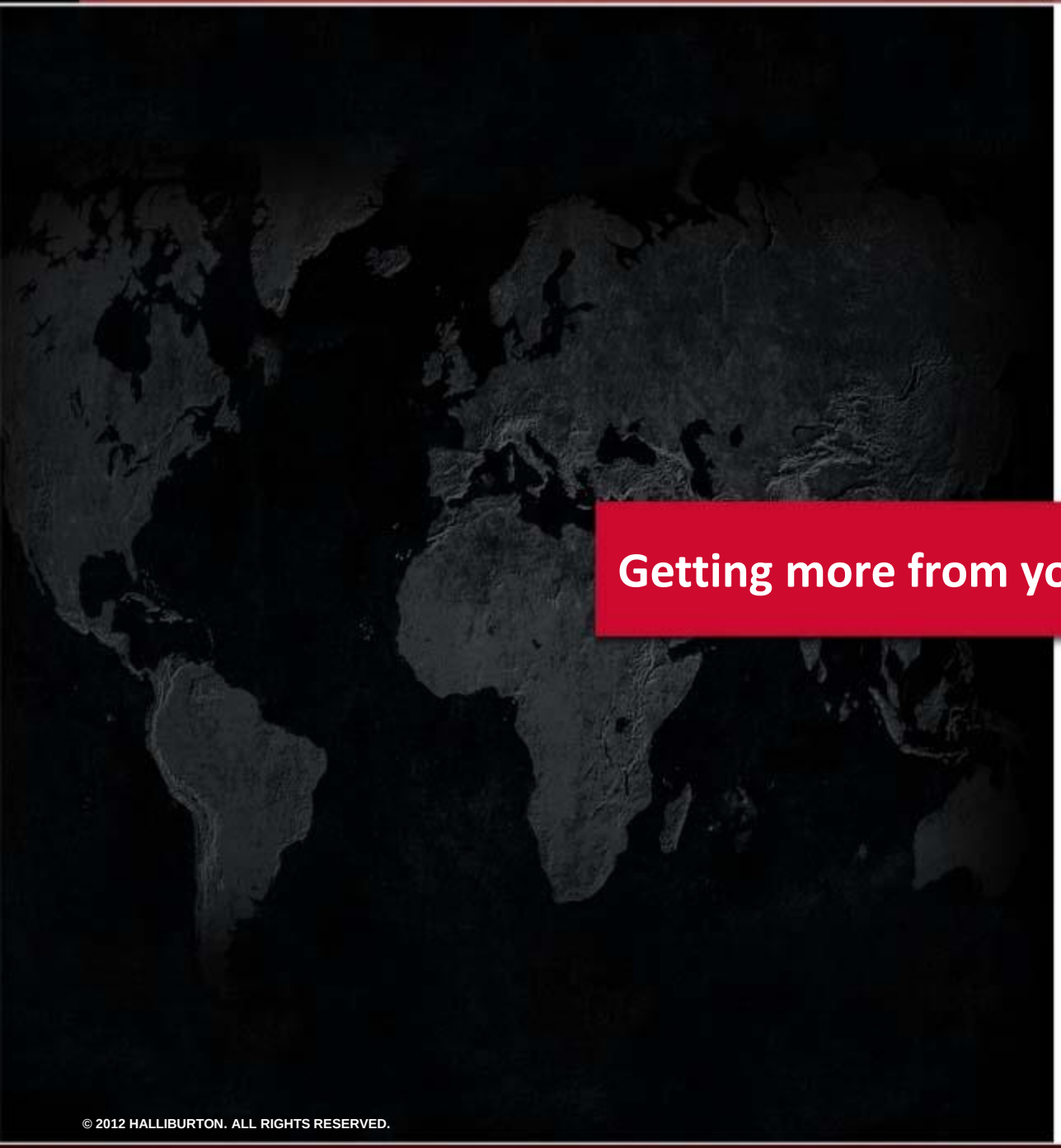


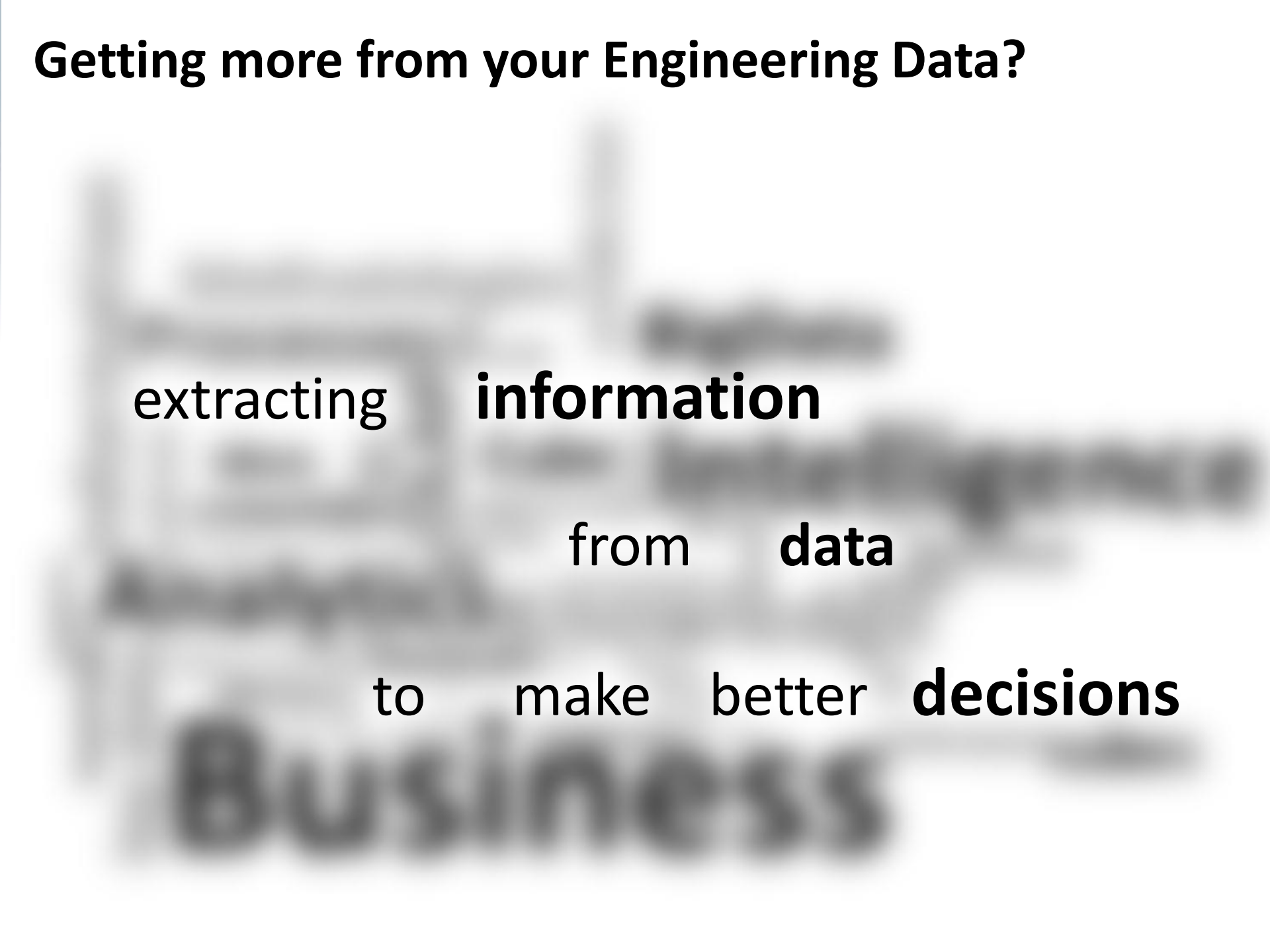
Getting more from your Engineering Data

John Chapman
Regional Technical Manager

HALLIBURTON | Landmark Software & Services

Getting more from your Engineering Data?

Getting more from your Engineering Data?



Getting more from your Engineering Data

- Data Analytics
- Big Data

As an industry, we plan new wells based on past drilling experiences and data

- Much of current historical analysis is based on the experience of the engineer, not on reliable data and consistent analytics
- For the data that is available, it is difficult to extract meaningful and timely knowledge from it

Getting more from your Engineering Data

"Data is not information,
information is not knowledge…"

Clifford Stoll

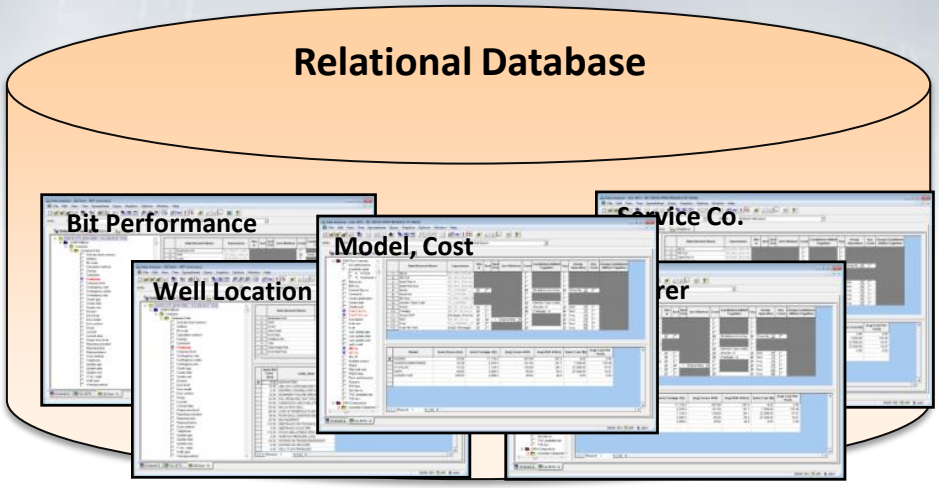
Why Analytics?

Optimize planning new wells Minimize costs Reduce down-time	• The ability to easily access, review, interrogate, & visualize all relevant data (including historical real-time data) from offset wells. • Quickly compare data from tens if not hundreds of wells in an area • Identify patterns that preceded previous downtimes
Benchmarking activities Rate, manage, and improve performance	• Identify the best performing options in relation to a specific process; this could include any process of well planning, well construction, or well abandonment. • Identify & rank underperforming units, service companies, wells etc.

Analytics

Relational Databases vs Analytical Databases

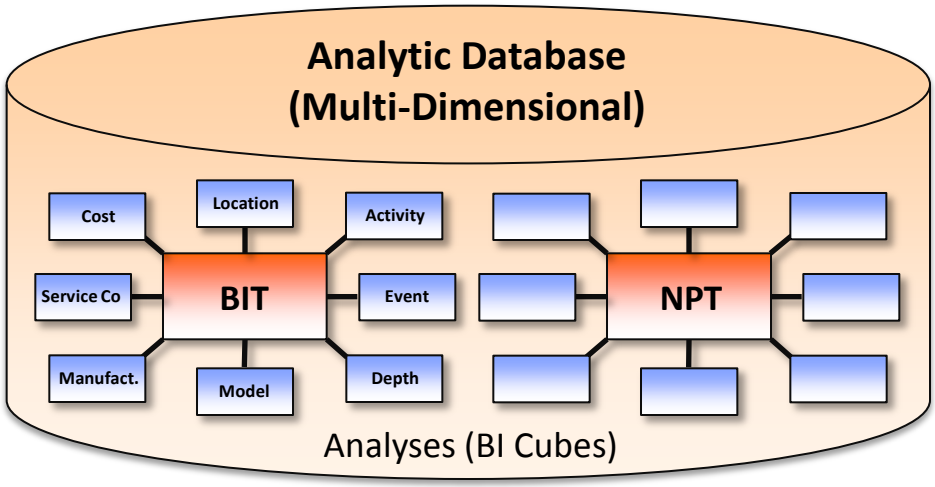
Relational vs. Analytic Data Models



Relational Database

Data is arranged in flat inter-related tables.

- Very efficient for storing lots of data
- Very inefficient for mining information.



Analytic Database

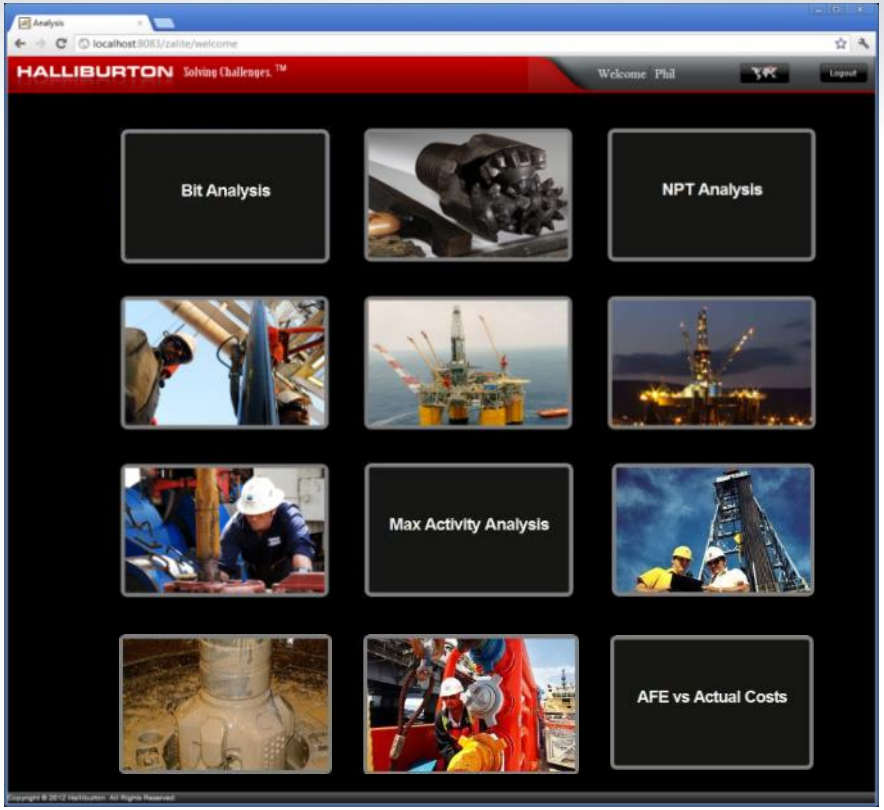
Data is arranged multi-dimensional data-structures known as cubes and centered on a single business question or concern.

- Very inefficient for storing lots of data
- Very efficient for mining information.

Common Analytical Models

Example of business intelligence models (analyses) for common drilling problems:

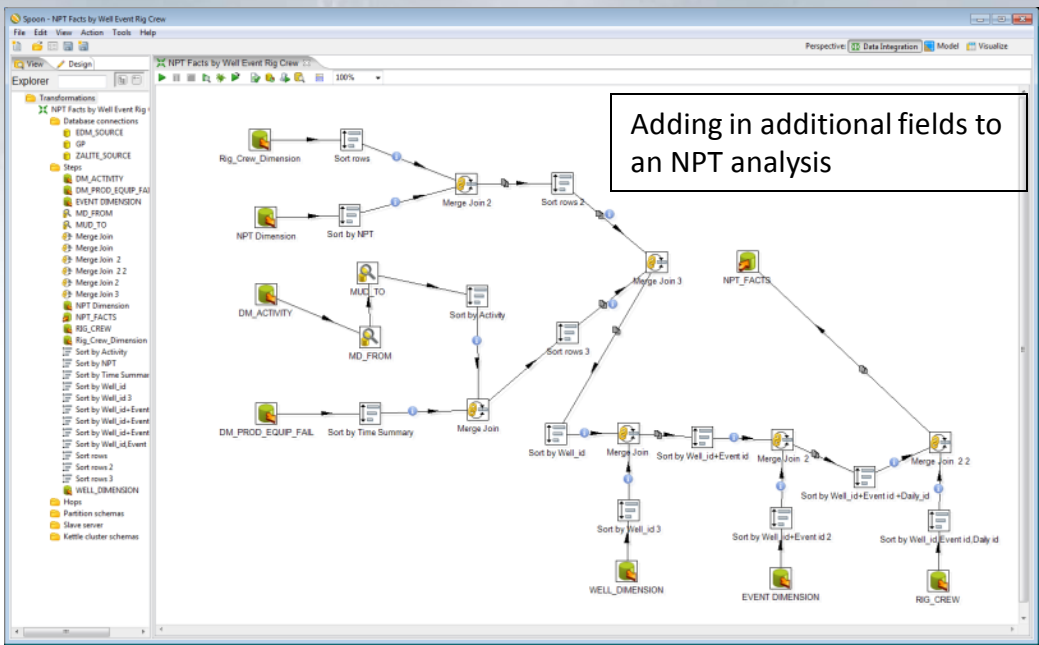
- NPT Analysis
- BHA Analysis
- Bit Analysis
- Safety Analysis
- Kick Analysis
- Mud Loss Analysis
- Asset Analysis
- Plan vs. Actual
- Rushmore Reports
- Max Activity Analysis

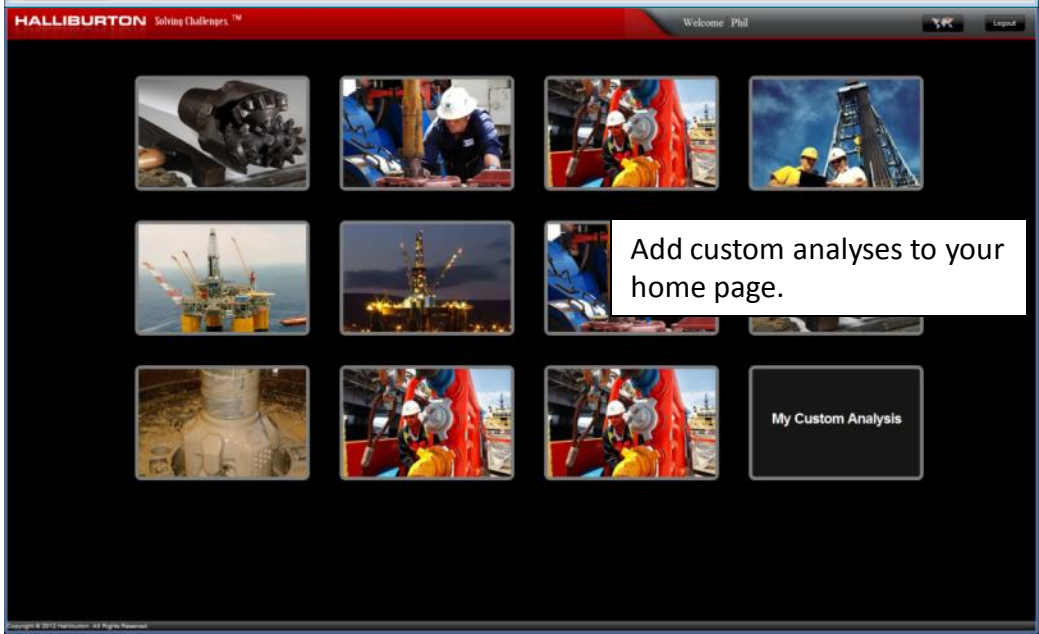


Building Analytical Models

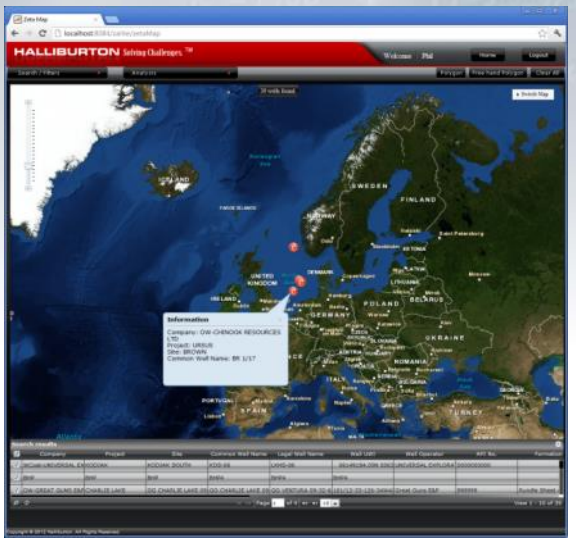
To be effective and utilised, an engineer needs to be able to create and edit the analytical model themselves and not rely on a database expert:

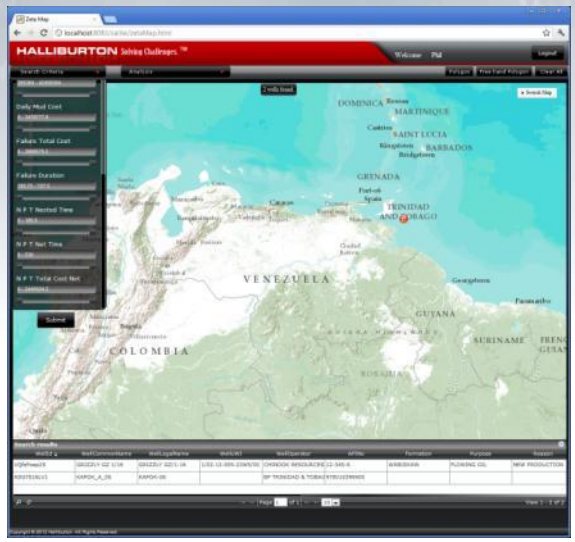
- Easily add in additional data from different database tables
- Join data from a completely different data-source such as Excel or other relational databases
- Build entirely new analyses based on your specific needs, problems, and data-sources





End User: Usability, Portability, Filtration and Visualisation



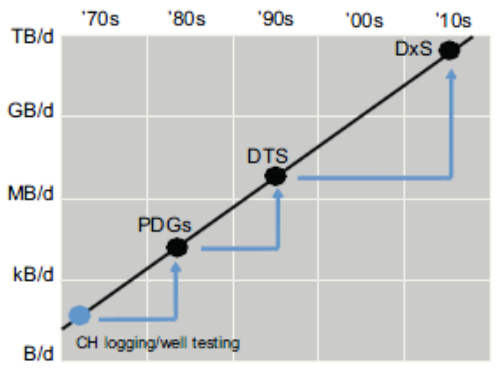


BIG data

What is Big Data? Definitions

Velocity

Data acquisition rates from in-well sensing has increased in line with Moore's Law with well-data rates doubling every 1.5 years[1].



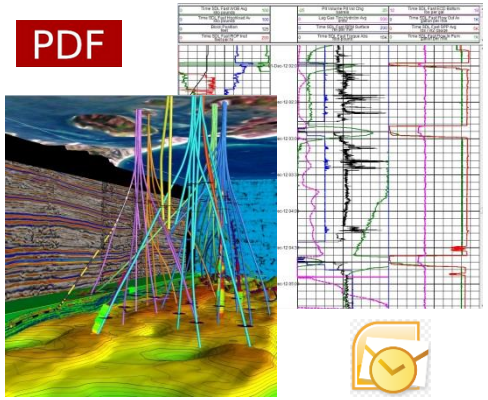
Volume

Large Operators can have 50+ disparate relational data-stores.

Super-majors can easily exceed 2TB of additional data-storage a day[2].

Variety

Typically there is a complete lack of integration between structured, semi-structured, and un-structured data systems[2].

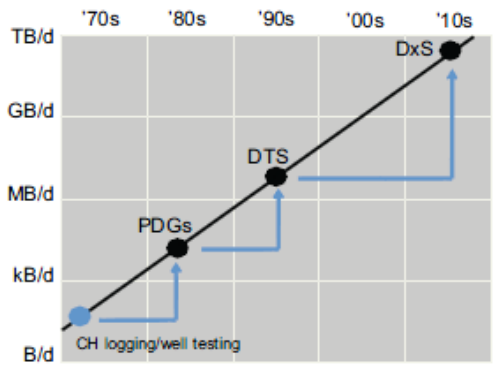


1) J. Vianney Koelman, JPT July 2011
2) Ahmed Abou-Sayed, JPT October 2012

What is Big Data? Challenges

Velocity

Traditional databases can not handle these data velocities, and will choke, and relational data-forms become increasingly unwieldy.

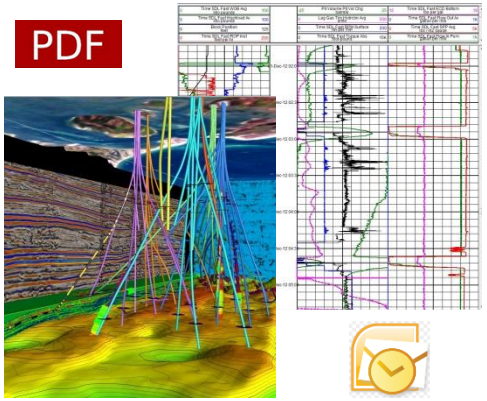


Volume

Large data-sets such as real-time data are typically not stored at all or stored in non-relational formats that are impossible to analyze.

Variety

Joining disparate data-sources becomes ever more complex and critical interpretive & contextual data is not included in typical analyses.



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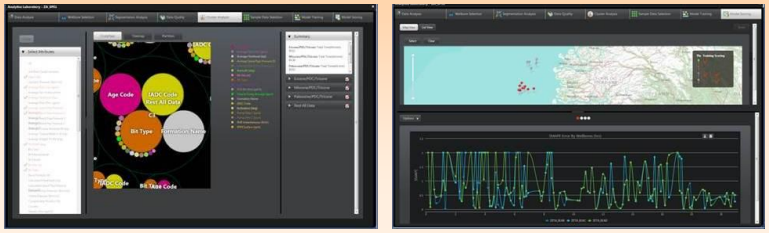
Big Data & Analytics Workflow

Data Mining & Predictive Analytics

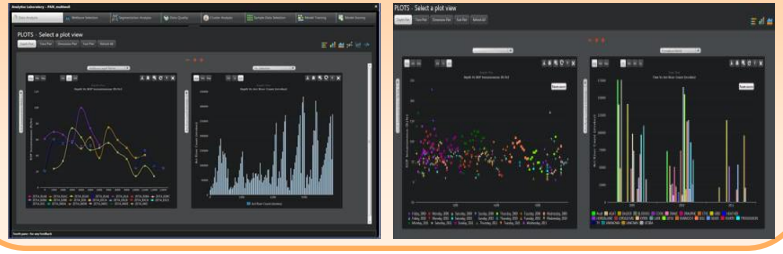
Predictive Model Building & Real-Time Decision Making



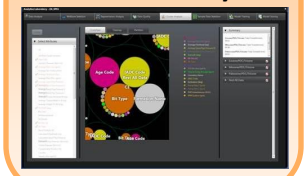
Big Data & Analytics Workflow

Data Cleansing & Analysis

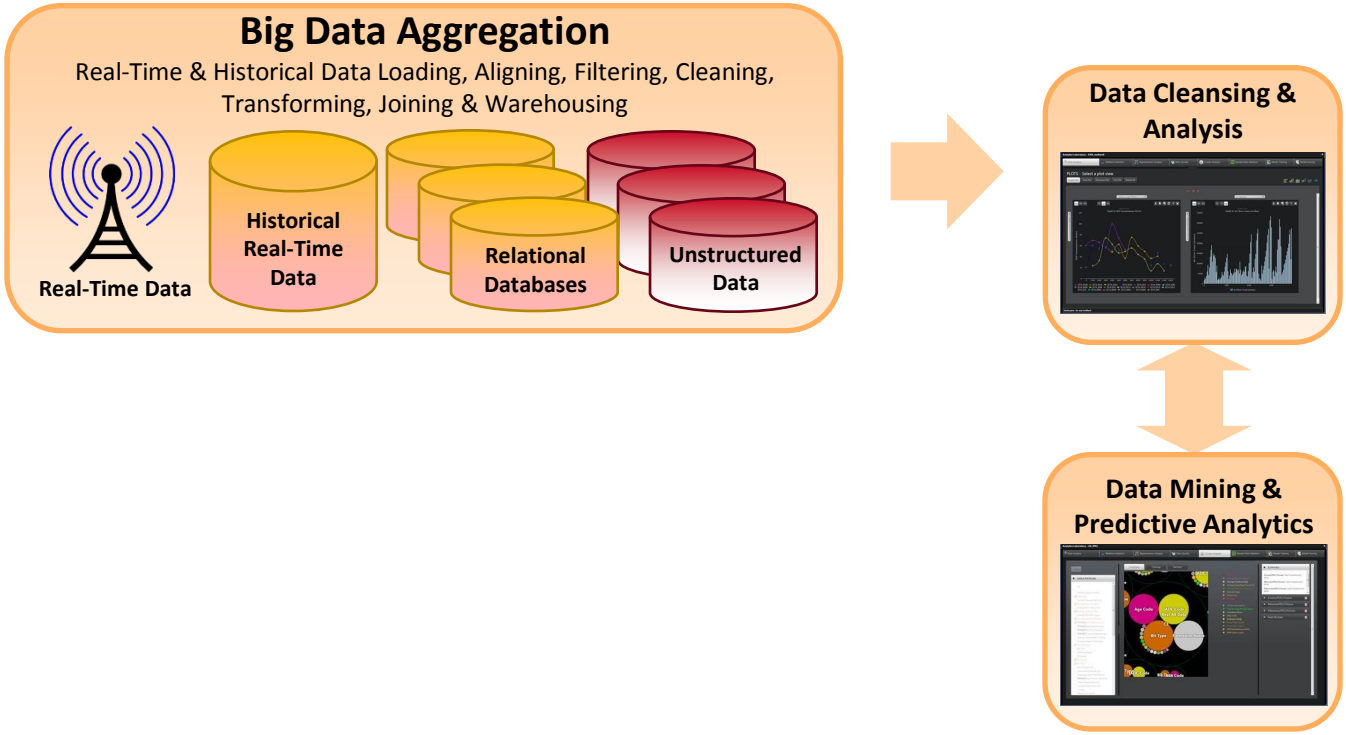
Business Intelligence Data Models and Interactive Visualization



Data Mining & Predictive Analytics



Big Data & Analytics Workflow



Big Data & Analytics Workflow

Big Data and Analytics

1. Big Data Aggregation

- *Stream WITSML data directly into data-warehouse in relational form*
- *Associate contextual engineering and real-time data*
- *Leverage existing EDM data-model for security and well identification*

2. Historical Data Modeling & Visualization

- *Drilling/engineering specific, problem-oriented data models (Analyses)*
- *Handles drilling/engineering specific data such as runs, activities, datums, units, time-vs-depth data etc.*
- *Easy-to-use, intuitive, interactive visualization of Real-Time data for historical analysis*

3. Predictive Analytics

- *Data mining & model-building for real-time data*
- *Easy-to-use segmentation, cluster analysis & data cleaning tools*
- *Single repository & tool for models, model scoring, analytical, and raw real-time data*

Data Aggregation: Real Time Data Alone is not Enough

- **Symptoms**
  - Block position (top drive) static
  - No rotation of the drill string
  - Pumps on and pumping down-hole

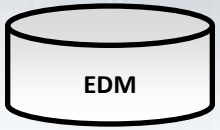
- **Diagnosis**
  - Off-bottom circulating
  - Scheduled top drive maintenance = Rig Repair
  - Unscheduled top drive maintenance = NPT
  - Safety Incident

Data Aggregation: Real Time Data Alone is not Enough

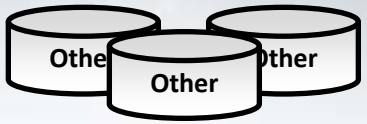
Real-Time Data Sources & Stores

Data Aggregation: Real Time Data Alone is not Enough

Real-Time Data Sources & Stores



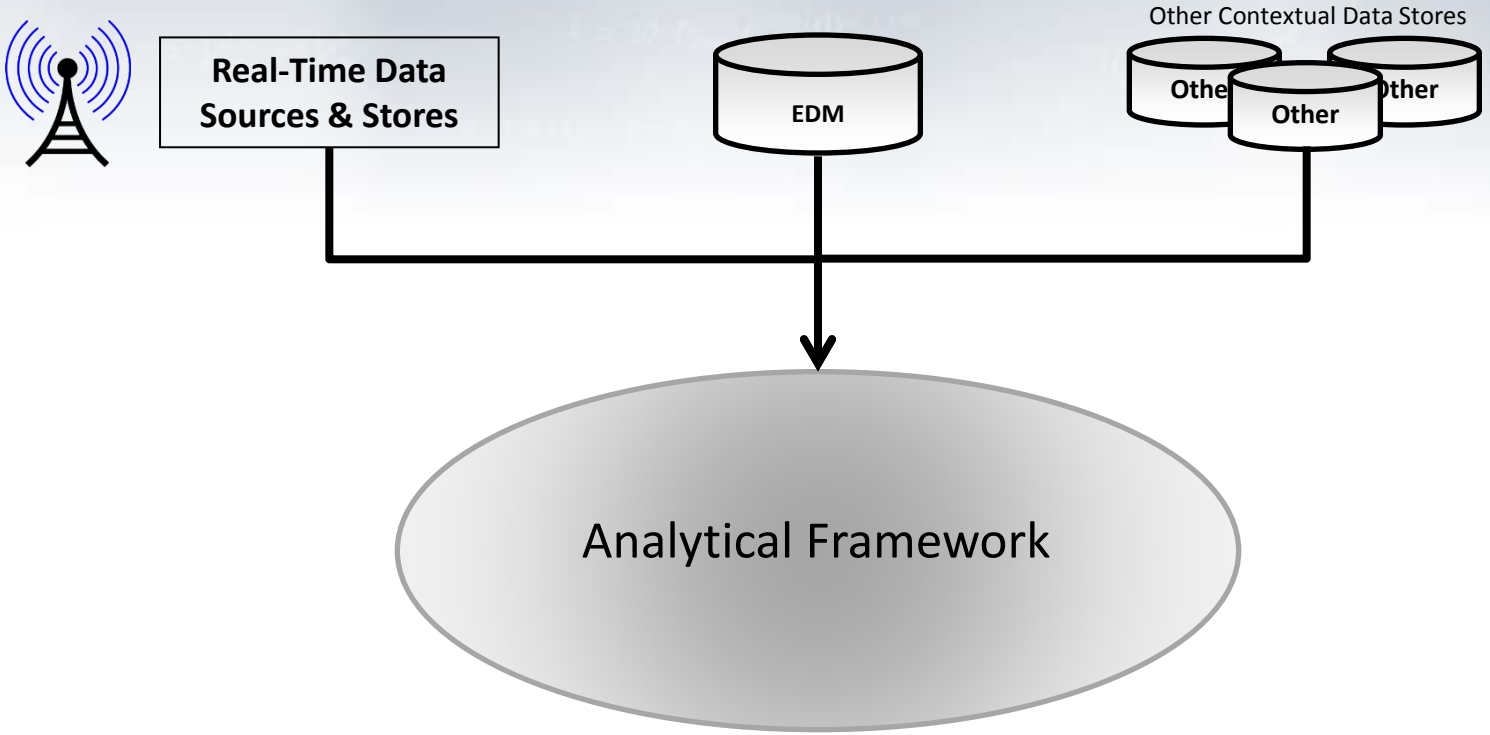
Other Contextual Data Stores



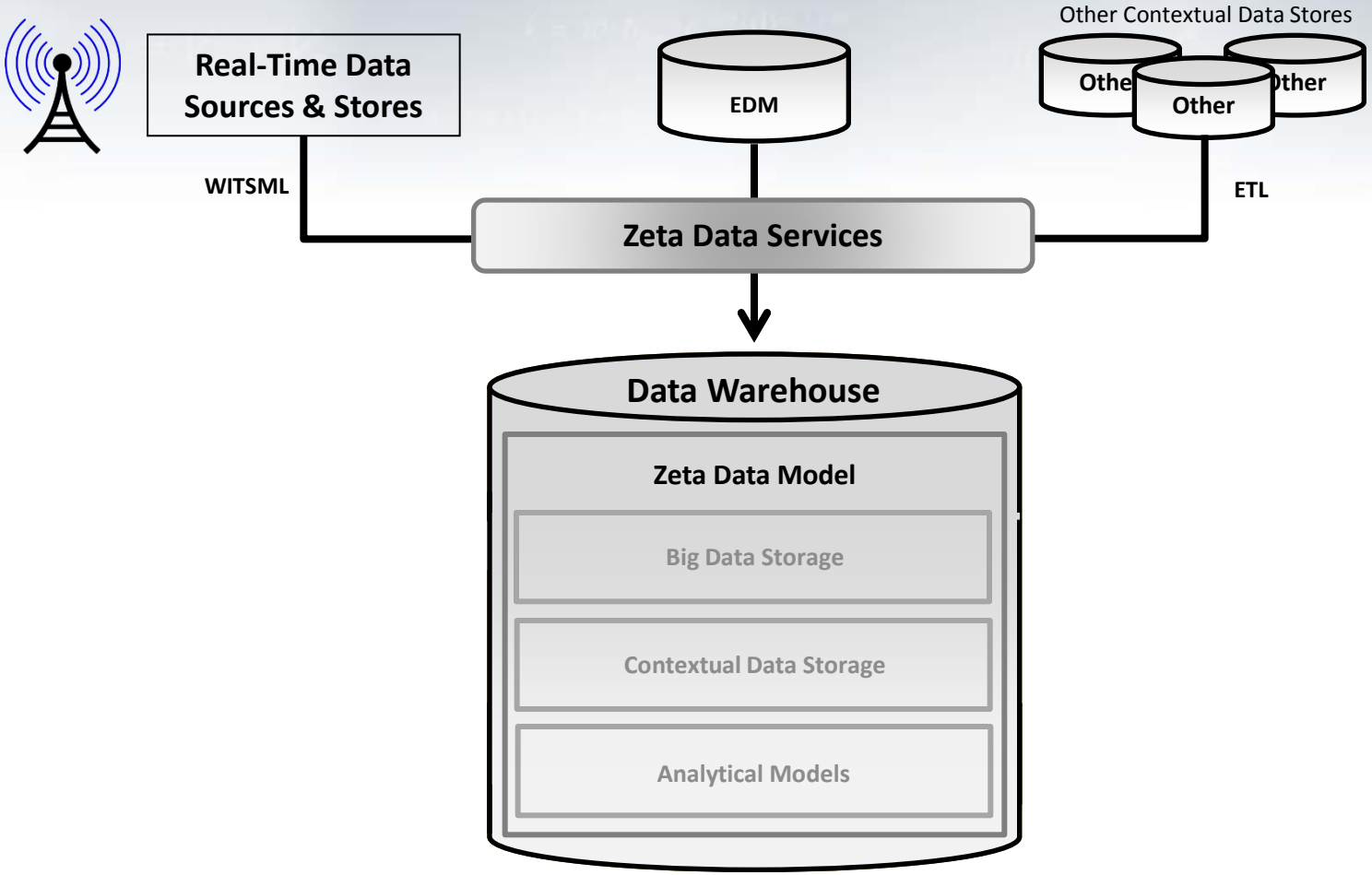
- Bit Manufacturer
- Bit Model
- Mud Motor Manufacturer
- Rig Name
- Rig Crew

- Costs
- Safety Incidents

Data Aggregation: Real Time Data Alone is not Enough



Data Aggregation: Real Time Data Alone is not Enough

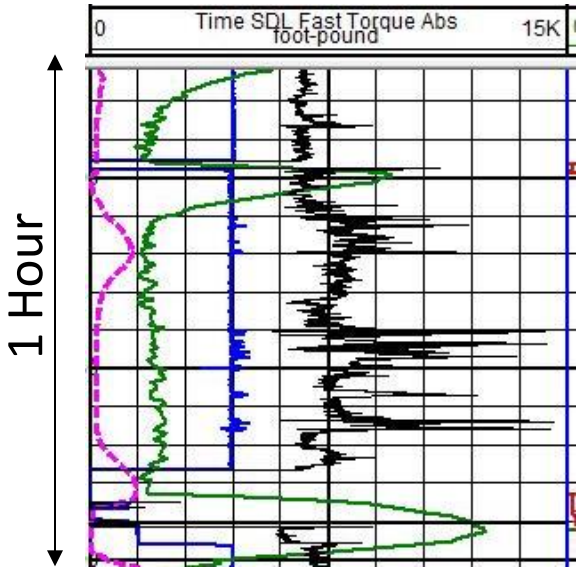


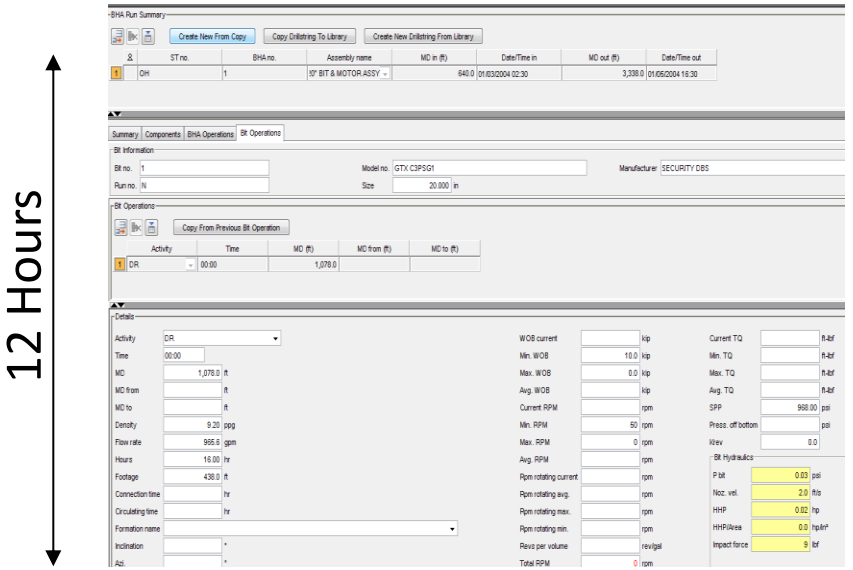
Data Aggregation: Joining Disparate Drilling/Engineering Data Sources is not Simple

- Granularity Differences
- Time vs Depth Data
- Interpolating Special Data
- Interpolating and Converting Instantaneous Events

Data Aggregation: Joining Disparate Drilling/Engineering Data Sources is not Simple

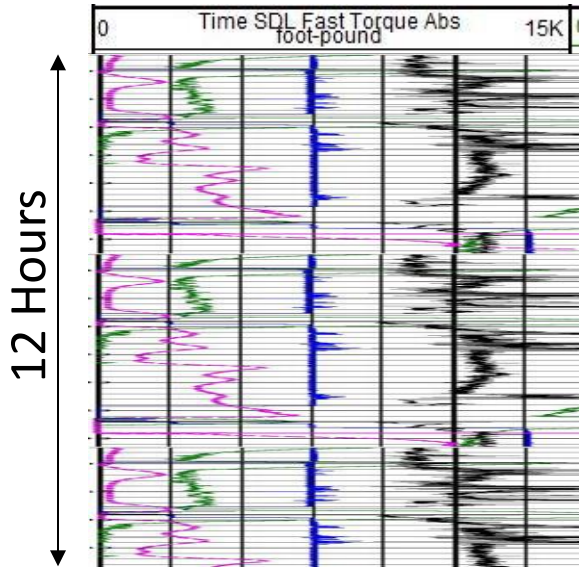
- Granularity Differences
  - Data from real-time sensors is at sample rates of 1 data-point per second or less
  - Contextual data from relational data sources is much less, on the rate of per hour or per day





Data Aggregation: Joining Disparate Drilling/Engineering Data Sources is not Simple

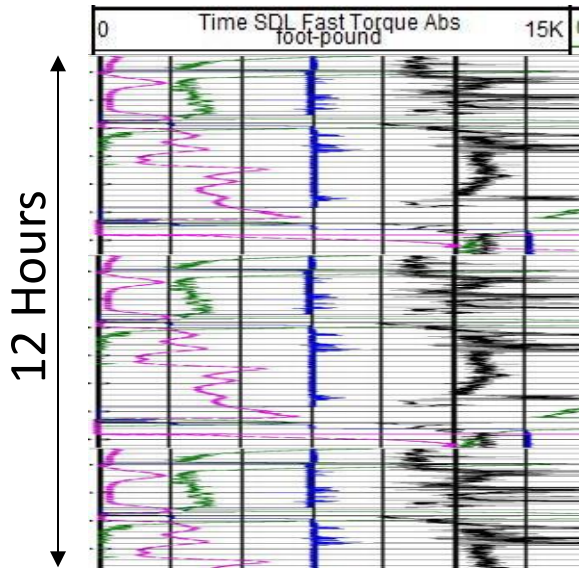
- Granularity Differences
  - Need a smart method to automatically populate the dense model with values from a less dense source to give a completely populated analytical dataset to analyze/predict from.



Log Sample	Condition	Bit Make/Model
T_1		Bit 1
T_2	Bit MD In	Bit 2
T_3		
T_4		
$T_{....}$		
$T_{....}$		
$T_{....}$		
$T_{....}$		
T_n	Bit MD Out	
T_{n+1}		Bit 3

Data Aggregation: Joining Disparate Drilling/Engineering Data Sources is not Simple

- Granularity Differences
  - Need a smart method to automatically populate the dense model with values from a less dense source to give a completely populated analytical dataset to analyze/predict from



Log Sample	Condition	Bit Make/Model
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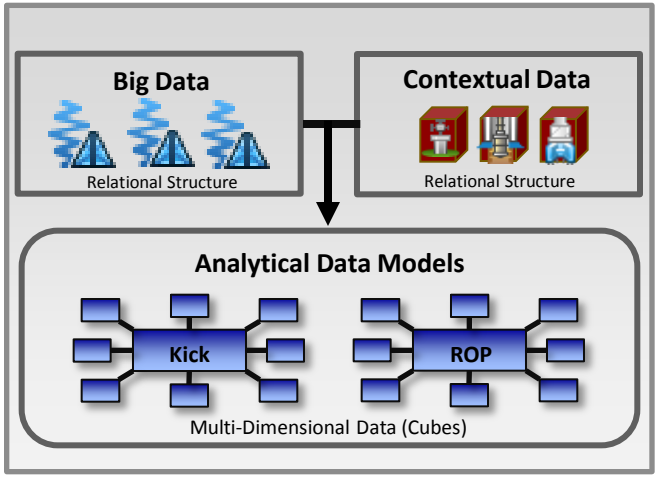
T_2	Bit MD In	Bit 2
T_3		Bit 2
T_4		Bit 2
$T_{....}$		Bit 2
$T_{....}$		Bit 2
$T_{....}$		Bit 2
$T_{....}$		Bit 2
T_n	Bit MD Out	Bit 2
T_{n+1}		Bit 3

Data Analysis: Drilling Analytical Models

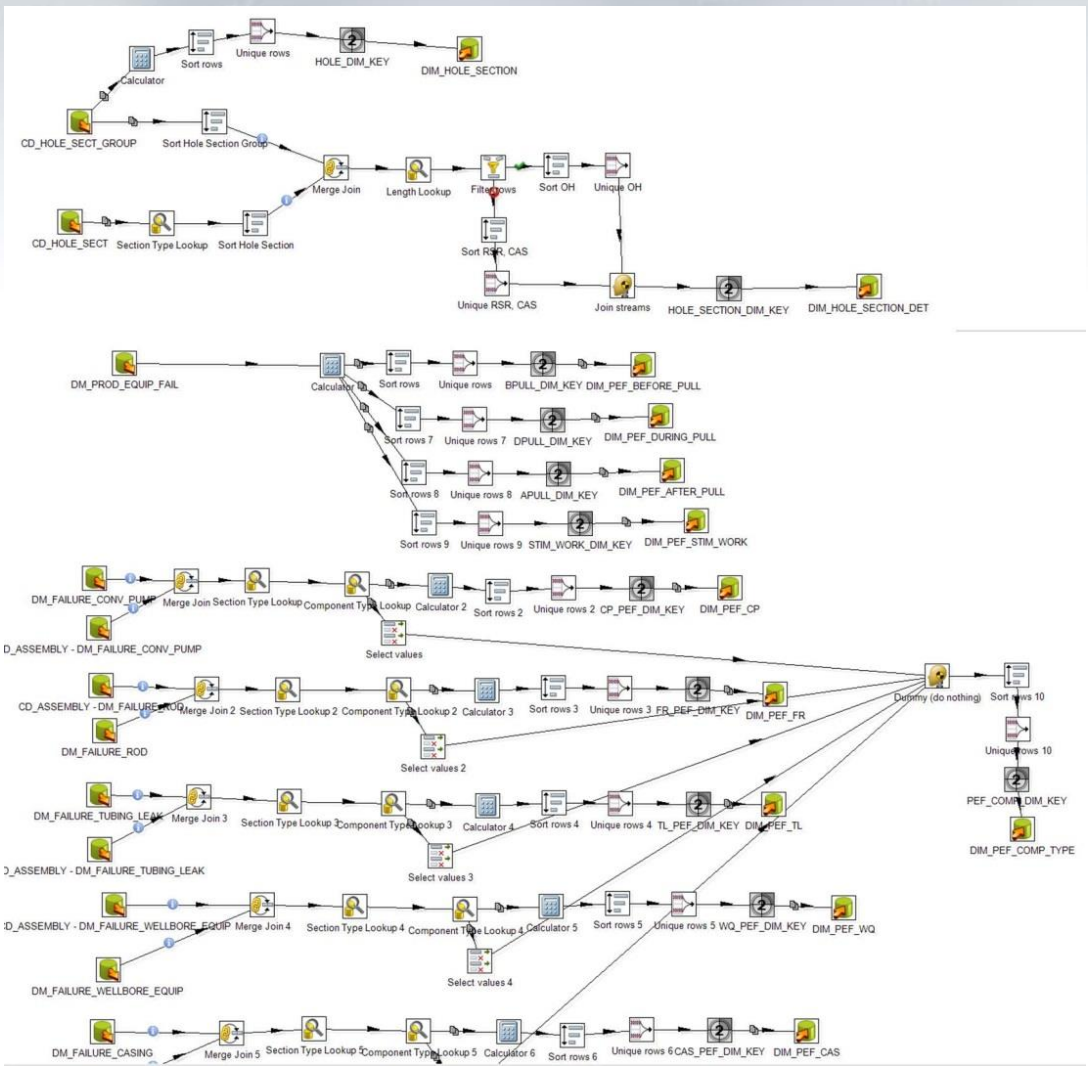
- Interrogating Terabytes of data can be a time-consuming and frustrating process
  - BI/OLAP-Cubes (multi-dimensional models) allow users to focus on specific drilling/engineering challenges
  - Data that can be joined in data-bases utilize the Analytics Engine for performance.
  - All streaming in optimized using Hadoop MapReduce



Data Analysis: Complex Joins & Common Data Model

- Joining data for traditional Analytics is based on time and/or contextual IDs
- With drilling data we have a combination of time and **depth** ranges across multiple data-sources as well as contextual IDs
- For example:
  - BHA run tables have Well ID, Wellbore ID, BHA Run ID, & Assembly ID
  - Assembly tables have Well ID, Wellbore ID, Assembly ID
  - Hole Section tables have Well ID, Wellbore ID, Hole Section ID, and Assembly ID (but only for certain applications & depths of Hole Section Annulus are not stored in the database)
  - Sections can have hole start and end depths, BHA in & out depths, section start and end times, BHA start & end times etc.
- To be successful we need to join across not only all these multiple tables, with multiple IDs, but also across multiple time and depth ranges.

Data Analysis: Complex Joins & Common Data Model



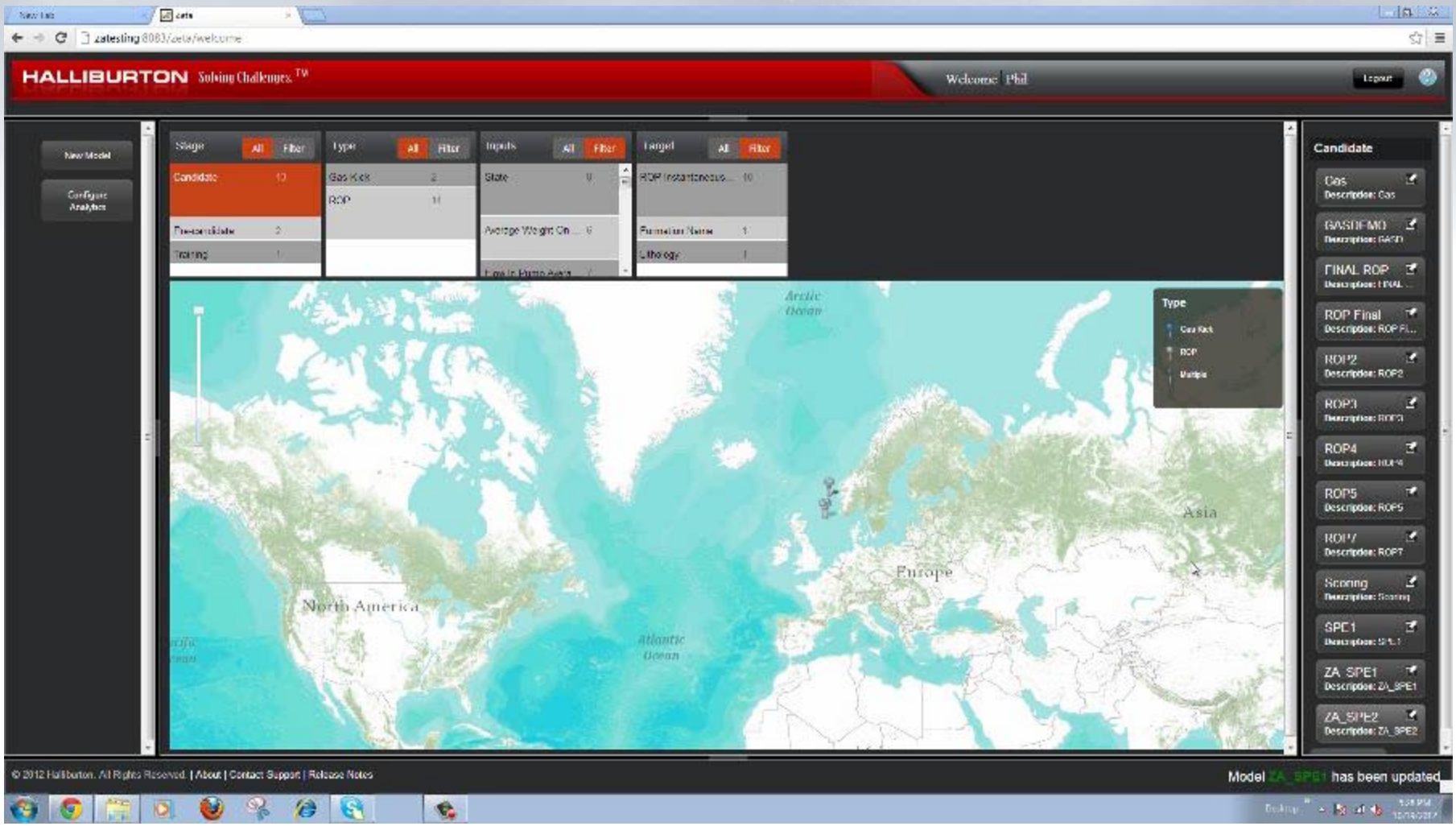
Data Analysis: Complex Joins & Common Data Model

- In ZetaAnalytics we have built a system & workflow to combine all these disparate drilling objects, and hide the complexity from the end-user
- We have designed a Common Data Model consisting of standard Dimensions for your common drilling objects that can be re-used with data from any E&P data-store

- Hole Sections
- Bit
- BHA
- BHA Components
- Costs
- Equipment
- Materials
- Phases/Codes
- Mud,
- Formations
- Well
- Wellbore
- NPT
- Event
- Perforation
- Stimulation etc.

Logical dimensional data-models for wellbore & drill-string

Data Analysis & Visualization



Summary

- Now is the time for Analytics & Big Data in E&P
- Traditional Analytical workflow and techniques will not Succeed with our data
  - Data Aggregation of disparate drilling & engineering data sources requires complex joining
  - Data Visualization needs to be built around Drilling & Engineering data and workflows
  - Data Mining needs to take into account the nature of our data and the skills of our users
- Landmark will continue to innovate in the field of Big Data & Analytics