Scalable, Useful and Maintainable Digital Twins:

Cross-Sector Experience from the Oil and Gas Sector

David Cameron
SIRIUS Centre for Scalable Data Access

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The SIRIUS Centre for Scalable Data Access

- Eight years' financing from Norwegian Research Council
- 13 Industrial Partners (11 in 2017)
- 3 Leading Academic Institutions
- Centre for Research-Based Innovation
- Funding for 20 Ph.D. students
- Innovation through prototypes and pilots
- 45 affiliated researchers

UiO : University of Oslo

simula

sfi Centre for Research-based Innovation

Schlumberger

equinor

SAP

IBM

DNV·GL

EVRY

Dolphin

NUMASCALE BIGGER DATA ANALYTICS

KADME Knowledge and data management expertise

OSIsoft.

TechnipFMC

fluidOps

computas

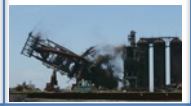
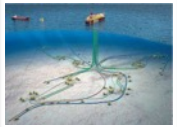
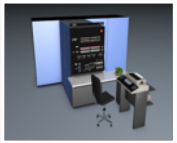
NTNU Norwegian University of Science and Technology

UNIVERSITY OF OXFORD DEPARTMENT OF COMPUTER SCIENCE

The hype of digital twins

The reality?

Why am I qualified to speak on this?

1982	1986	1988	1993	2000	2007	2011	2013	2015
Chemical engineering and trainee in steel industry. Thesis on physical properties of oil and CO_2	Blast furnace simulation and on-line systems. New steel technologies. 	Dynamic data reconciliation using process simulators. Apply Kalman filters to chemical processes.	Simulation and optimization of fertilizer, chemical and petroleum plants.	Whole plant simulators. Advanced control. On-line simulators. 	Virtual flow metering and on-line systems for complex sub-sea plants. 	Technical and business consultancy in chemicals and petroleum	Business development in petroleum, energy & industrial sector	Centre for Scalable Data Access. Research entrepreneur and translator between business and academics
								

Parallels between oil and gas and steel

Upstream

NG
LNG
LPG
Condensate
Crude

Downstream

Slab
Bloom
Billet
Rod

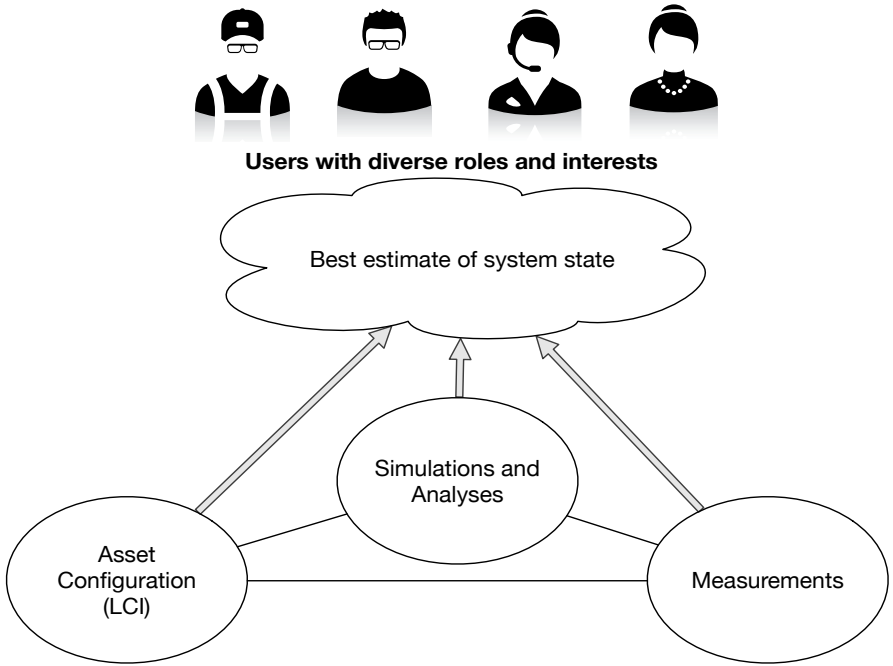
Wide variety of products with tight quality constraints and specifications

What is a digital twin?

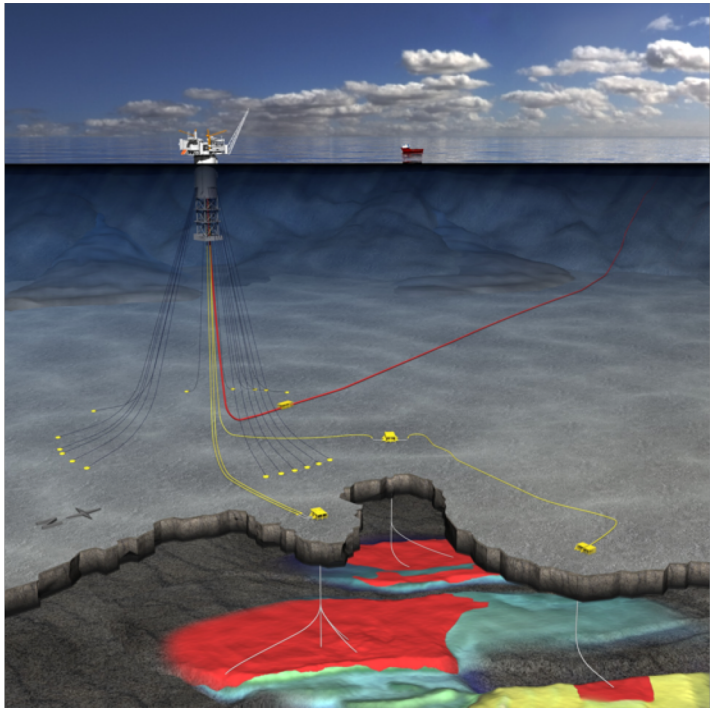
"An integrated multi-physics, multi-scale, probabilistic simulation of an as-built system, … that uses the best available models, sensor information, and input data to mirror and predict activities/performance over the life of its corresponding physical twin."

www.dau.mil/glossary/pages/3386.aspx

A conceptual framework for twins



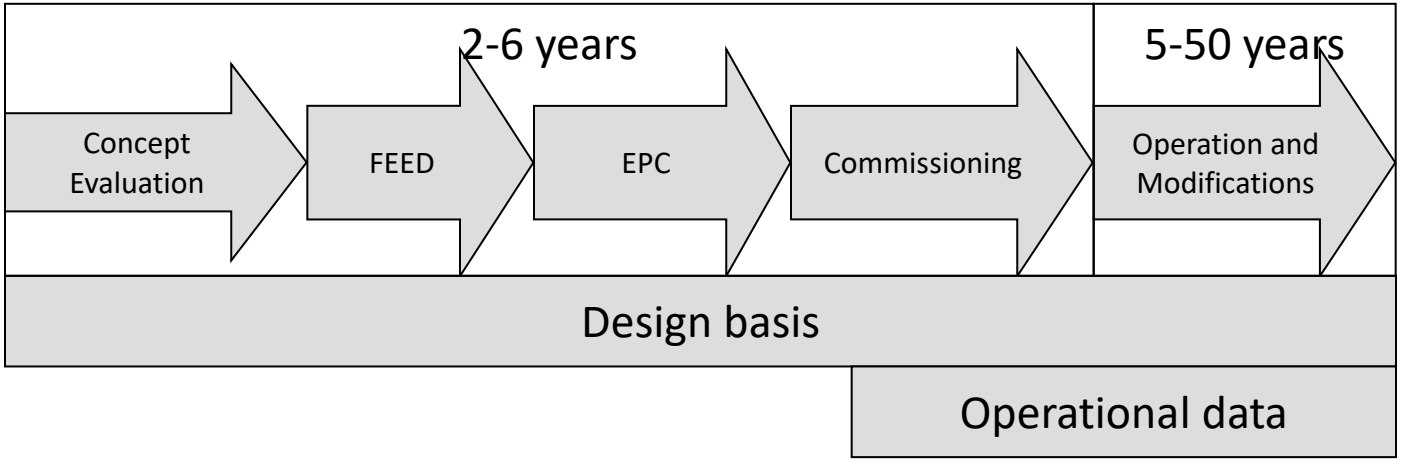
Oil and gas assets



The oil and gas asset life-cycle

The sub-surface (underground) lifecycle: > 80% of capital cost

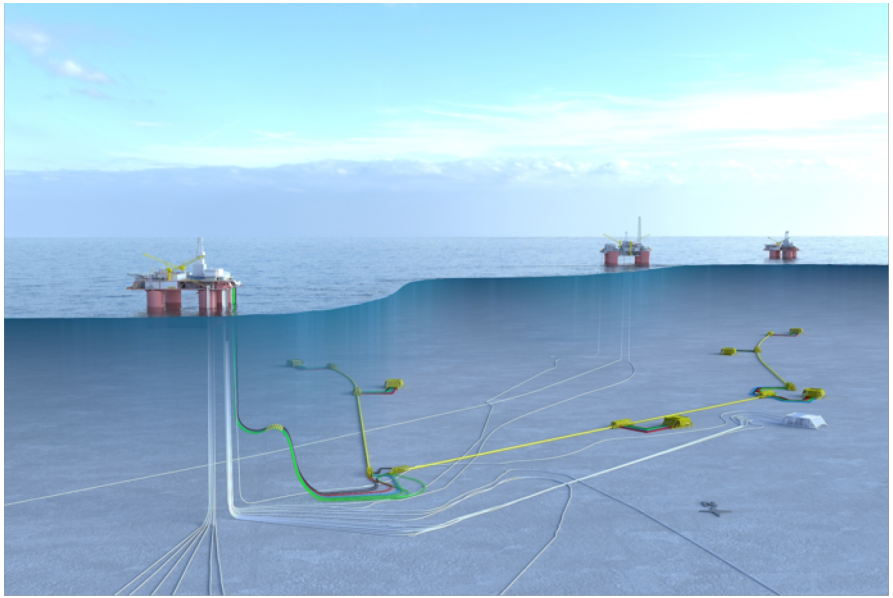
The production facility lifecycle: < 20% of capital cost

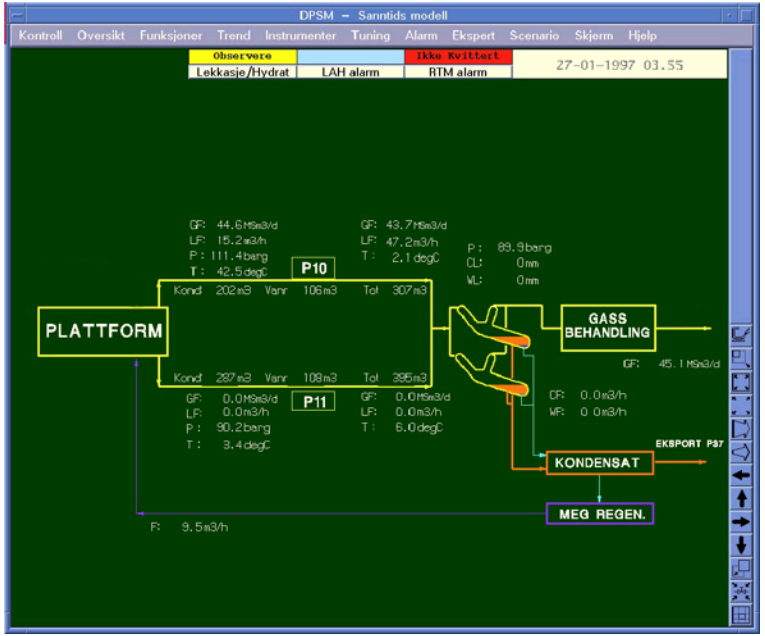


Alphabet soup:

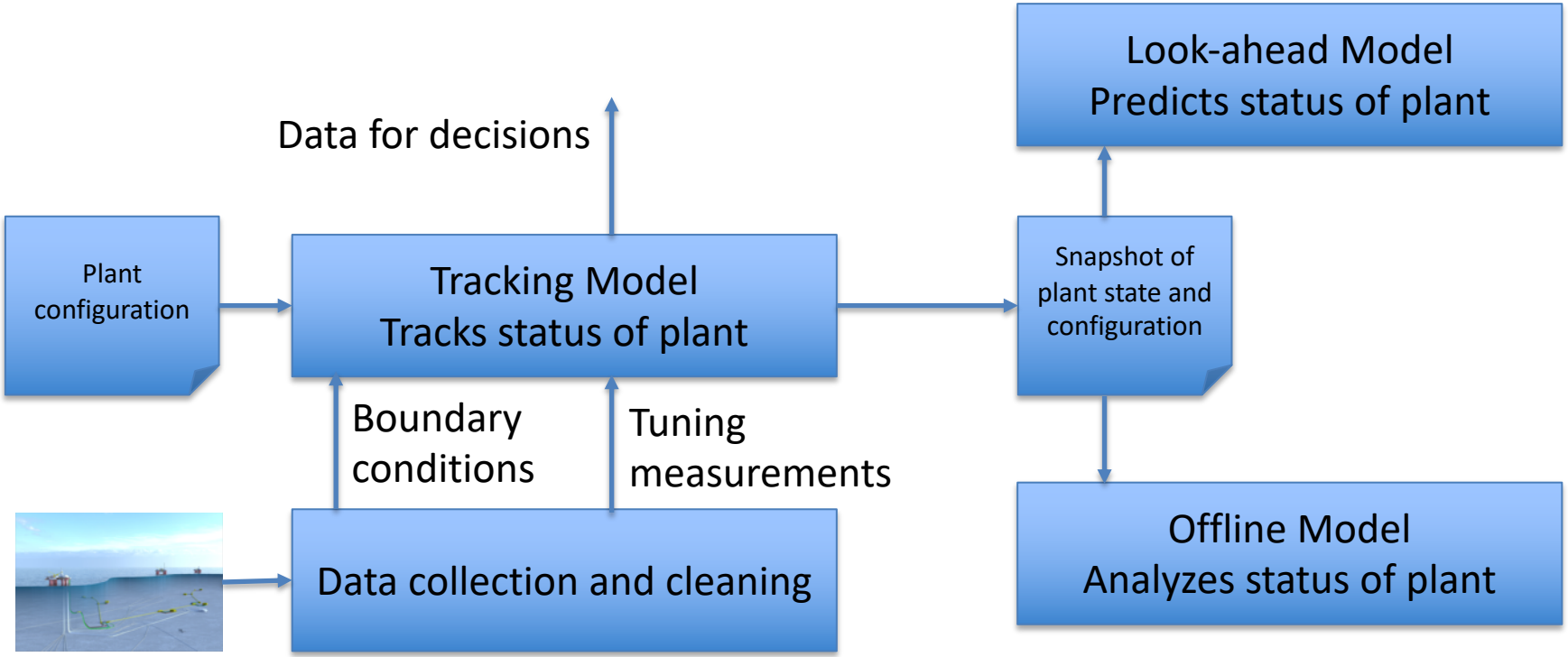
- EPC: Engineering, Procurement and Construction
- FEED: Front-end Engineering and Design

A digital twin success story: on-line flow assurance





How the flow assurance digital twin works



Current and planned twin applications

- Established practice
  - Flow assurance twins
  - High-quality visualization of operational data with 3-D model of facility
- Commercial but novel
  - On-line top-side operations simulators for prediction and data reconciliation
  - Structural and other special-purpose twins
- Future
  - Whole field twin: reservoir, flow assurance and top-side in interaction
  - Integrated twin along asset lifecycle and product lifecycle

Challenges to be addressed

- Business Models, Security and Confidentiality
- Integration
- Work practices
- Maintenance
- Scope
- Computational overload: edge and cloud
- Usability
- Uncertainty, validation and data science

Business models, security and confidentiality

- An enabler of new business models?
  - New ways of procurement, engineering and operations.
  - Challenges are commercial and contractual.
- Security and confidentiality
  - Twins bring together all data: access by role
  - Securing applications that are connected to the Internet by a wide variety of not-very-smart devices.
  - Sharing data and sharing rewards, while not running a cartel

Work practices

- Tangible and measurable benefits to managers, engineers and operators.
- Safety and availability are paramount.
- A help, not a hindrance.

Scope

- If you try to do everything, you will do nothing well.
- Just enough functionality: Shell's ALOS: Appropiate Level of Smartness
- Support different granularities and time constants:
  - Compressor (ms), pipes and wells (days), reservior (weeks).

Usability

- All data is available!
- But I have to wade through huge amounts of irrelevant data.
- How can I filter down to the data I need for my job?
  - Superintendent, operator, process engineer, electrical engineer...

Integration

- How do we avoid the “point-to-point” nightmare?
- Everybody has a platform, with the aim of being the master.
- A digital twin must integrated multiple platforms and legacy sources.

Maintenance

- Need simple tools to build and configure digital twins.
- Need to maintain the system through the life of the asset: planned modifications and maintenance
- Easy to justify for a blower, but harder to justify for a software system?

Computational overload: edge and cloud

- Large systems, complex models and optimization = large resources
- Implemented in a hybrid, hetergeneous cloud
- Implementation needs to be designed

Uncertainty, validation and data science

- Measurements and models are both wrong
- … And the plant can malfunction too
- Models must be tuned to follow the facility
  - Parameter estimation
- Measurements must be validated and reconciled
- Fruitful area for data science:
  - When combined with the physical models that constrain reality

A research program for digital twins