Analytics and scalable data access: the future of industrial information technology

Mobilizing fundamental research to digitize the oil and gas industry

David Cameron, Centre Coordinator, SIRIUS Centre for Research Based Innovation, University of Oslo
ECIM, Haugesund, September 2016
1986

• BHP
• A newly minted chemical engineering
• Big glasses
• Lots of hair
• A PR picture with a VAX VT340 terminal
• Using simulation and real-time data to transform manufacturing
2005?

• During 2001/02, leading enterprises will increasingly use a **centralized data warehouse** to define a **common business vocabulary** that improves internal and external **collaboration**.

• Through 2003/04, data quality and integration woes will be tempered by **data profiling technologies** (for generating metadata, consolidated schemas, and integration logic) and **information logistics agents**.

• By 2005/06, **data, document and knowledge management** will coalesce, driven by **schema-agnostic indexing strategies** and **portal maturity**.

Doug Laney, Meta Group AD949, 6th February 2001
2020?

- Digital heaven?
- Johan Sverdrup in production ... and then what?
- Oil at USD 105/bbl? Or 20 USD/bbl?
- Demand for petroleum decreasing?
- Industrial transition from oil dependence under way?
Some safe predictions

• Sneaking revolution
  – Transformation by increments

• Competitiveness based on quality, flexibility and knowledge.

• Need to keep knowledge in the oil and gas sector
  – for at least maintenance, safety and decommissioning.

• Transfer of skills and knowledge to new – export oriented – industrial sectors.

• Our neighbours are reindustrialising.
  – Will we do the same?

• Basic information technology is already a service
  – IT must be high competence, high value
The oil and gas industry has shot itself in the foot ... again

- University of Stavanger
  - Petroleum Geology: 12 applicants to 25 places.
- University of Tromsø
  - Process technology: 2 applicants
- NTNU
  - Petroleum technology: 420 applicants in 2013, 31 this year.
- Broad political scepticism to oil, gas and heavy industry.
- Low on our students’ aspiration list.
Collaborative research centres can help

- **SIRIUS**
  - Centre for Research-Based Innovation
  - 8 years (5+3) financing from Research Council of Norway
- **Not a new idea:**
  - Canada and Australia set them up in the 1990s.
- **Already third generation in Norway**
  - Integrated Operations Centre in Trondheim
  - DRILLWELL in Stavanger
  - Subpro in Trondheim
Trying to keep two masters happy

Both cardinality constraints $\geq 2$ boss $\sqsubseteq \bot$ and $\text{Project} \sqsubseteq \geq 3\text{worksOn}^-$ require a more powerful language. Finally, we have to say that a top manager manages exactly one project and also works on that project, while a project is managed by exactly one top manager. In OWL 2 QL, we can only write:

$$\exists \text{manages} \sqsubseteq \text{TopManager}, \quad \exists \text{manages}^- \sqsubseteq \text{Project},$$
$$\text{TopManager} \sqsubseteq \exists \text{manages}, \quad \text{Project} \sqsubseteq \exists \text{manages}^-,$$
$$\text{manages} \sqsubseteq \text{worksOn},$$

but not $\geq 2\text{manages} \sqsubseteq \bot$ and $\geq 2\text{manages}^- \sqsubseteq \bot$. We cannot, obviously, represent constraints such as $\text{CEO} \sqcap (\geq 5 \text{worksOn}) \sqcap \exists \text{manages} \sqsubseteq \bot$ (no CEO may work on five projects and be a manager of one of them) either.
### Scalable data access in the oil and gas domain?

<table>
<thead>
<tr>
<th>Problem scope</th>
<th>Toy problems</th>
<th>Realistic pilots</th>
<th>Enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption</td>
<td>The evangelists</td>
<td>The converted</td>
<td>The people</td>
</tr>
<tr>
<td>IT operations</td>
<td>On-premises</td>
<td>Outsourced</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Problem size</td>
<td>Megabytes</td>
<td>Gigabytes</td>
<td>Terabytes</td>
</tr>
<tr>
<td>Decision speed</td>
<td>Weeks</td>
<td>Hours</td>
<td>Seconds</td>
</tr>
<tr>
<td>Data complexity</td>
<td>Single databases</td>
<td>Local silos</td>
<td>Corporate data</td>
</tr>
<tr>
<td>Computing power</td>
<td>Commodity</td>
<td>Terascale</td>
<td>Exascale</td>
</tr>
<tr>
<td>Innovation</td>
<td>Basic research</td>
<td>Applied research</td>
<td>Products and services</td>
</tr>
</tbody>
</table>
Scalable data access in the oil and gas domain

- Different formats
- Old software
- Complex, inconsistent data models
- Inefficient access methods
- Access and security
- Unstructured data
- Missing data
- Poor-quality data
- Too much data
- Manual work processes

Accessing data is a technical and organizational bottleneck for using data. We make poorer decisions and waste time on tedious work getting data.
Scalable data access in the oil and gas domain
Scalable data access is interdisciplinary.

- Work Practices
- Semantic Technologies
- Natural Language Technologies
- Database Technologies
- Cloud Computing
- High-Performance Computing
- Experiment
- Laboratory
- Pilot
- Prototype
- Systems
- Services
- Ph.D. & M.Sc. graduates
- Academic publications
Successful Piloting in Exploration

- 30–70% of exploration engineers’ time spent on data gathering
- Dependent on IT experts to deliver reports and data warehouses
- The professional wants to:
  - Use own terminology in technical software
  - Make quick and easy ad hoc requests. Not a project!
- **Speed-up from weeks to minutes in data access.**
- Project met all EU agreed targets after 3 of 4 years.
Letting the expert ask in her own language

“Show all Norwegian wells with cores in Brent with measured permeability and where it is larger than a given value, e.g. 1 mD.”
Natural Language: Understanding when no means no

• World leading in negation detection
  – Apple did not acquire Wi-Gear
  – Apple failed to acquire Wi-Gear
  – Apple denied not acquiring Wi-Gear
  – Apple acquired Siri, but were unable to acquire Wi-Gear
Services deployed in the cloud: Predicting behaviour from models

**ABS**: modeling language for distributed software systems

**Make Model-based deployment decisions** at design time using ABS models of the services

**Resource-aware design**: Build software that can dynamically modify its own deployment to improve performance and/or reduce cost

**Formal semantics for prediction and monitoring**: Architects and developers can simulate and analyze at design time how an application runs on the cloud

"The Envisage project is developing technology which could be a potential game changer in the Cloud environment"

- EU project review
HyVar: Managing large-scale systems of things

- On-board car systems
- Scalable, elastic, context-aware reconfiguration of on-board applications.
- Hybrid reconfiguration algorithm based on device configurations and sensor data
- Over-the-air updates of distributed applications
Making data access really scalable needs

- Work in specifying and maintaining **useful semantic models about real things**
- Good, fast, effective **databases** – in memory and in place
- Linkages to **natural language** – in data and interaction
- Efficient, predictable access to **data spread across the cloud**
- **Secure**, role-based access to data
- **High-performance computing** to access data, reason and calculate
- Modelling, optimization and reasoning – **analytics**
- Sensitive and effective transformation of **work practices**
- i.e. the whole of **industrial informatics**.
And it needs collaboration in and beyond Norway

- World-class research links
  - Via EU projects / JIPs / bilateral arrangements
  - Be the best to work with the best
  - Participation in the European PPPs – both IT and “business”
- Work with related “Business” Centres for Research-based Innovation
  - Subpro, Drillwell, Mechatronics
- Real cases across the supply chain with all actors
- Cross-fertilization with Health, Aerospace, Manufacturing
  - Revitalization of Nordic collaboration?
  - The best of US, Asian and Latin American research.
Our Status in 2016

• Just started
• Winding up the existing EU projects
• 5 doctoral students already or soon in place
• Planning with partners for innovation projects in 2017
Remember the continuity in the hype ... do more than talk

• Analytics
• (Industrial) Internet of Things
• Big Data
• Deep Learning
• Digitalization
WE ARE SIRIUS