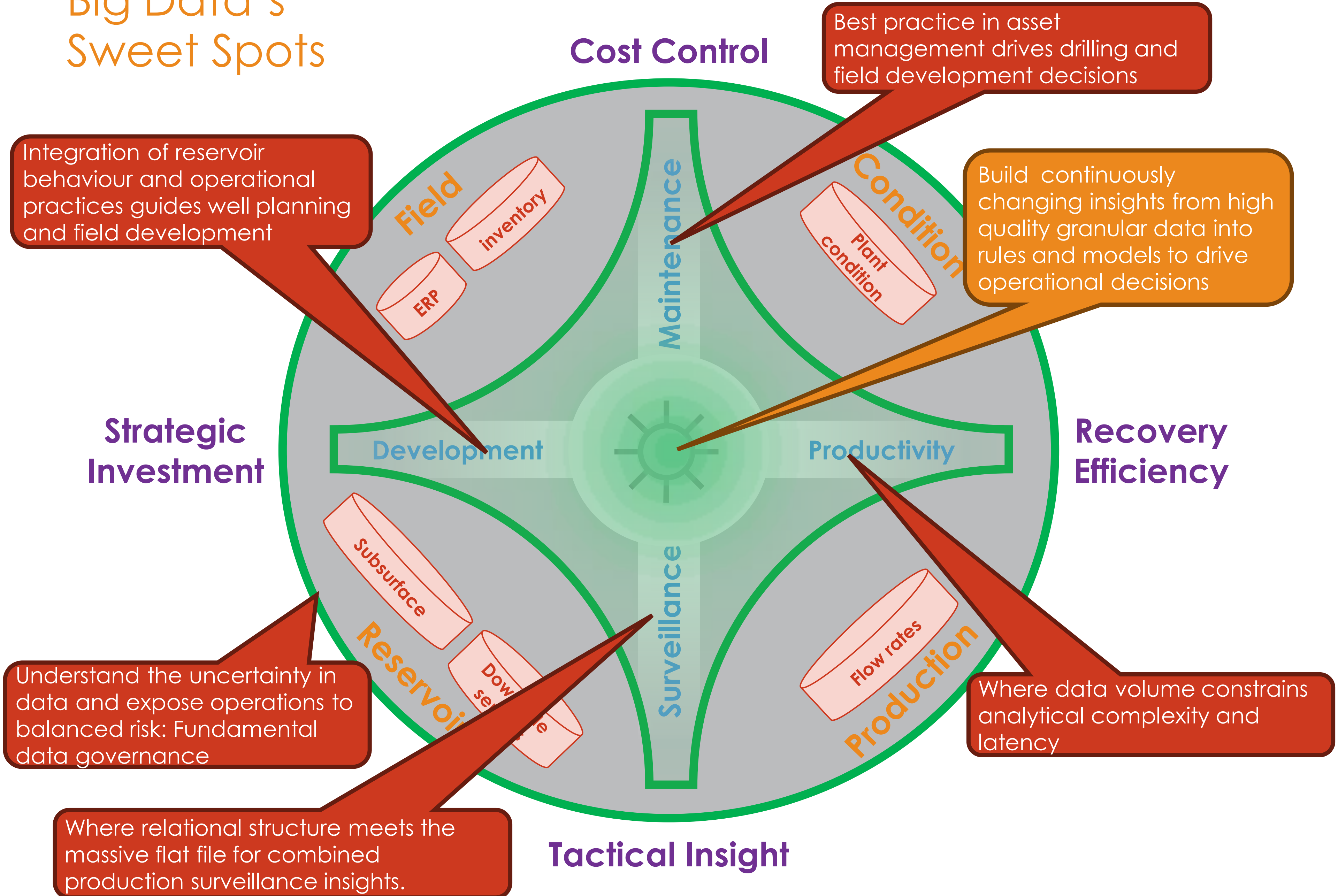
The Connected Well



Big Data's Sweet Spots



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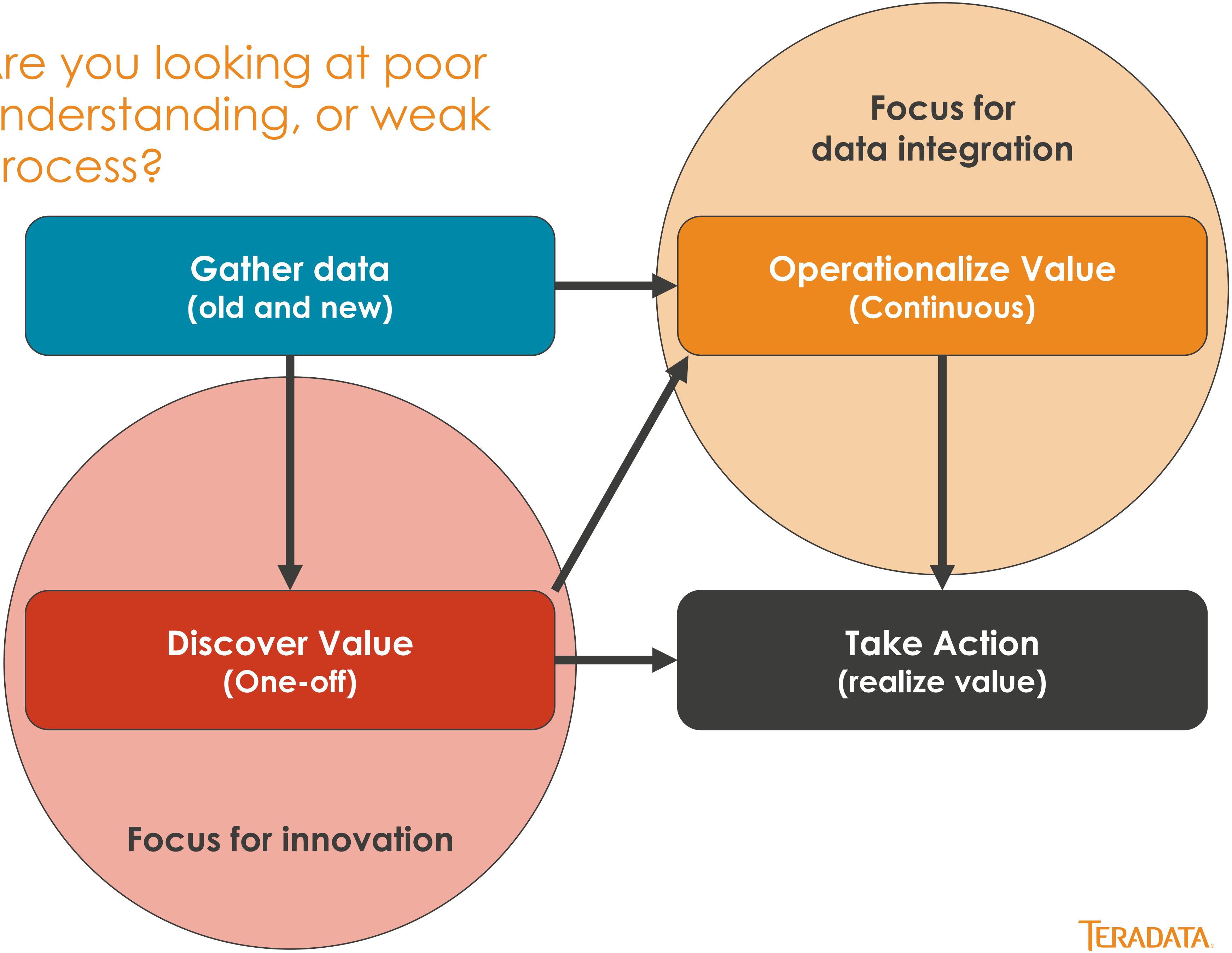
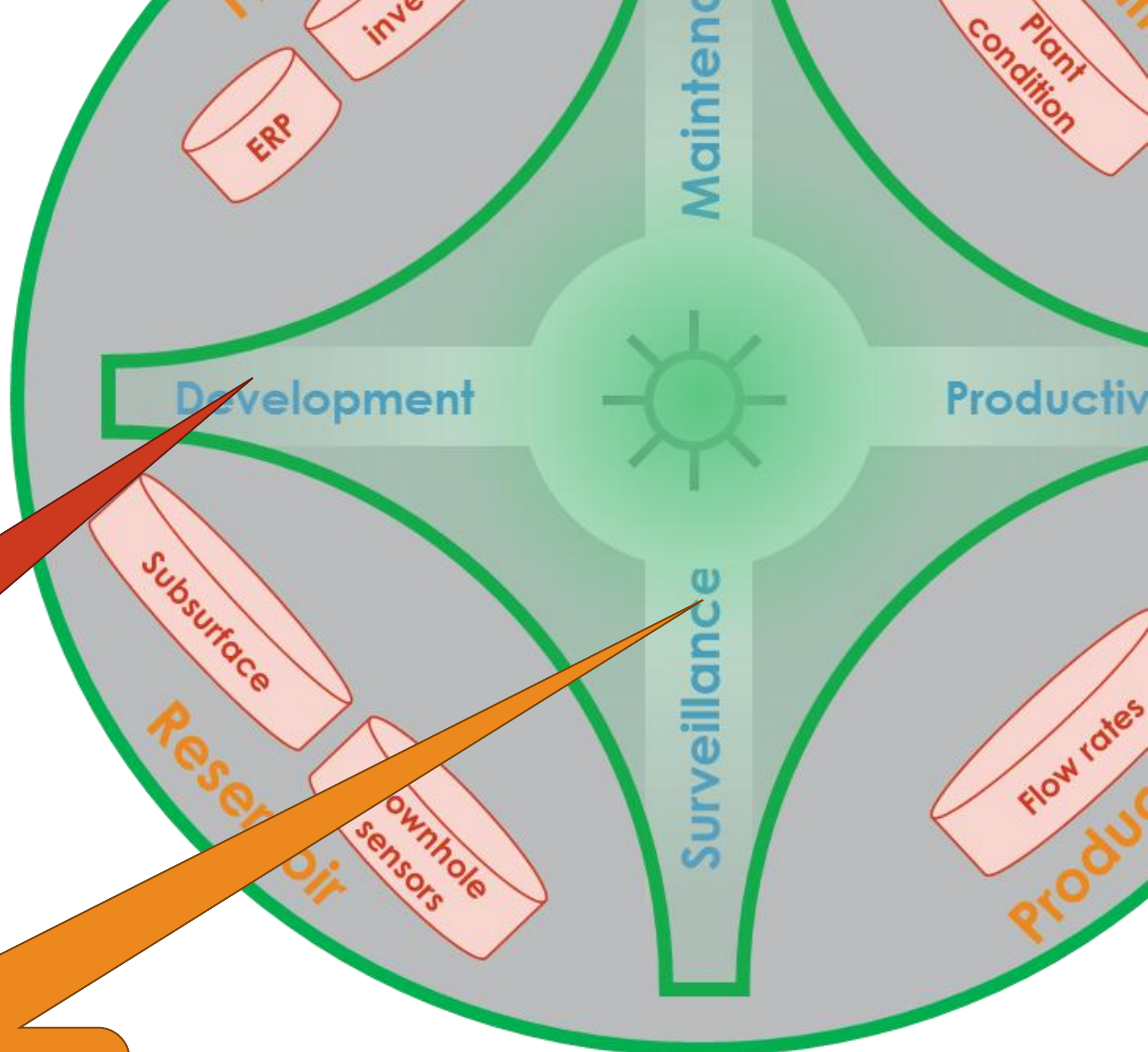
Are you looking at poor understanding, or weak process?



Some Examples

Strategic Investment

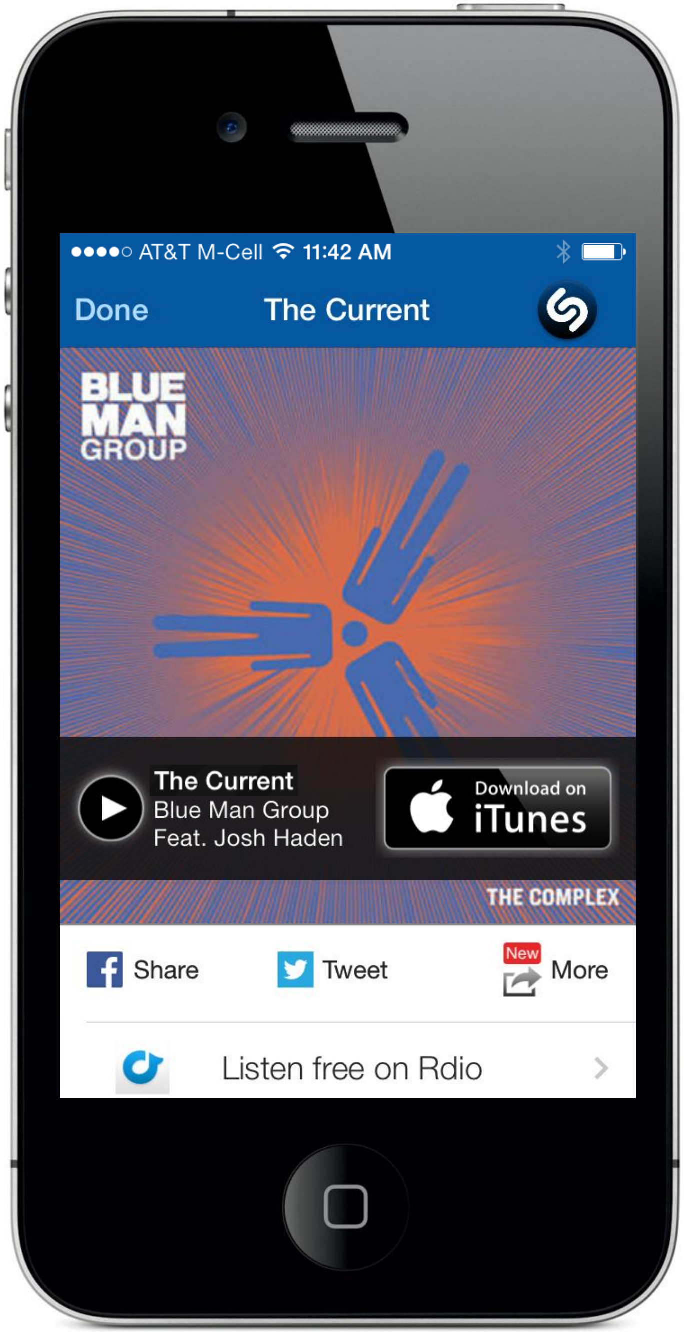


A better understanding of geomechanics and drilling performance

Reservoir data integration to enable faster intervention decisions

Tactical Insight

Discovery Analytics: A better understanding of geomechanics and drilling performance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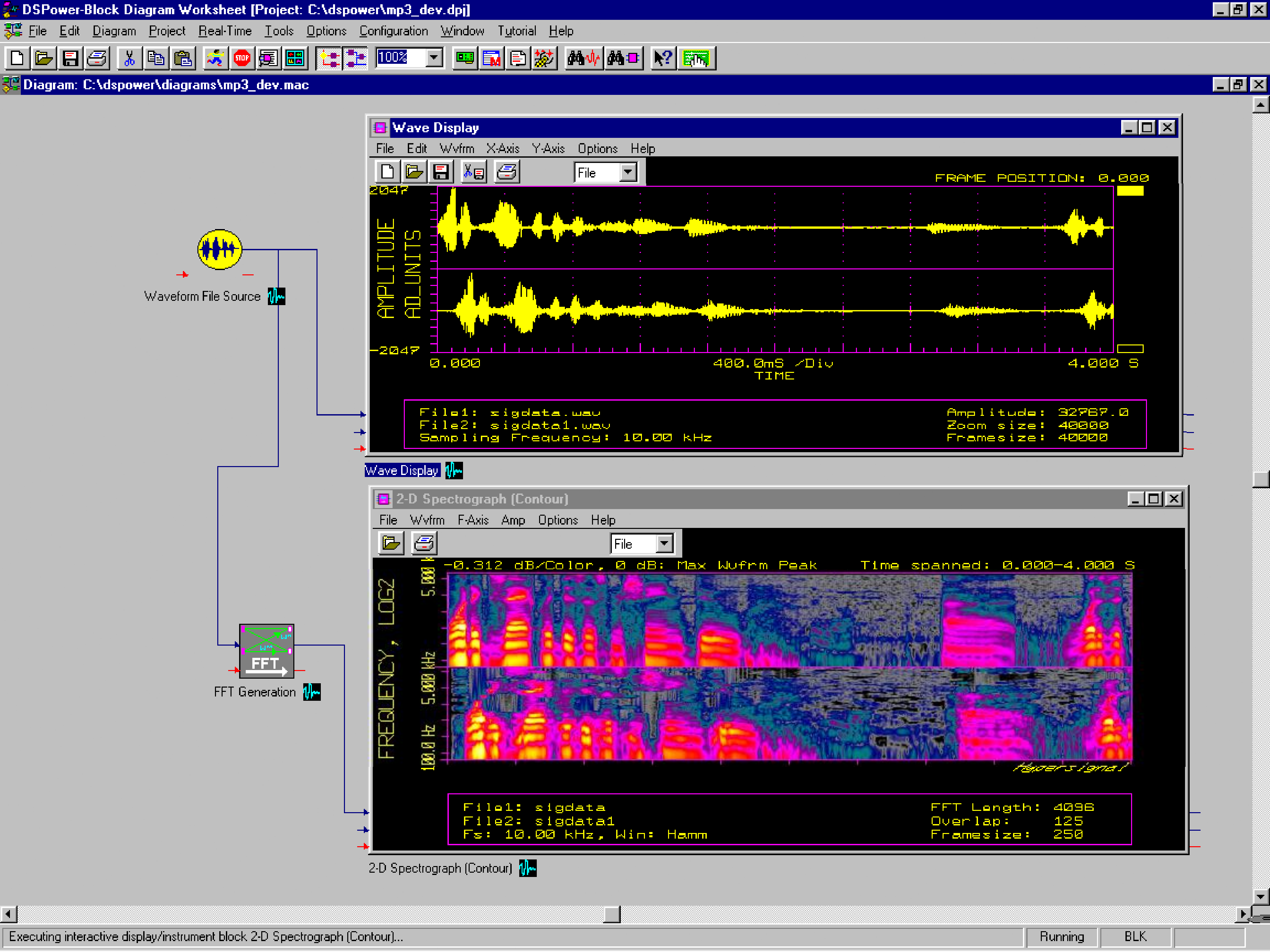
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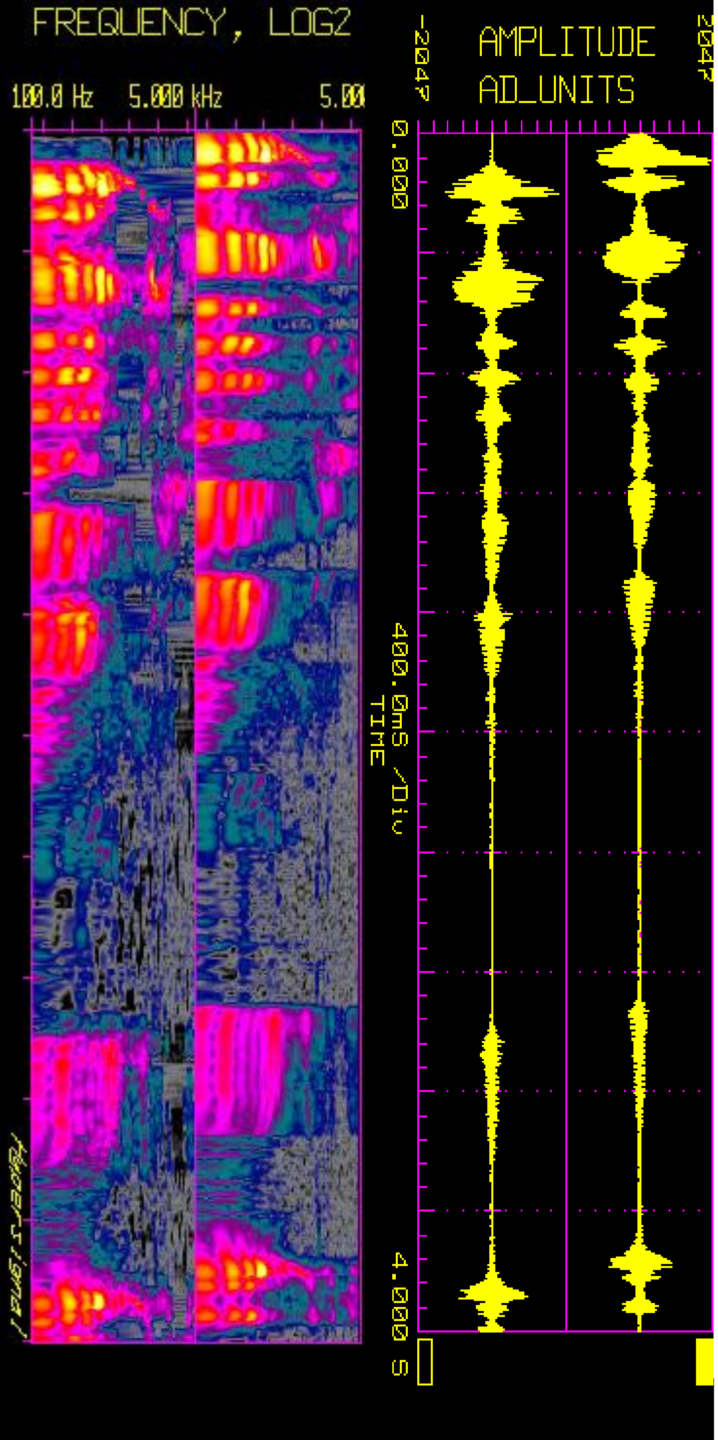
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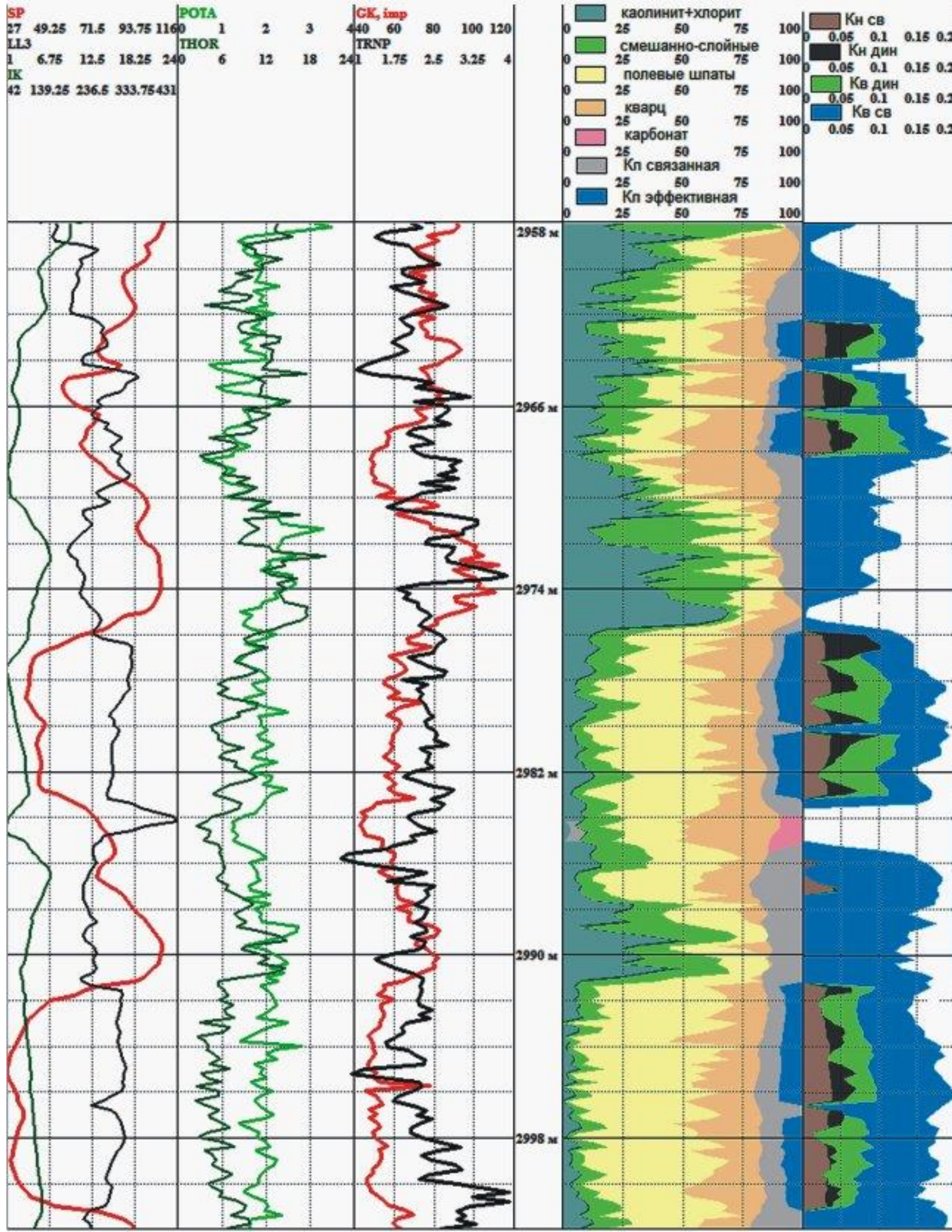
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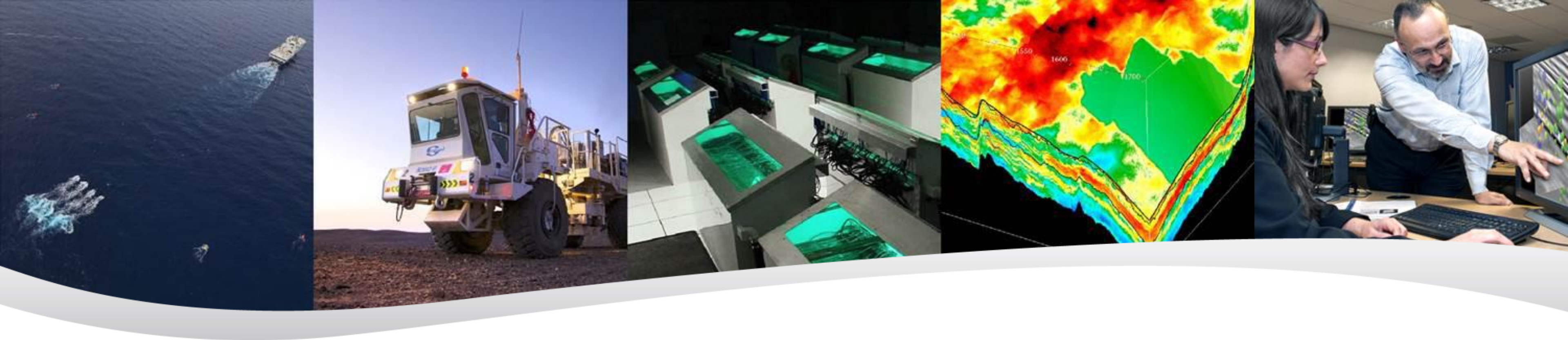


Use of Big Data Analytics in O&G

Project Contacts:

Joe Johnston, Joe.Johnston@cgg.com

Aurelien Guichard, Aurelien.Guichard@teradata.com

Passion for Geoscience

CGG

Drilling Story

It is expensive to drill.

Drilling involves a large number of unknowns especially in Exploration phase and a large number or parameters, mud weight, torque, weight on bit, and so on.

Adjusting these parameters while drilling is a modern practice because of downhole drilling measurements

Drilling Efficiency/Safety

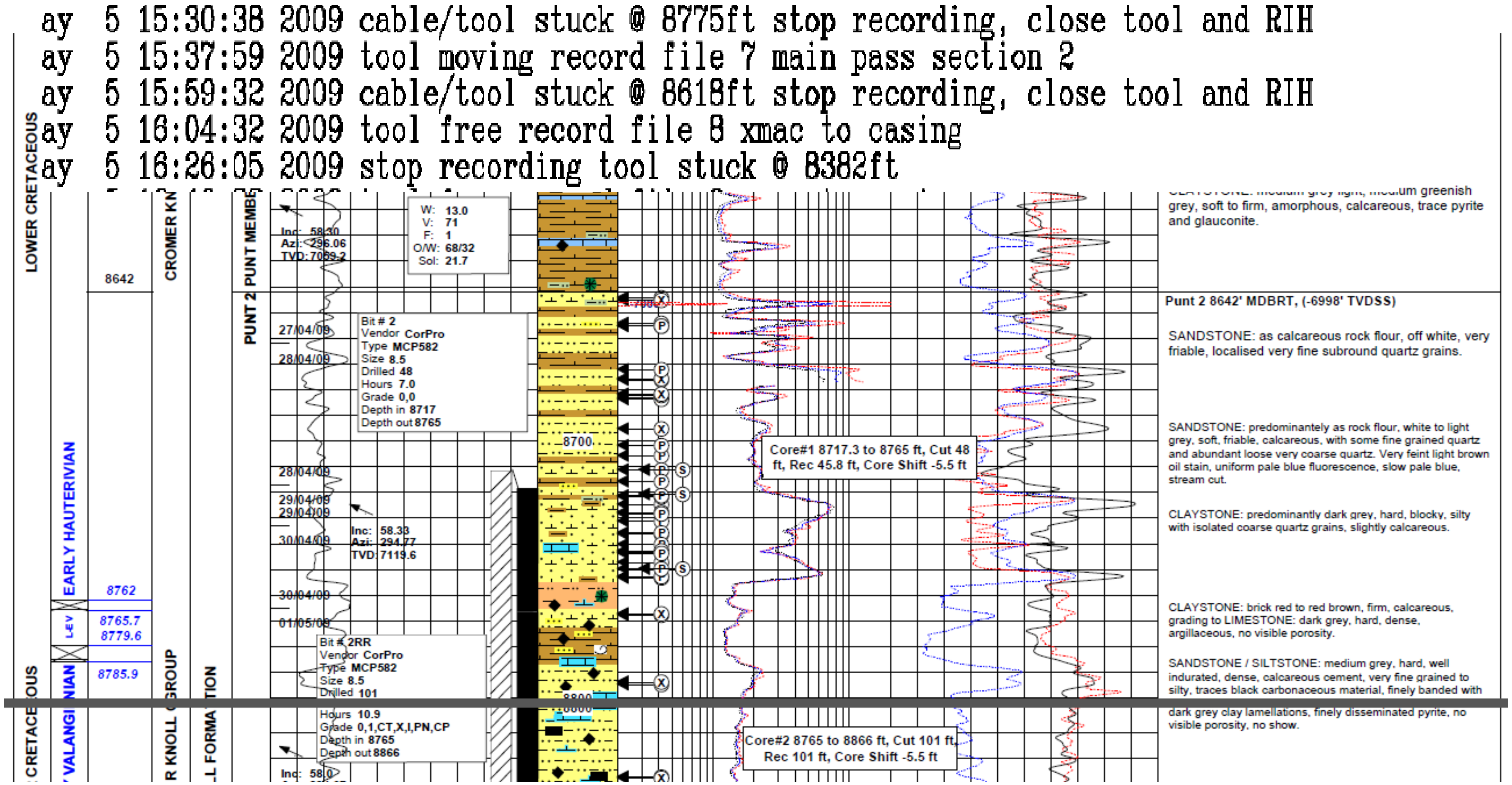
- Stuck Pipe = cost
- Why stuck?
  - Geology (link) e.g. swelling shales
  - Rock properties e.g. weak rocks
  - Deviation/deviated wells
  - Bit type
  - Mud type WBM vs OBM
  - Other
- If we can analyse the conditions causing stuck pipe we can reduce the risk/cost

Borehole Conditions

Poor borehole means

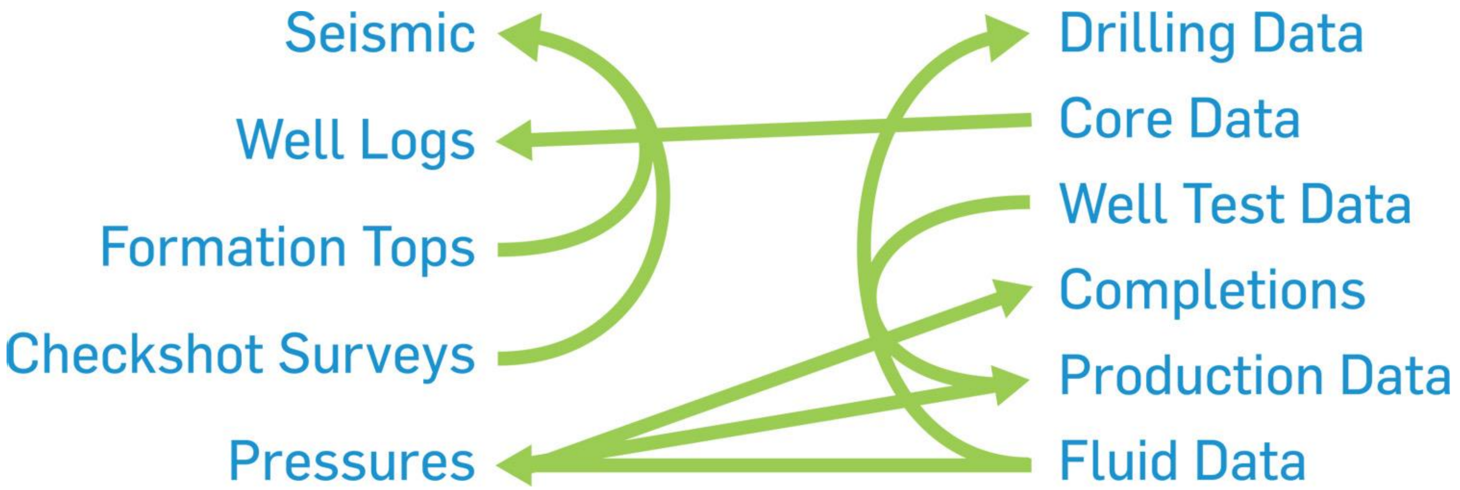
- Potential stuck pipe (time)
- More wiper trips (time)
- Cementing problems (time)
- Logging problems (time)
  - Stuck, sticking tools, more wiper trips
  - Poor data quality, poor completion decisions

Bad Hole Example – Single Well



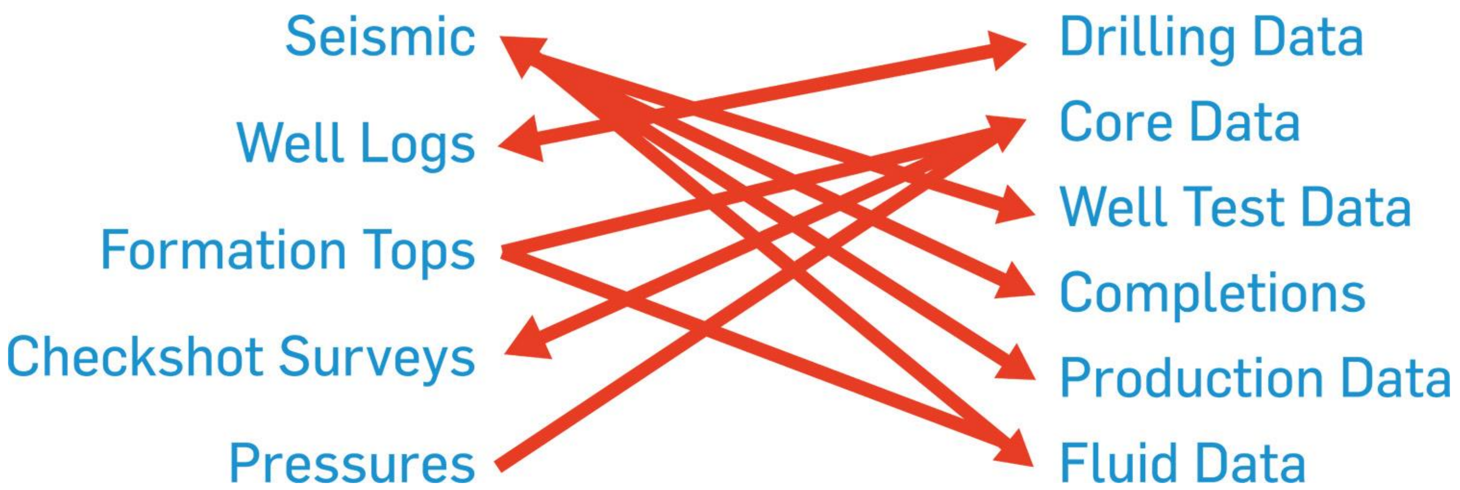
The completion log gives no clues to the problems encountered.

Data Links



A lot of these connections are routine, check shots and seismic, fluids and pressures. Some of this data is used in combination in reservoir studies, seismic, well logs, formation tops, pressures, fluids, core data. However these are single instances, single wells or a field study.

Data Not Linked



- A lot of data types are not-linked or only linked occasionally. Why?
- Are all links equal or are some ridiculous?

- Sometimes new techniques are found by linking diverse data types for example

  - Seismic to Fluids is AVO

  - Seismic to pressures is overpressured zones

Links

- Sometimes there is just too much data.

- Few links are created on the truly enormous scale, the entire North Sea for example, thousands of wells and thousands of kilometres of seismic lines. There is too much for conventional analysis techniques to handle in its entirety.

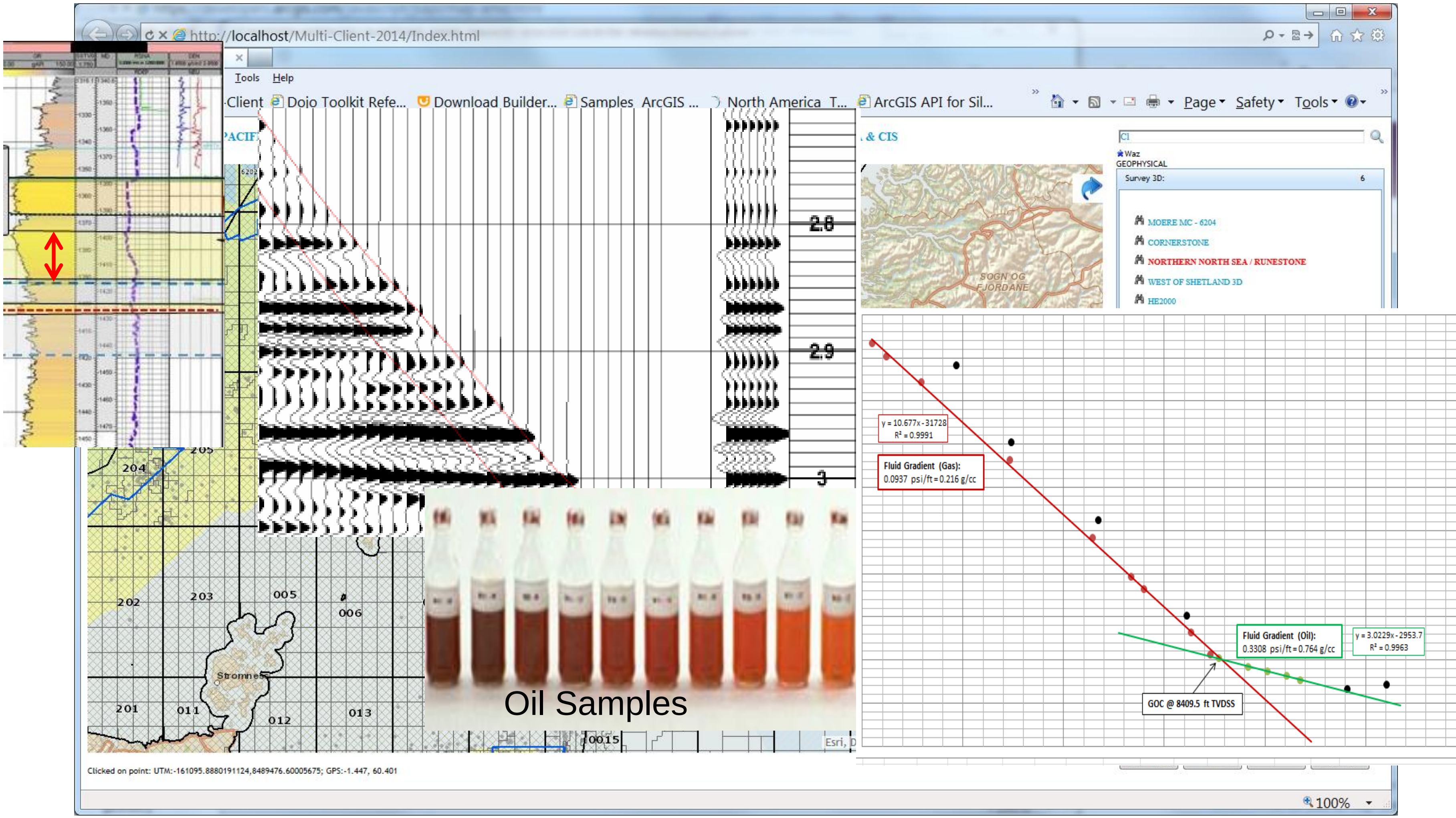
Data Analytics

- Big data analytics is the process of examining large amounts of different data types, or big data, in an effort to uncover hidden patterns, unknown correlations and other useful information.

- We hopefully find what we didn't know we had but didn't know we didn't know we had it!

- It is a voyage of discovery and then exploitation.

Combining Big Data Techniques & RDBMS



Challenges

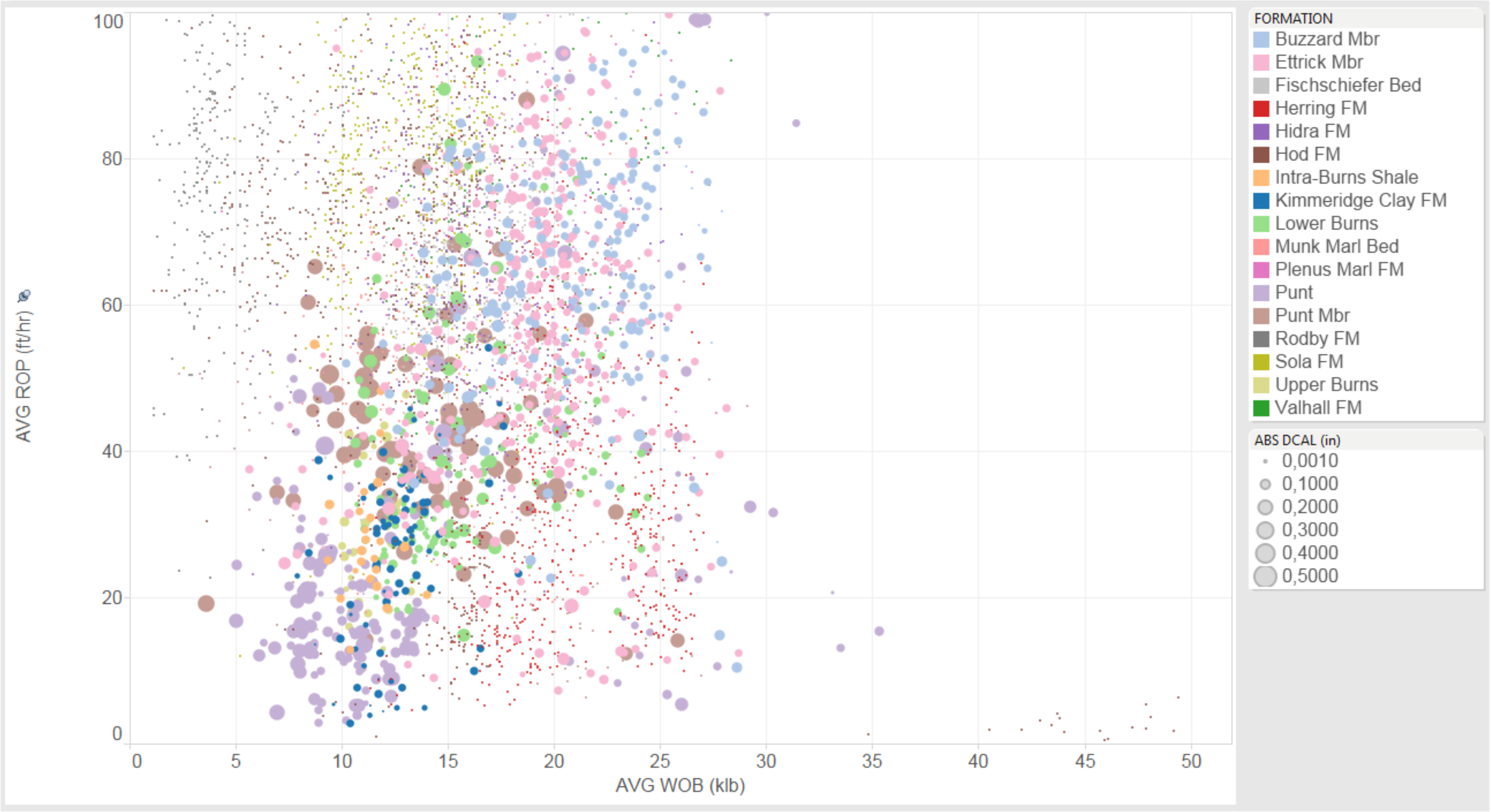
- Loading numerous different types of data
- Linking data types
- Visualisation methods
- Finding usable correlations

Data Loading / Data Types

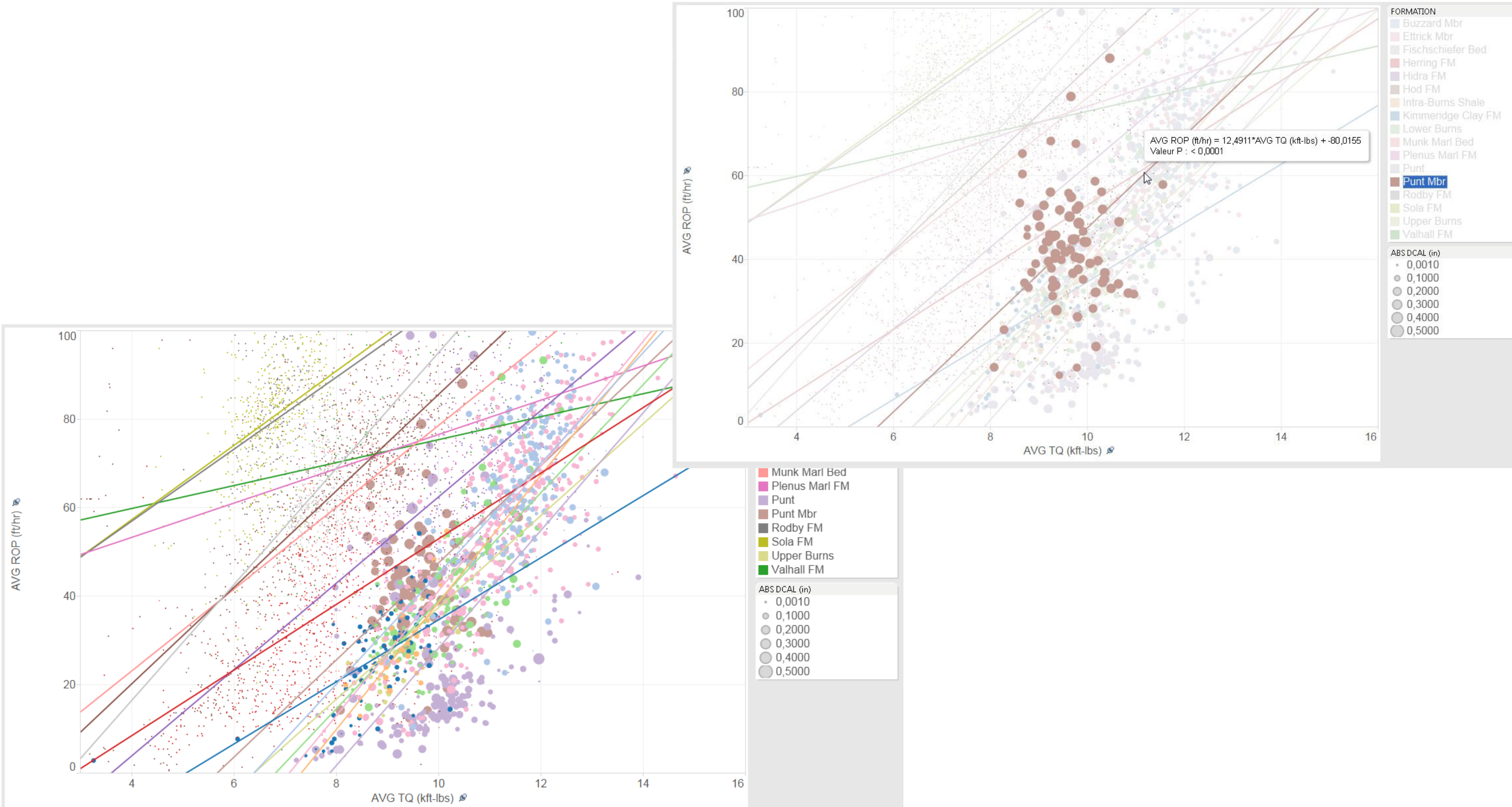
- It is possible to load lots of differing types even with non specific loading tools.
- All data is available from metadata e.g. license number to individual logging curves.
- The manipulation and querying of data is done without any preconception of the analysis to be made.

Data Visualisation Multi Well

- Visualisation of a number of parameters simultaneously.



Data Analysis



Analysis of the data gives correlations and probabilities.

Challenges in Employing BDA

- Enough data for statistical relevance
- Multiple file formats
- Some parameters slowly varying, some fast e.g. mud weight and Gamma Ray
- Predicting coherently over large areas/regions/formations
- Data accuracy/quality/completeness

Conclusions from the Pilot

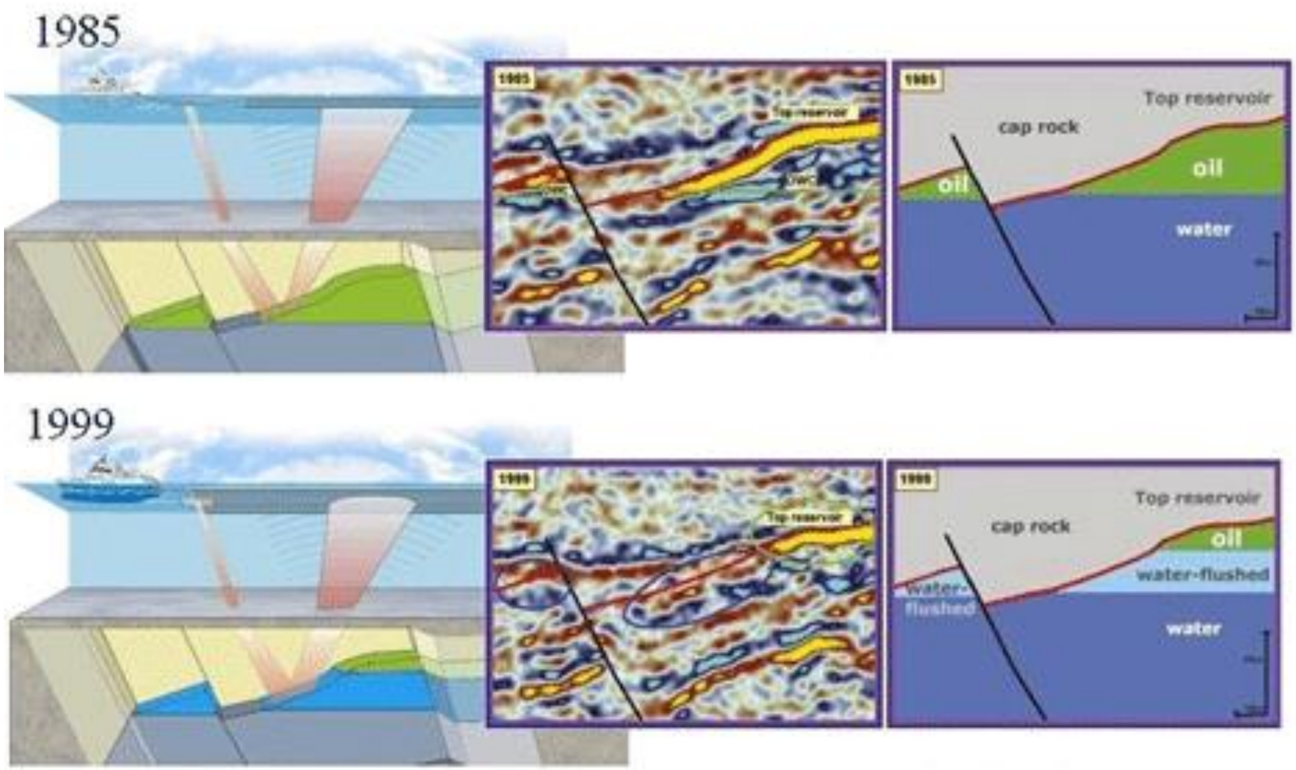
- It is possible to use Big Data Analytics on diverse data such as employed in the Pilot
- A variety of techniques are employed to display multiple types of data
- Multivariate analysis are performed on the data without preconceptions

- Unexpected correlations are exhibited
- Differences were discovered spatially across areas and vertically through formations
- The correlations allows predictive statistics to be computed

- The Pilot confirmed the possibility to improve the Drilling Models using Data Analytics
- Hence we can apply these techniques on any kind of Oil and Gas data

Operational Analytics: Reservoir Monitoring for Better Intervention Planning

4D Seismic – seeing what happened



Principle of 4D acquisition

Gullfaks field

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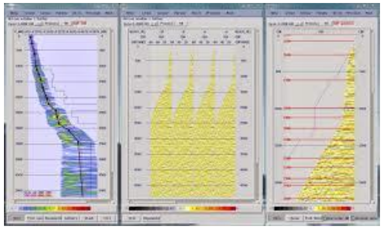
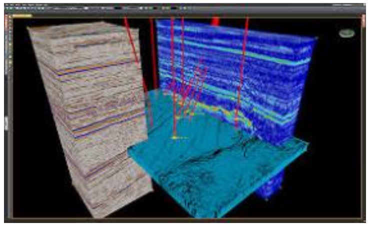
Traditional Marine Seismic Surveys

Planning
1 year

Acquisition
1 month



Processing
6+ months



Interpretation
3-6 months

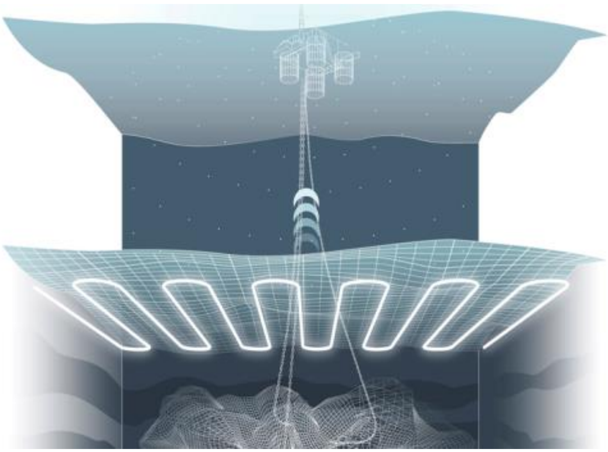
Average 2 years between “snapshots” of the reservoir

Permanent Reservoir Monitoring (PRM)

"Operationalizing" the workflow

With a fixed seabed receiver array:

- Simpler source vessel
  - Cheaper per survey
  - More weather independent
- Receiver geometry the same
  - Surveys are more repeatable
  - Faster processing turnaround
- Can do more frequent surveys



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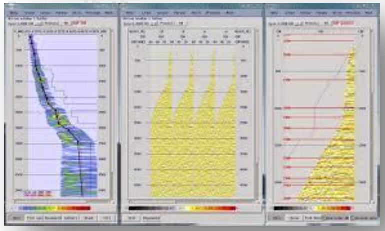
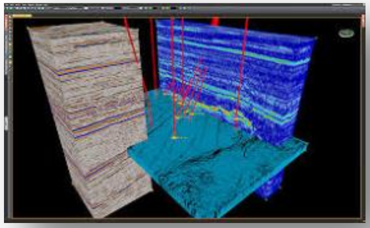
PRM: Shortens the time frame

Planning
1 month

Acquisition
3 weeks



Processing
<3 months



Interpretation
<1 month

- New survey at least every 6 months
- Decision making on the timescale of interventions
- Need a much more streamlined process for receiving new data and interpreting it

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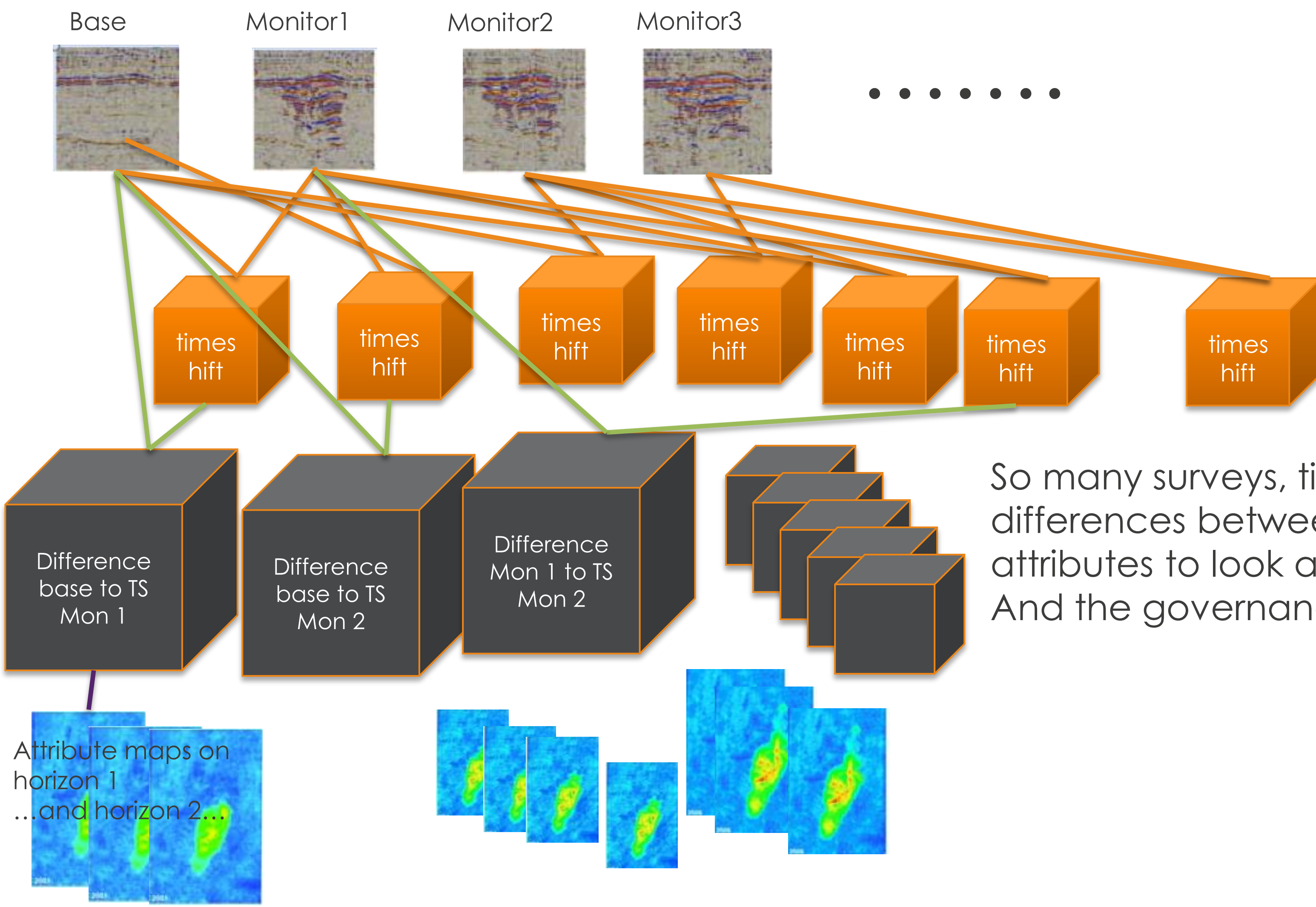
And brings so much data…



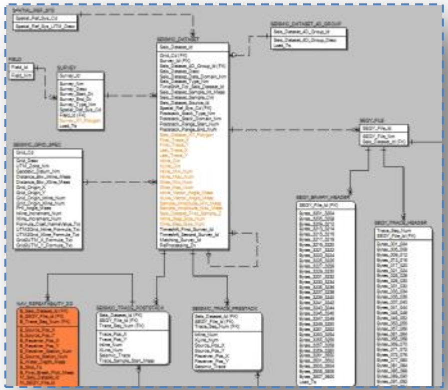
So many surveys, time shifts, differences between pairs, attributes to look at.
And the governance..?

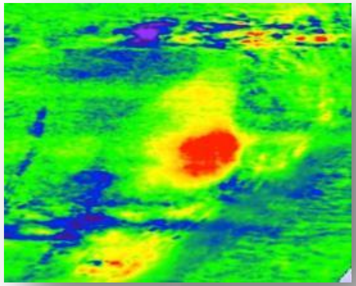
We need a Reservoir Data Warehouse!

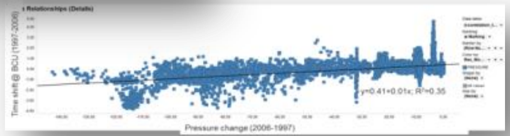
We store detailed subsurface data in an MPP Analytical database

We integrate it in space and time as well as logical relationships

And users can visualise detailed data and analysis, calculated on-the-fly







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Results

- 4D workflows not fully supported by today's tools
- Explaining 4D "effects" requires other data
  - Identifying artefacts of processing or acquisition
  - Identifying events that correlate
- Giving confidence to data-driven decisions
- Combine data mining (discovery analytics) + data integration to give robust reservoir intervention decisions

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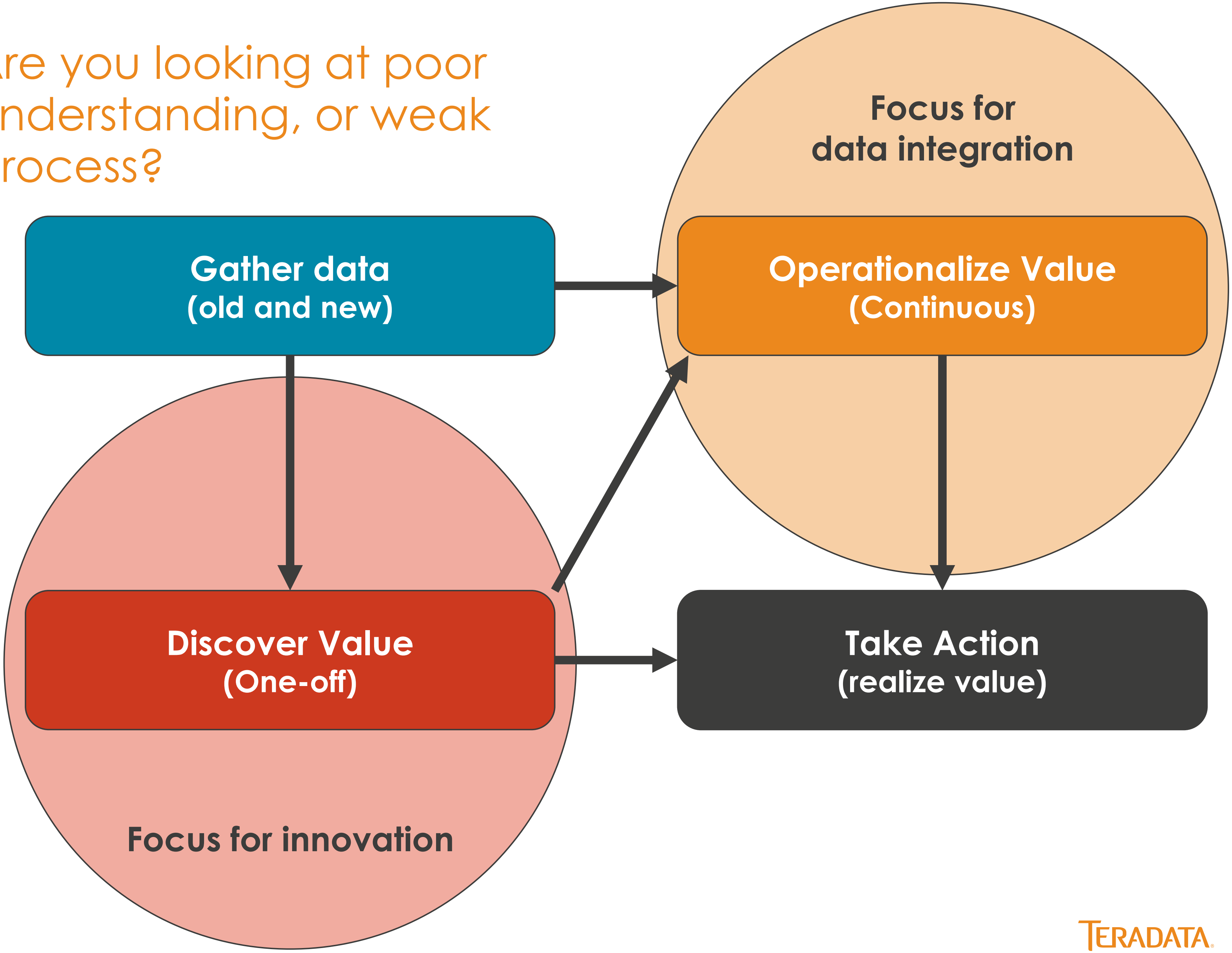
Are you looking at poor understanding, or weak process?



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duncan.irving@teradata.com

