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

Mobilizing fundamental research to digitize the oil and gas industry

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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?
- China? Russia? Korea? Turkey? UK? USA?

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 $Project \sqsubseteq \geq 3 worksOn^-$ 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:

$$\exists manages \sqsubseteq TopManager, \qquad \exists manages^- \sqsubseteq Project,$$
$$TopManager \sqsubseteq \exists manages, \qquad Project \sqsubseteq \exists manages^-,$$
$$manages \sqsubseteq worksOn,$$

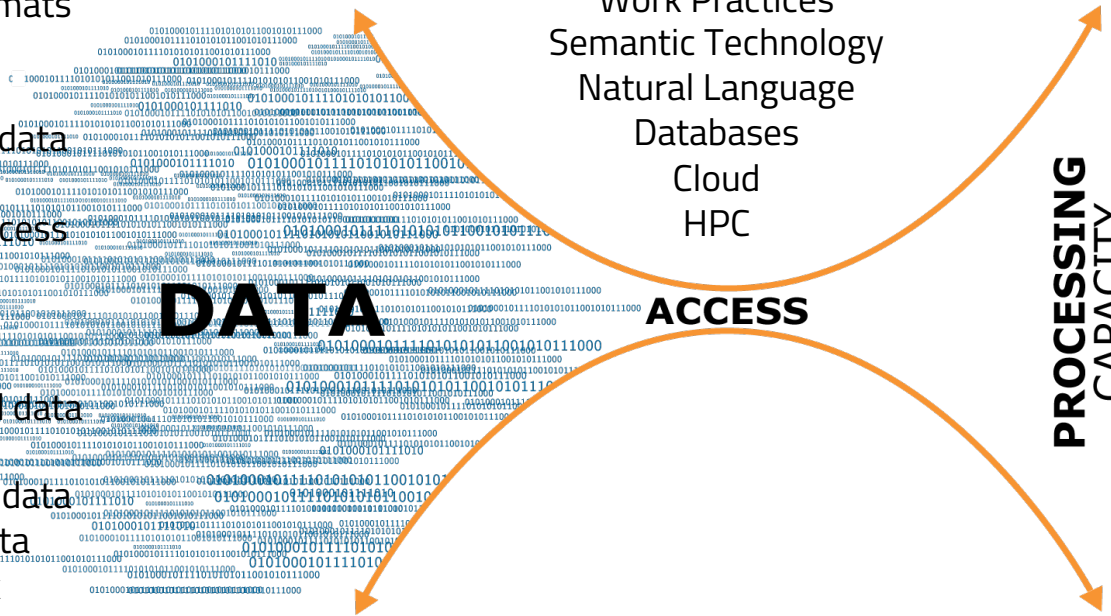
but not $\geq 2 manages \sqsubseteq \bot$ and $\geq 2 manages^- \sqsubseteq \bot$. We cannot, obviously, represent constraints such as $CEO \sqcap (\geq 5\ worksOn) \sqcap \exists manages \sqsubseteq \bot$ (no CEO may work on five projects and be a manager of one of them) either.

Scalable data access in the oil and gas domain?

Problem scope	Toy problems	Realistic pilots	Enterprises
Adoption	The evangelists	The converted	The people
IT operations	On-premises	Outsourced	Heterogeneous
Problem size	Megabytes	Gigabytes	Terabytes
Decision speed	Weeks	Hours	Seconds
Data complexity	Single databases	Local silos	Corporate data
Computing power	Commodity	Terascale	Exascale
Innovation	Basic research	Applied research	Products and services

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



Work Practices
Semantic Technology
Natural Language
Databases
Cloud
HPC

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

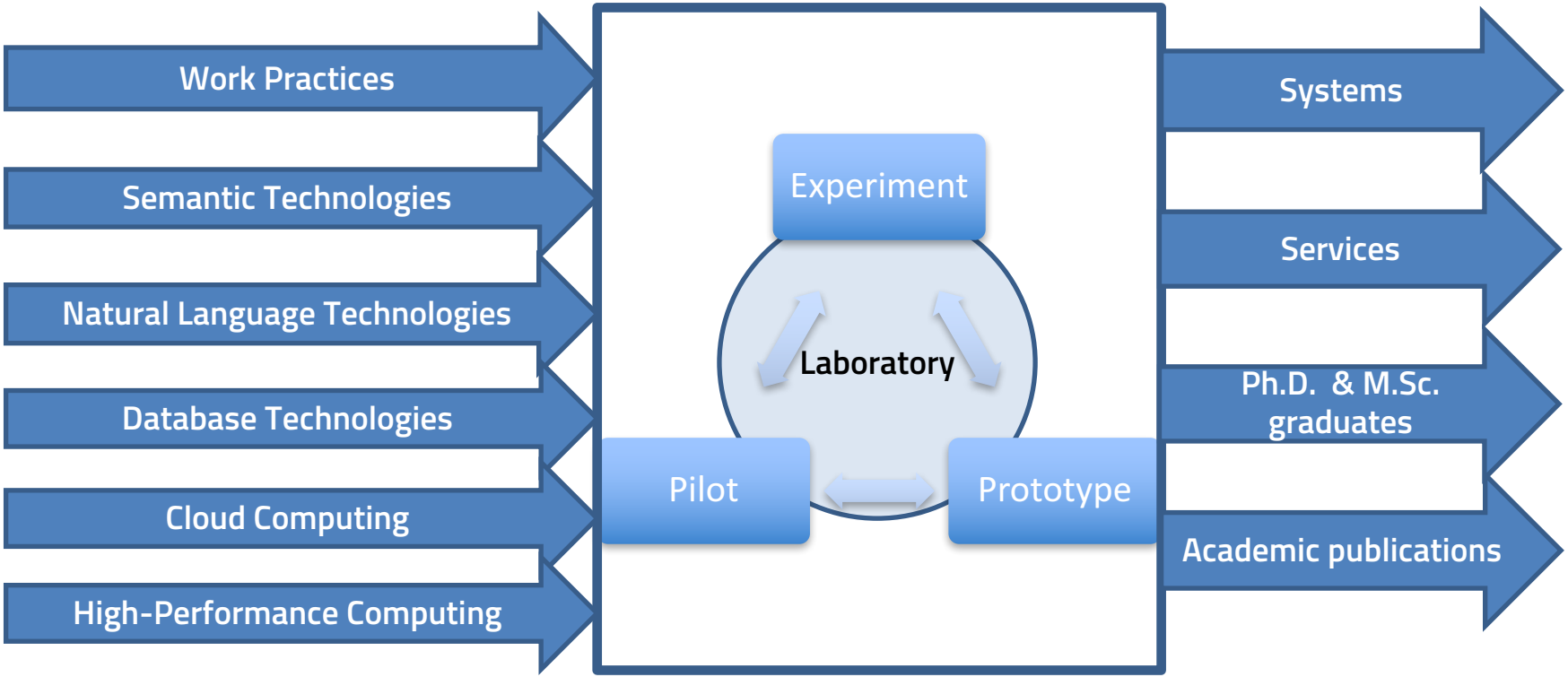
UiO : University of Oslo

[simula . research laboratory]

NTNU
Norwegian University of Science and Technology

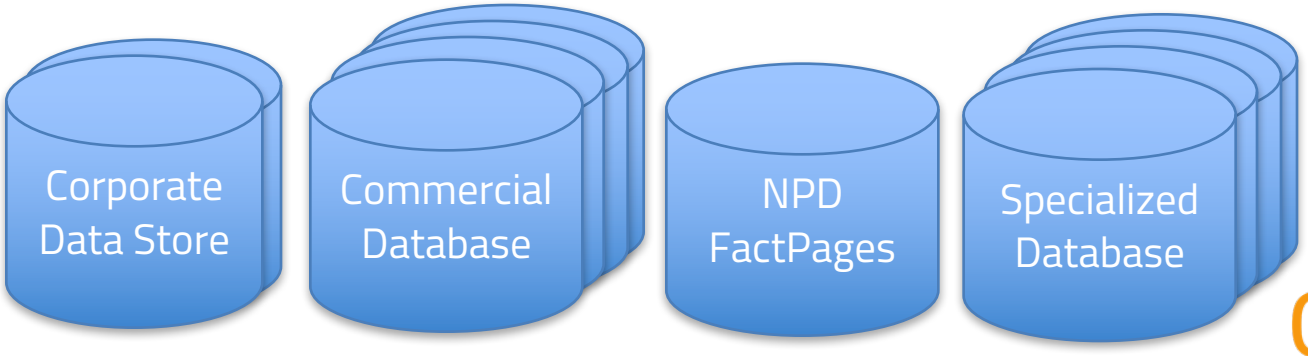
DEPARTMENT OF COMPUTER SCIENCE

Scalable data access is interdisciplinary



Successful Piloting in Exploration

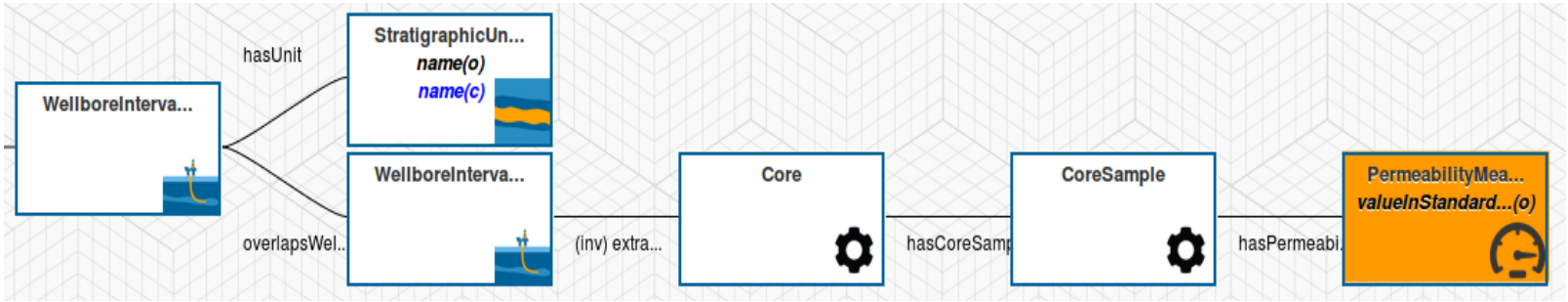
- 30-70% of exploration engineers' time spent on data gathering
- Dependent on IT experts to deliver reports and data warehouses
- The professional wants to:
  - Use own terminology in technical software
  - Make quick and easy ad hoc requests. Not a project!
- **Speed-up from weeks to minutes in data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



Optique

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

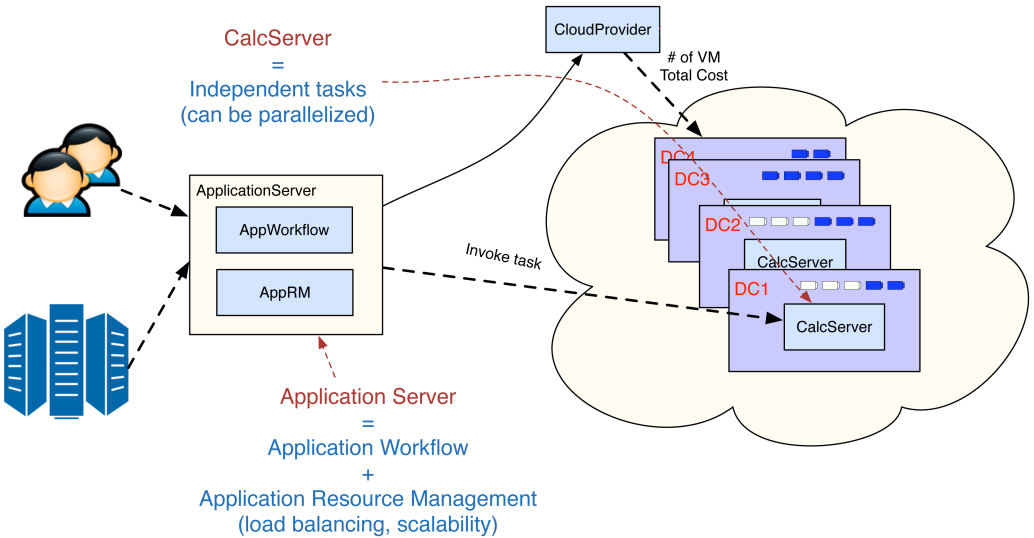
Make Model-based deployment decisions at design time using ABS models of the services

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

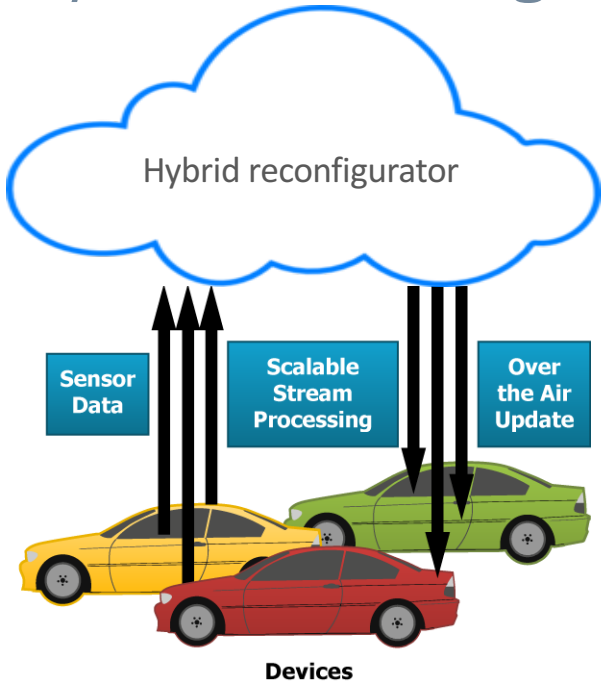
"The Envisage project is developing technology which could be a potential game changer in the Cloud environment"

- 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