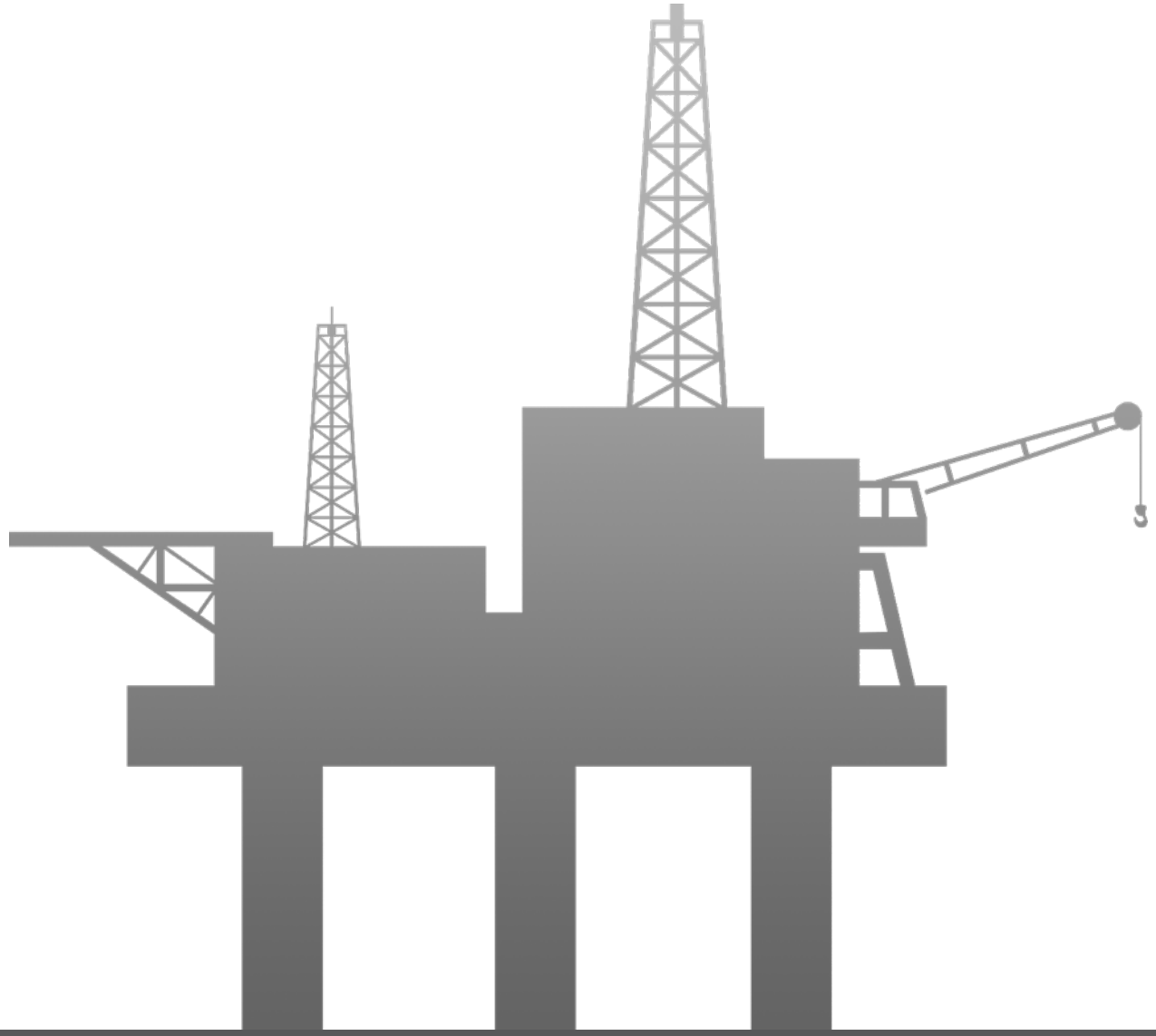
Integrated Operations
- experiences from Norway



Dr. Thore Langeland

Strategic adviser, EPIM

Email: tla@epim.no

Phone: +47-9095 1756

Content

1. Introduction

Digitalization of the oil and gas industry

Think GLOBAL, act LOCAL

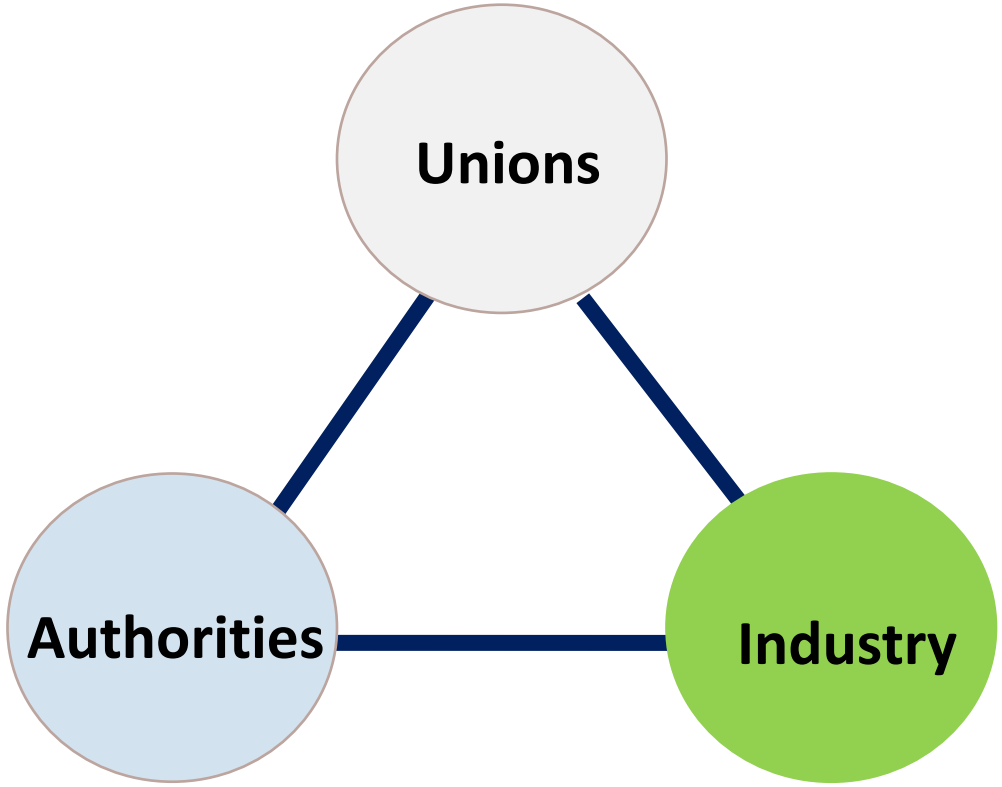
Theorem 1
50% of the problems in the world result from people using the same words with different meanings

Theorem 2
The other 50% of the problems results from people using different words with the same meaning.

Stan Kaplan (1925 - 2011)

USA and Norway – Offshore petroleum exploitation

1. In Norway there is a trusted 3-party collaboration between unions, industry and authorities
2. USA regulations seems to be more detailed and in some areas stricter than the Norwegian regulations
3. In Norway the operator is responsible for any event related his Production License
4. In Norway, after an accident, the 3-party collaborate in improving regulations, systems and procedures (self-regulation)



http://www.uis.no/research-and-phd-studies/research-centres/seros/research/vulnerability/projects/robust-regulation-in-the-petroleum-sector-the-relationship-between-behaviour-and-culture/

Efficient information sharing – but how?

Norsk olje&gass

NORSOK*) Steering Group

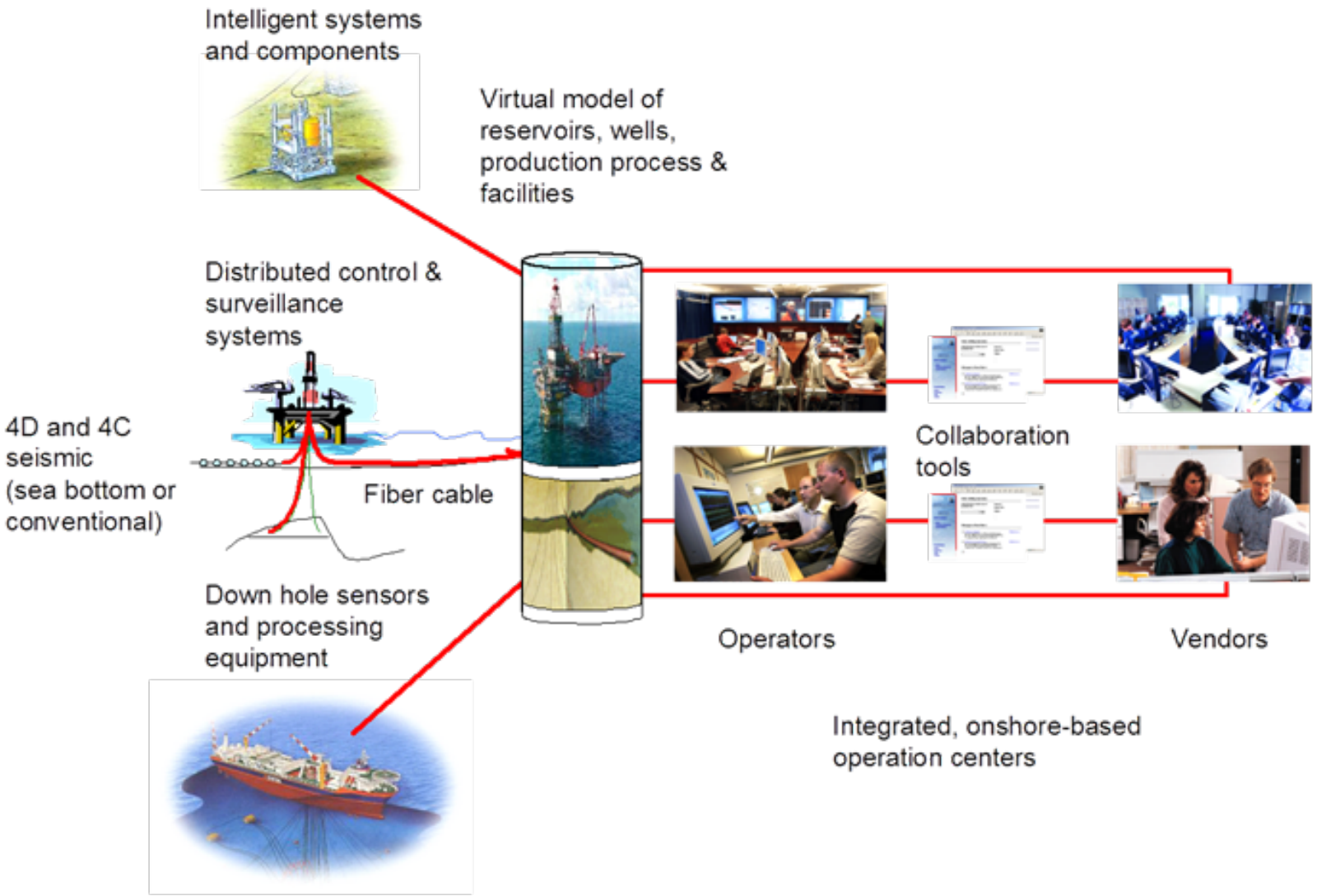
- **Cost analysis and bench-marking**
- **Standard ization**
- **Operator and supplier relations**
- **IT and Documen-tation**
- **Base and transport activities**
- **Health, the environment and safety**
- **Petroleum Policy issues**

400+ Statoil Technical Standards (STS) ➡ 87 NORSOK standards on Internet, but not machine-readable

Efficient information sharing will improve work processes with 20-25%.

Today's activity: NOK 50 billion reduced cost

Integrated Operations (IO) – but how?



Competitive suppliers – but how?

The news February 2014: Statoil's cost reduction

Prime minister Erna Solberg:

Make your suppliers competitive!

CEO Helge Lund, Statoil

Operators' cost structure

Internal	**20%**
External	**80%**

Working Environment

Technology/Software

IBM Microsoft ORACLE SAP

AVEVA Bentley INTERGRAPH

EMERSON NOV HALLIBURTON Schlumberger

Documents

Laws & Regulations

Standards

Enterprise Governing Documents

2. *Integrated Operations (IO)*

a) The idea

b) Business benefits

c) Organization

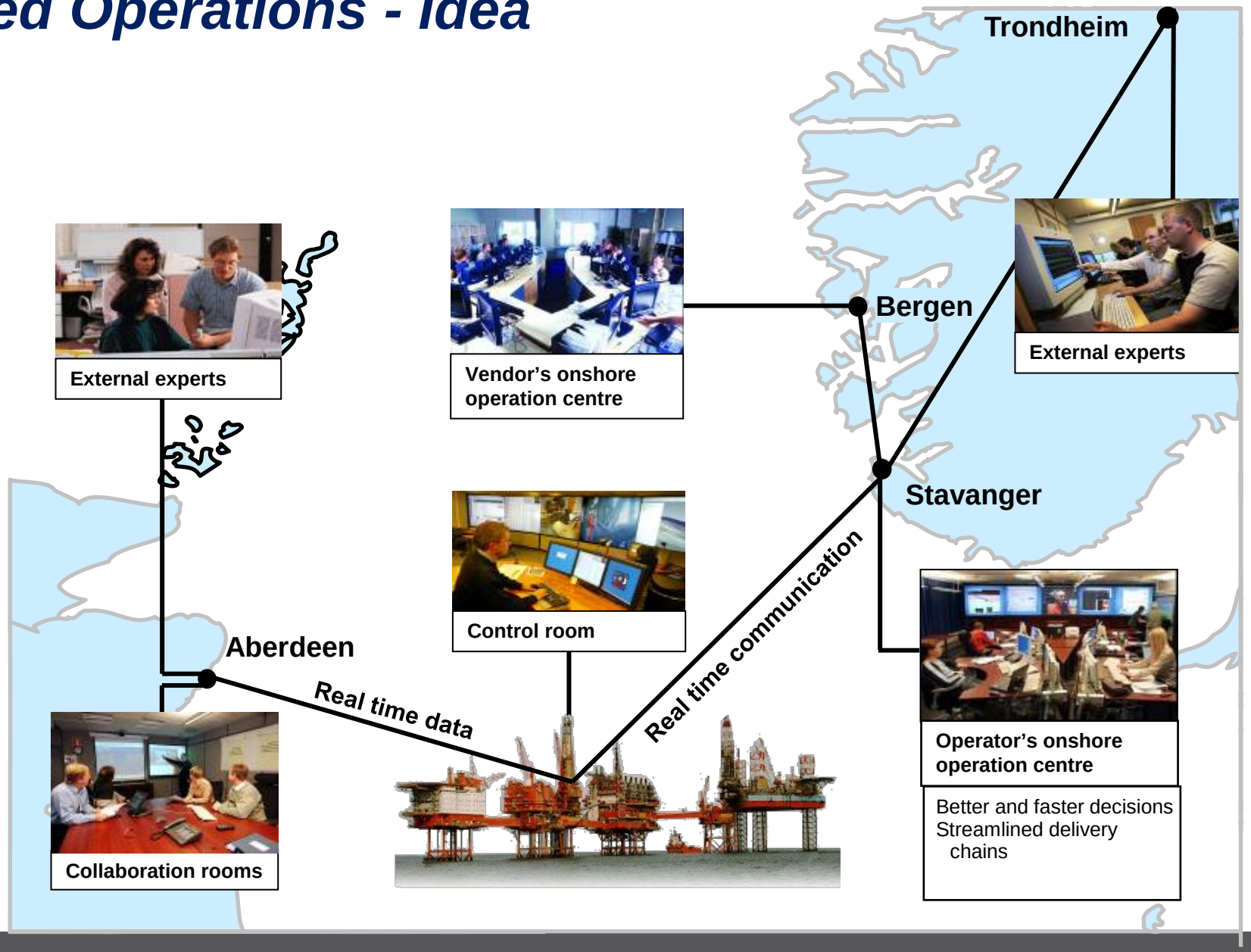
d) The plan

e) Some results
   - ✓ HSE
   - ✓ Drilling
   - ✓ Production
   - ✓ Operations

f) IO Generation 2

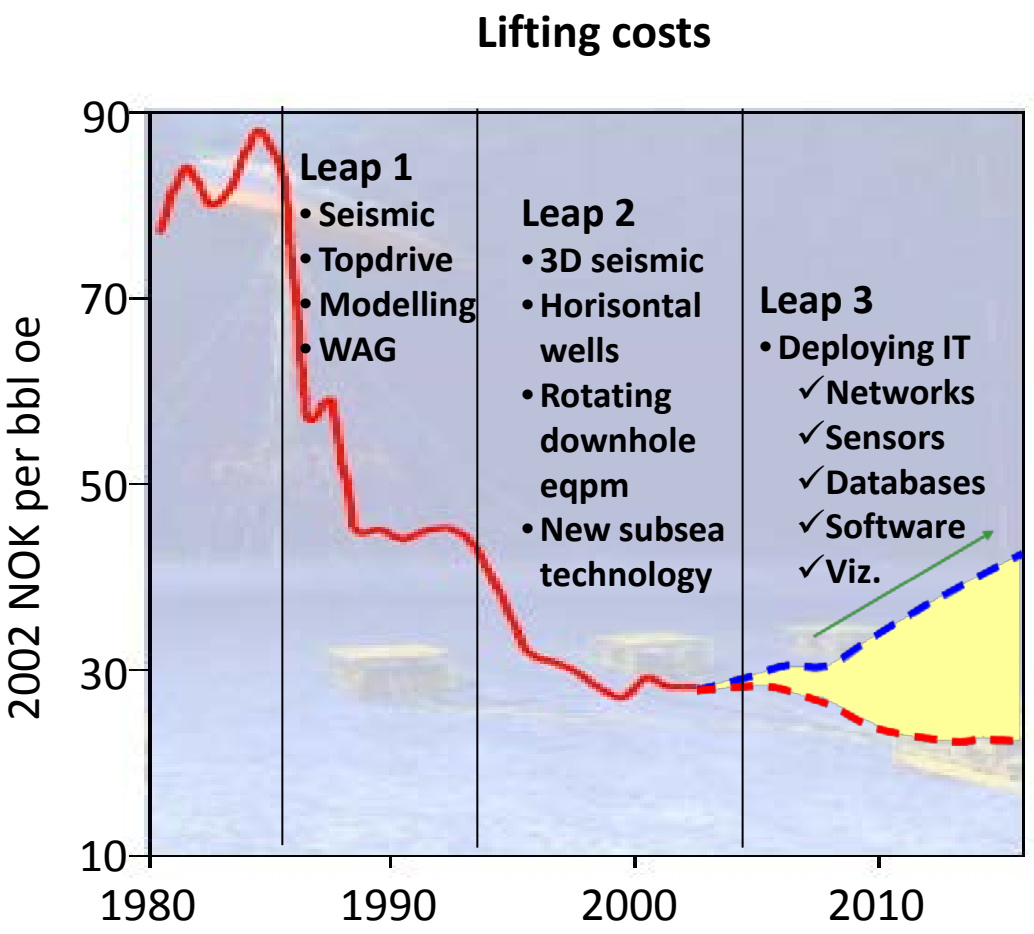
IO is safer, faster and better decisions

Integrated Operations - Idea



IT is moving into E&P

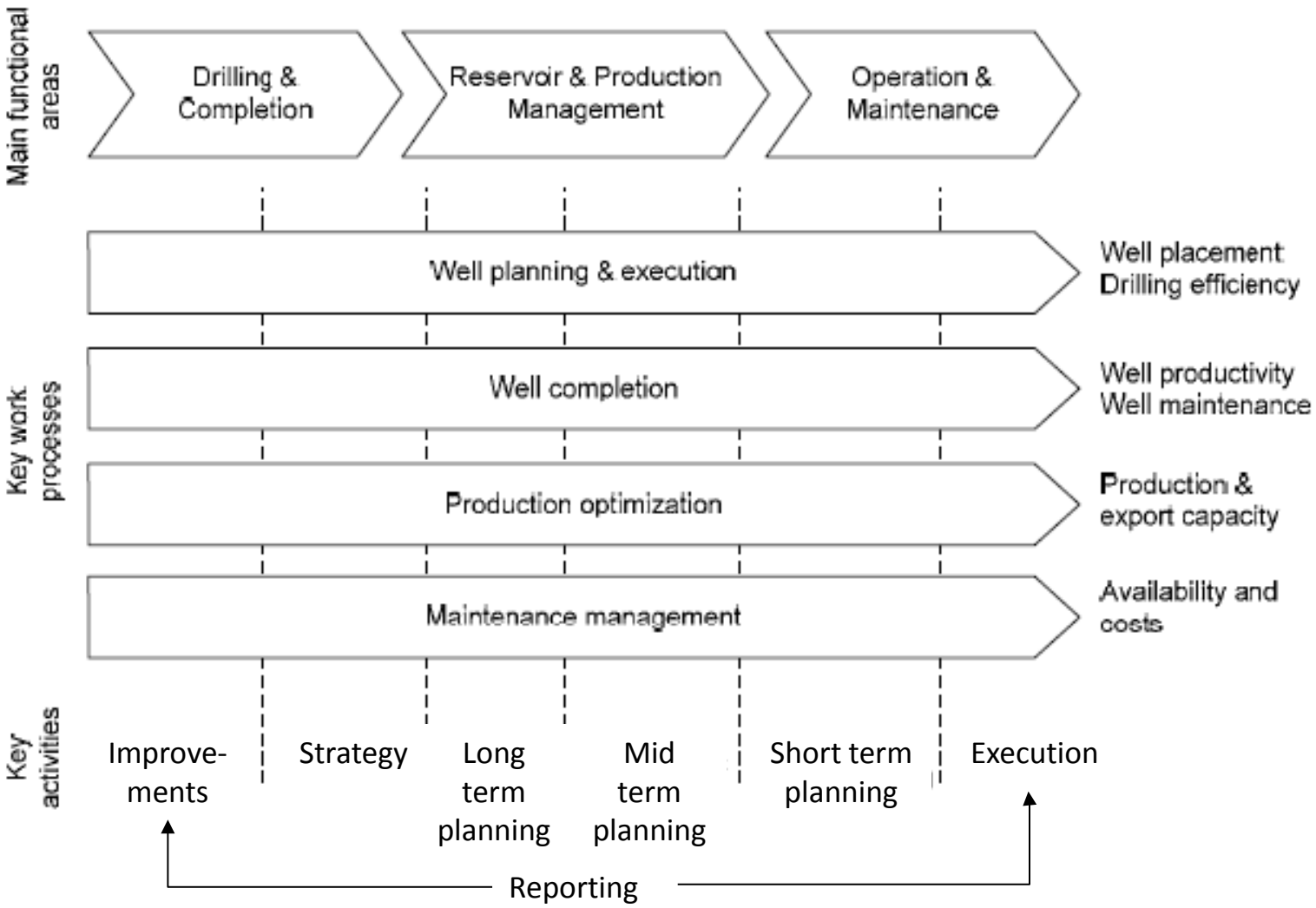
- The Norwegian Continental Shelf (NCS) has become a mature petroleum province
  - All major production areas but one opened
  - Competitive Norwegian oil & gas industry established
  - Logistical system in place
  - Plateau passed in 2004
- Two major technology leaps boosting production before year 2000
  - The first caused by falling oil prices
  - The second induced by falling finding rates
- Integrated Operations (IO) – deploying IT in E&P might be the third leap
- The economical potential of IO is high - 80% is related increased production and 20% is related reduced costs



Prioritized areas

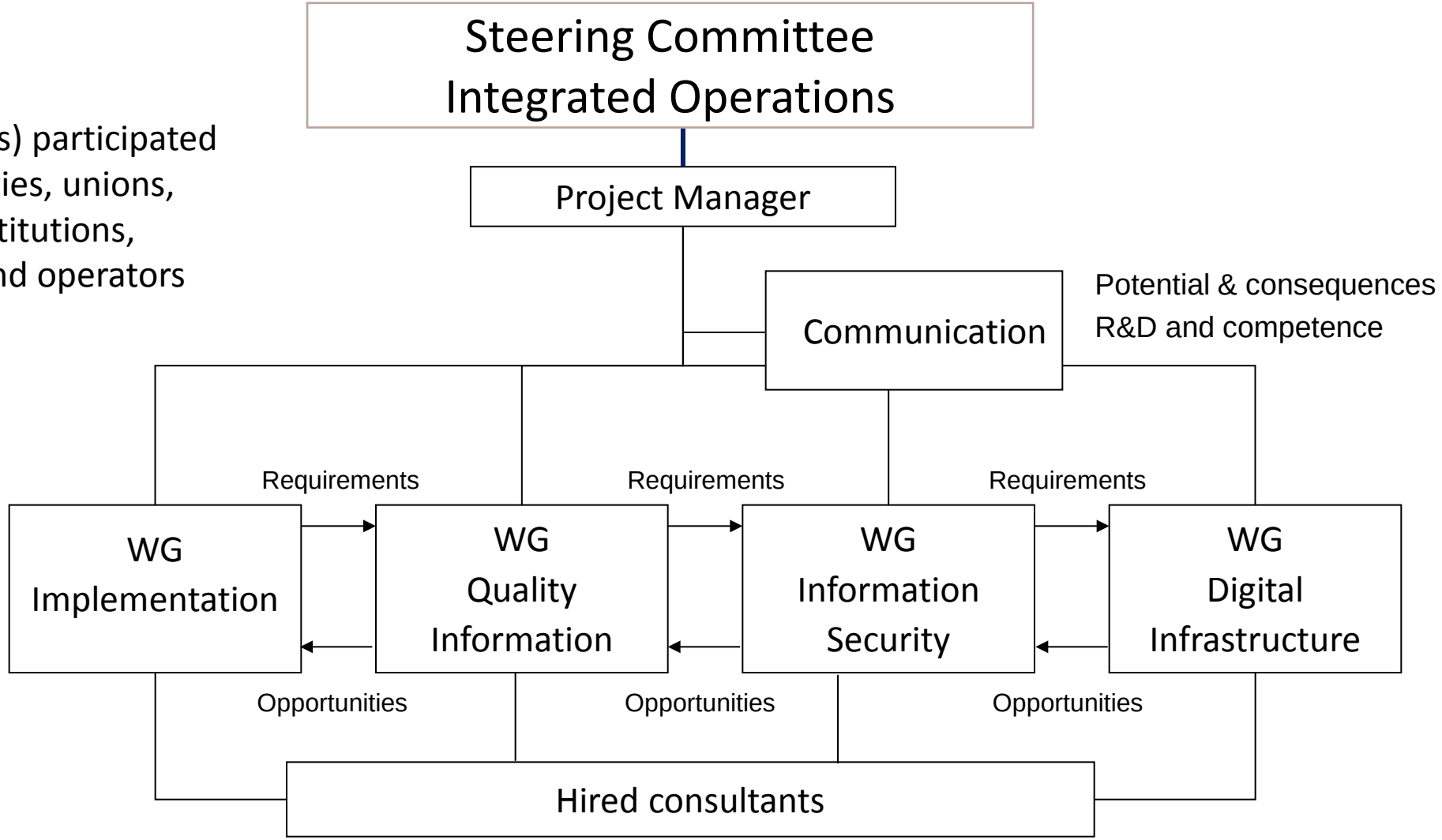
The «high-cost» and «high-value added» areas

- High level description of processes
- Key technology, organizational , business model and skill requirements



IO Project Organization

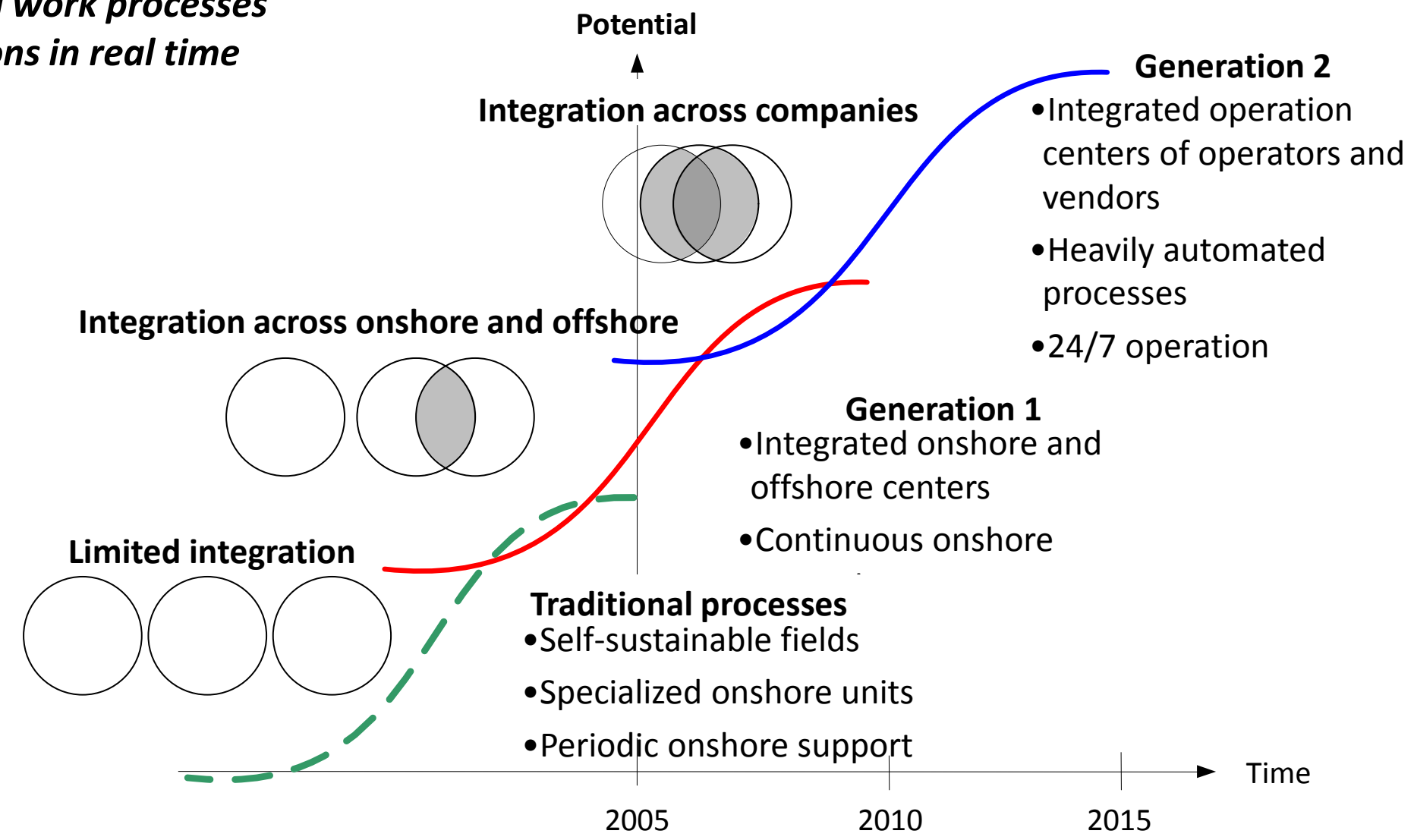
In the Work Groups (WGs) participated all stakeholders: authorities, unions, universities, research institutions, associations, suppliers and operators on their own costs.



Integrated Operations (IO)

Generation 1 and 2

IO is integrated work processes across operations in real time (IO = RTM)



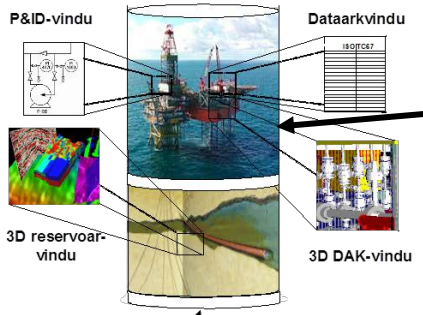
Integrated Operations - Structure

Data acquisition and automation and autonomous systems

Digital infrastructure and information security

Real Time Data

Data Integration (ISO 15926)



Information management (Information quality)

Computing and software

Operation Centre

- ✓ Analysis
- ✓ Visualizatior
- ✓ Knowledge
- ✓ Decisions
- ✓ Actions

Improved work processes and decisions

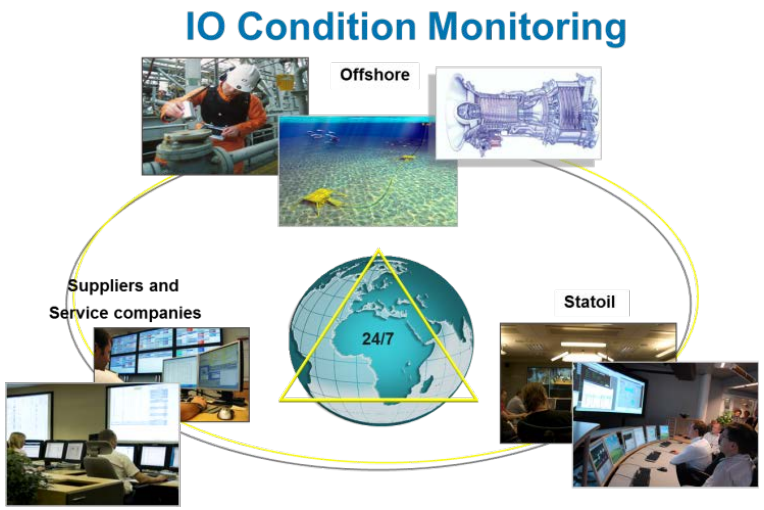
DATA

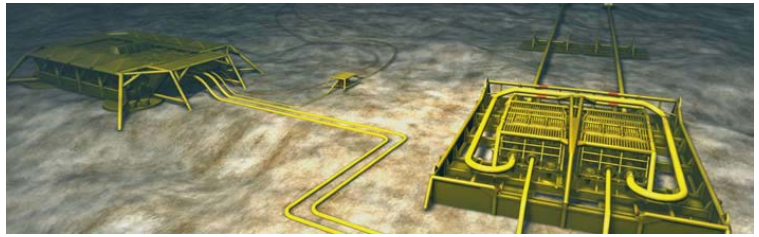
Data acquisitions

- Regrettable acquisition was not a part of the IO project

- Instrumentation has increased **5-10 times** in new offshore developments the last 20 years providing a lot more real time data from equipment and processes

- Optimization and condition based maintenance requires condition and performance monitoring (not all data through the PCU)
  - ✓ Wells
  - ✓ Processes
  - ✓ Turbines
  - ✓ Compressors
  - ✓ Motors
  - ✓ Pumps
  - ✓ Valves





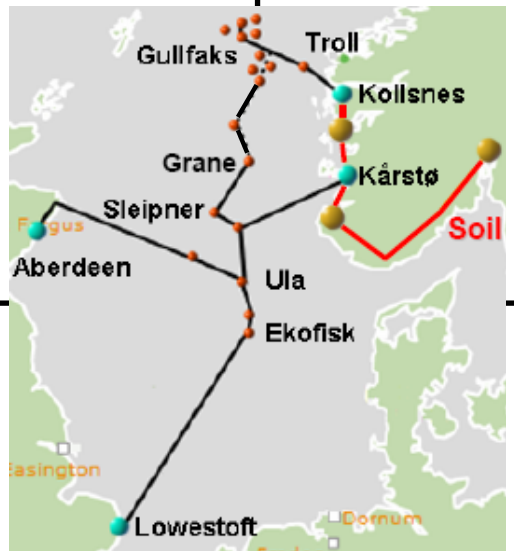
Ormen Lange
The Flow Assurance System (FAS) receives data from both subsea and surface instrumentation through the control system. Data from pressure and temperature sensors, multiphase flow meters, chokes, rates, etc. is reconciled in a tuned model. Through a comparison between modeled data and actual data, anomalies can be detected in real time at any point in the production system, with an immediate visual notification.

Digital Infrastructure on the Norwegian Continental Shelf

Everything is connected to everything else

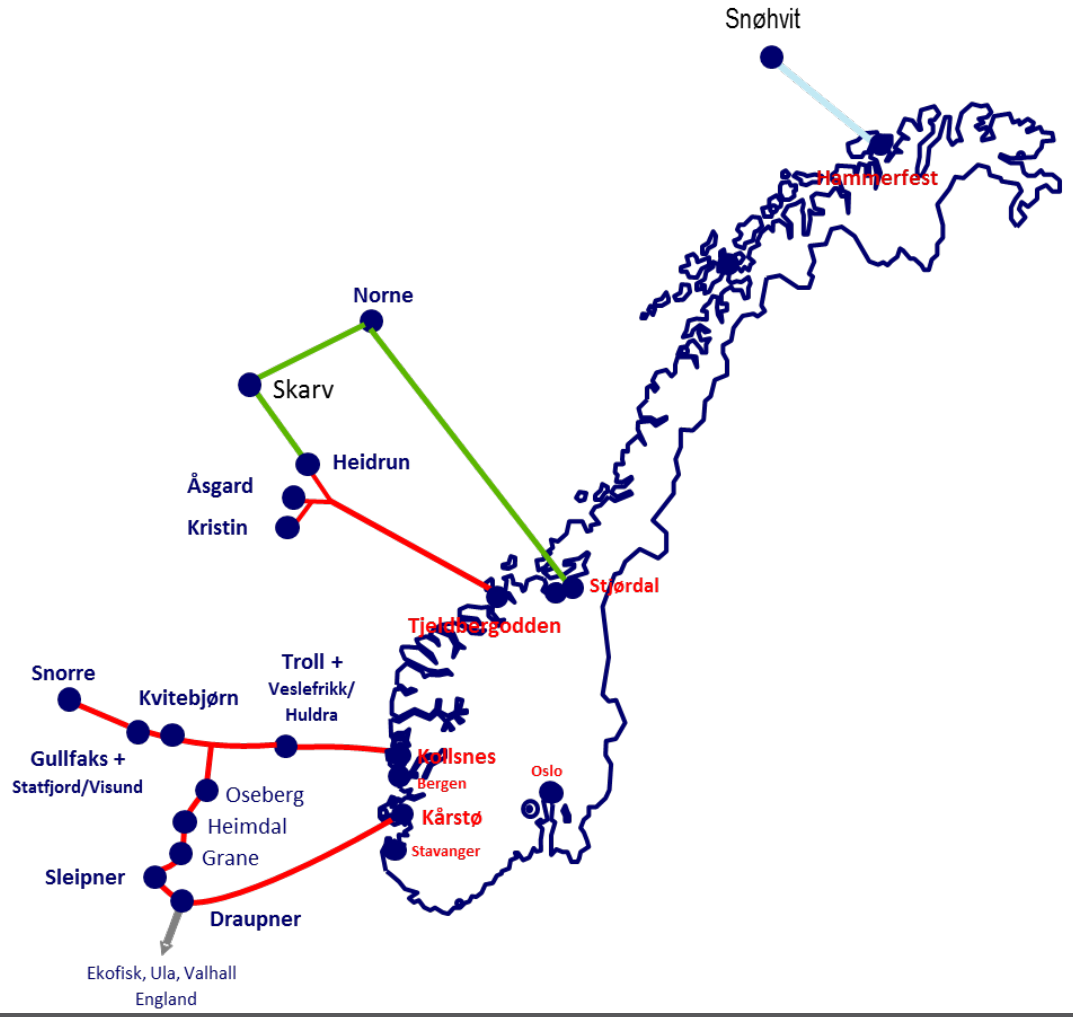
Oil companies

Vendors



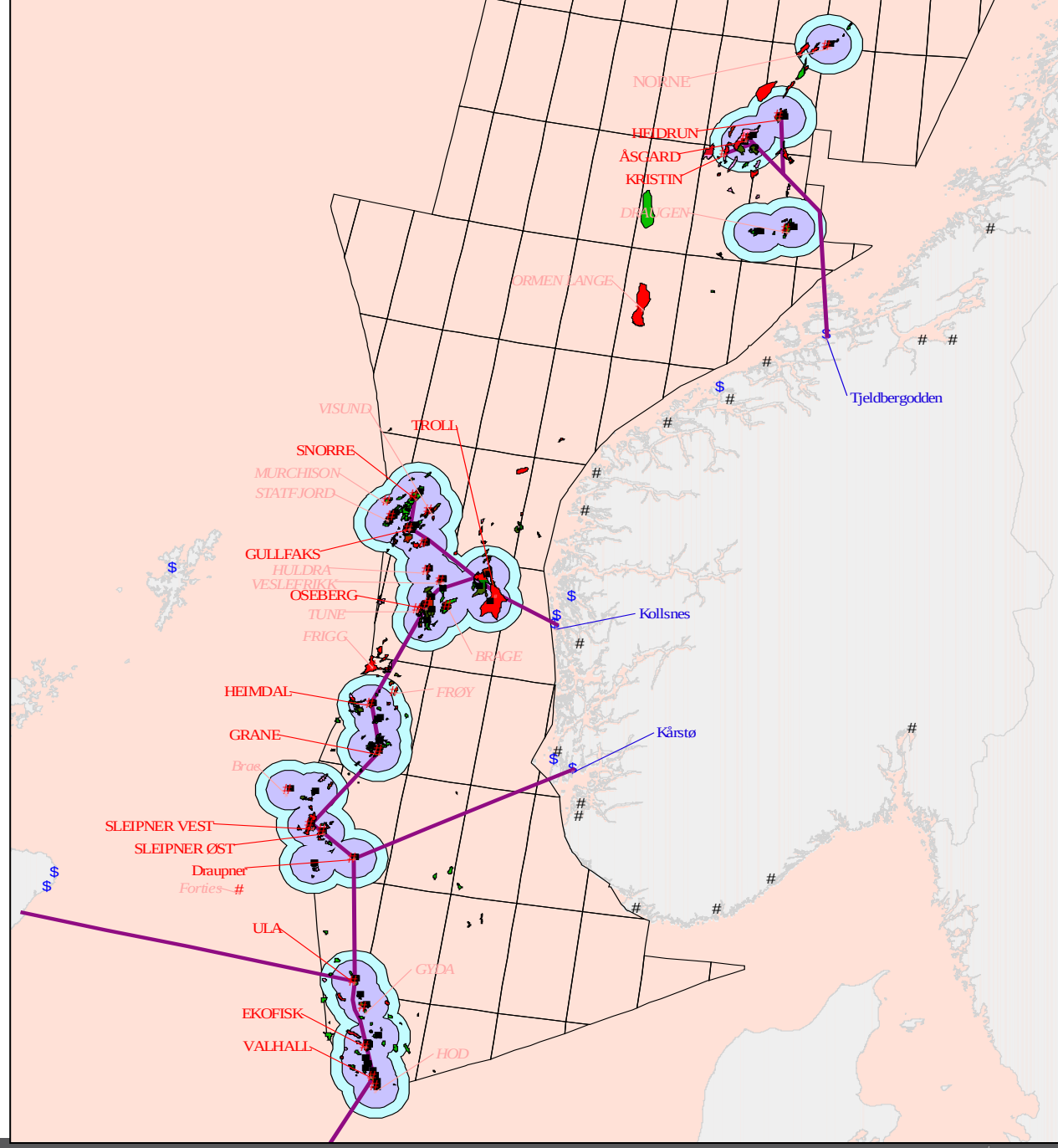
Authorities

Fiber optics on NCS



Wireless Communications Offshore

- **Sattelite communications**
  Has up to 600 ms latency and is costly
- **Radio Link Connectivity**
  Point-to-point radio link connectivity is a well proven technology that provide temporary connections of drilling rigs
- **Long Term Evolution (4G)**
  A process has been started for an offshore wireless broadband access network/services



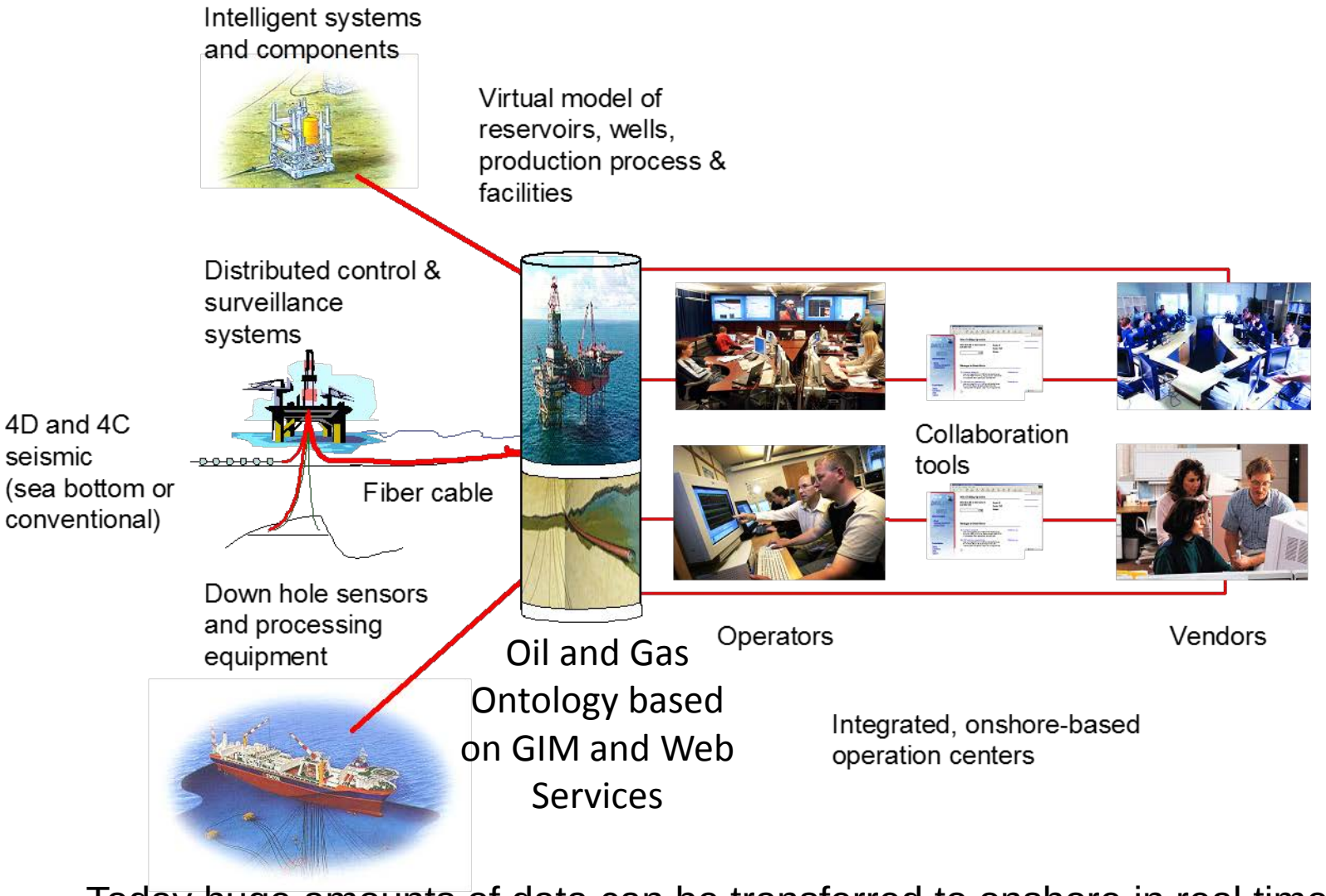
Information Security

- To manage identified risks satisfactorily, common security requirements and guidelines are needed
  - ✓ Control of ICT equipment brought offshore
  - ✓ Security requirements for ICT solutions on production networks
  - ✓ Criticality analysis and classification of ICT systems
  - ✓ Reporting of ICT incidents

- OLF has now defined these requirements in guidelines based on ISO 27 000+

- Three guidelines have been developed (No.104, 110, 123) (http://www.norskoljeoggass.no/en/)

Information Strategy: A common communication platform

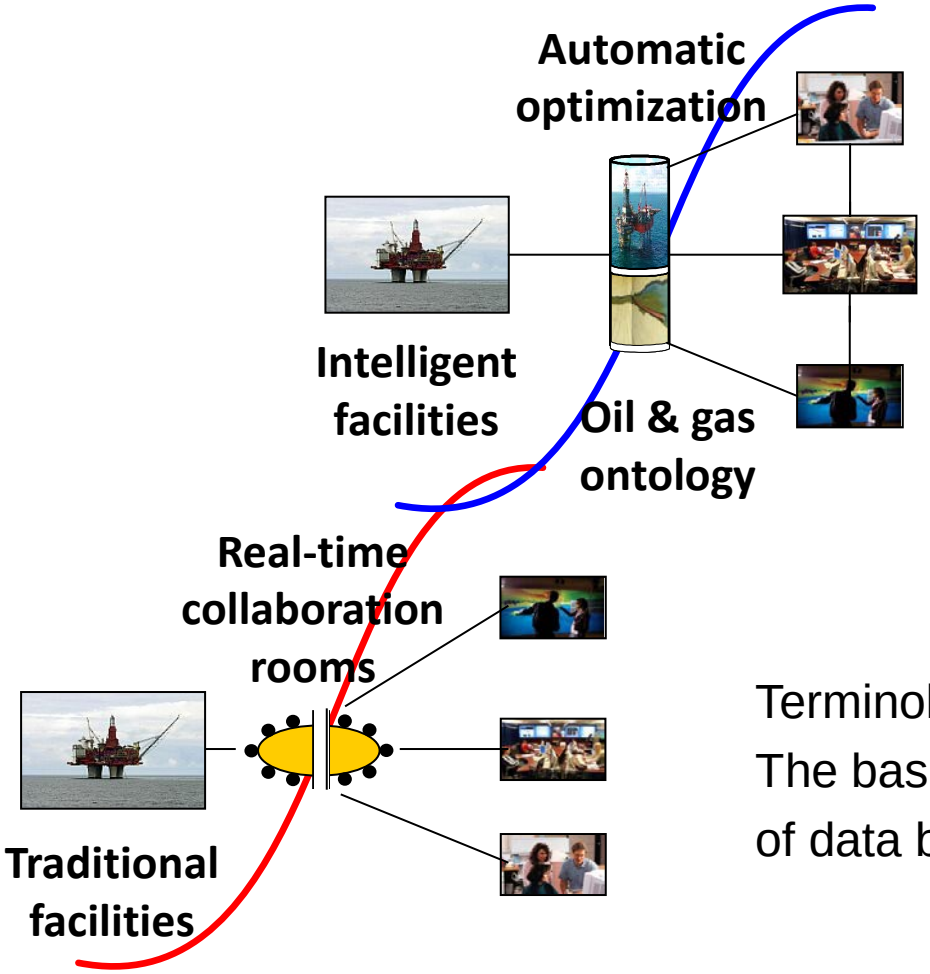


Today huge amounts of data can be transferred to onshore in real time and the capacities for deploying them are gradually increasing

Information quality: IO require an oil and gas ontology (conceptual model)

Field data

- ✓ Health, safety, environment
- ✓ Seismic
- ✓ Drilling
- ✓ Completion
- ✓ Reservoir & production
- ✓ Operation & maintenance



Generation 2

Complete ontologies supporting automated reasoning or inference of data using logical rules

Taxonomies for multiple domains

Generation 1

Terminologies for single domains

The basis for XML schemas for automatic transferal of data between applications in same domain

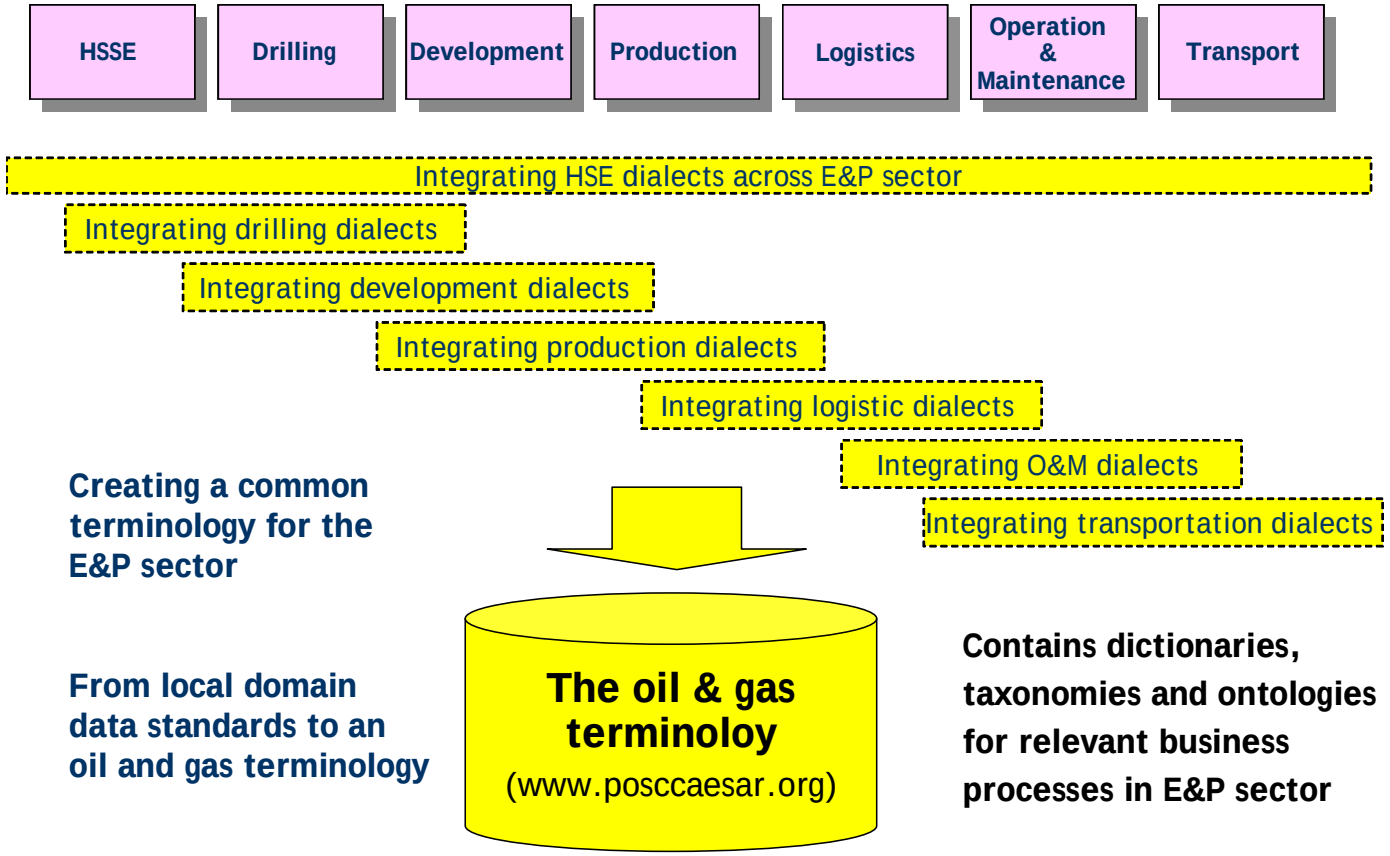
Information quality

- Information quality
  - ✓ A common ontology with good definitions of the concepts (HSE, drilling, development, production, logistics, operation and maintenance)

- Deployments
  - ✓ Daily Drilling Report
  - ✓ Daily Production Report
  - ✓ Monthly Production Report
  - ✓ Yearly Environmental Report
  - ✓ RFID deployment
    - Personnel
    - Container
    - Drill string
    - Equipment
  - ✓ EqHub – a common database for standard equipment
  - ✓ ReportingHub

Harmonizing the E&P terminology

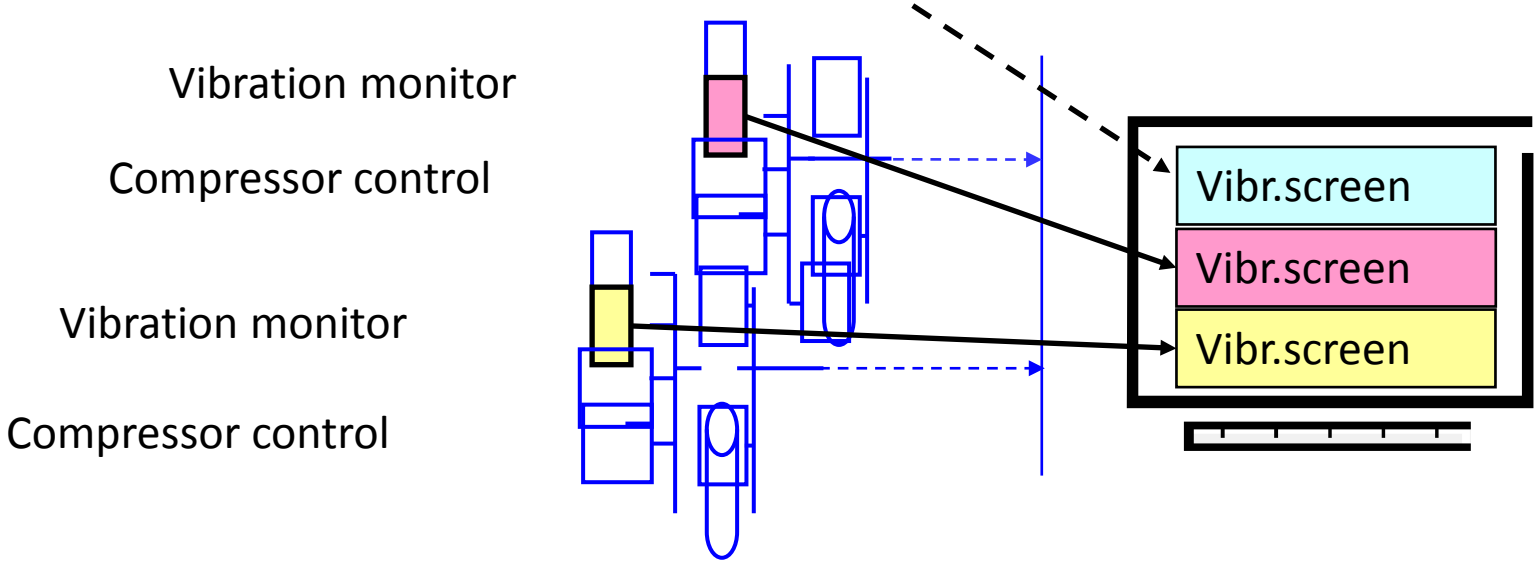
Integrating the terminology from the different business domains in E&P



Quality information: An example from the CBM area*

Traditional

- Many applications are used, even on the same installation, for the same purpose, e.g., vibration monitoring and compressor control
- There are many screens per domain, e.g., many for monitoring and analysis of vibrations, and data are “locked” in the various applications

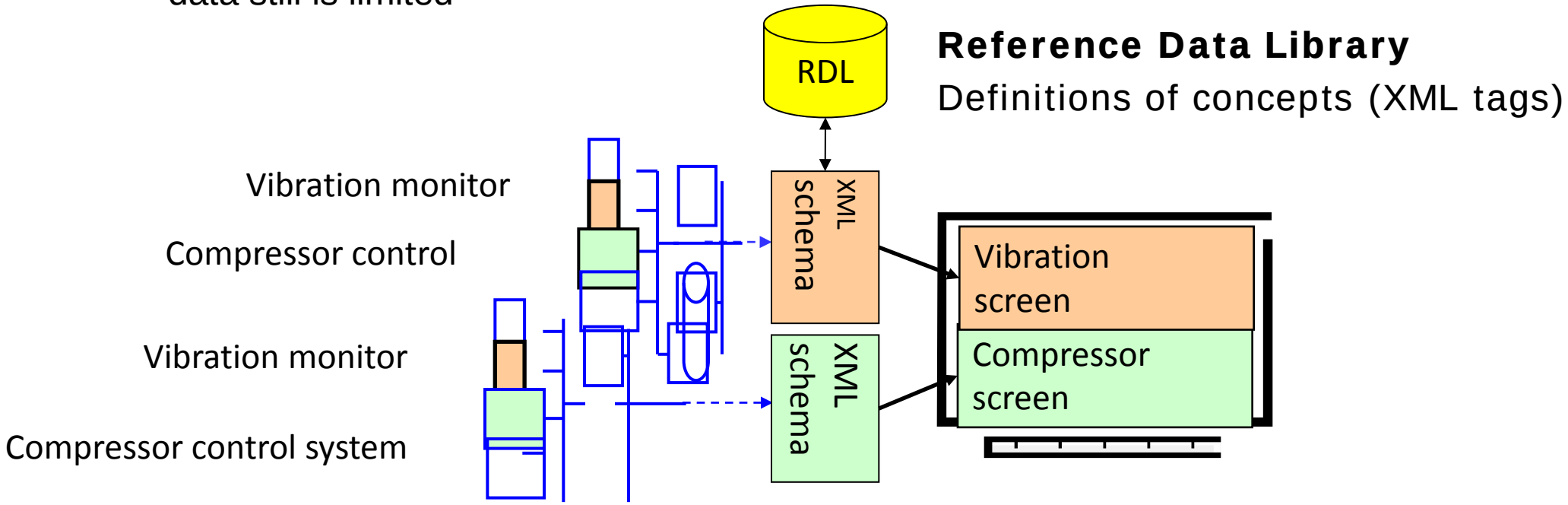


* CBM = Condition based maintenance

Quality information: An example from the CBM area

Generation 1

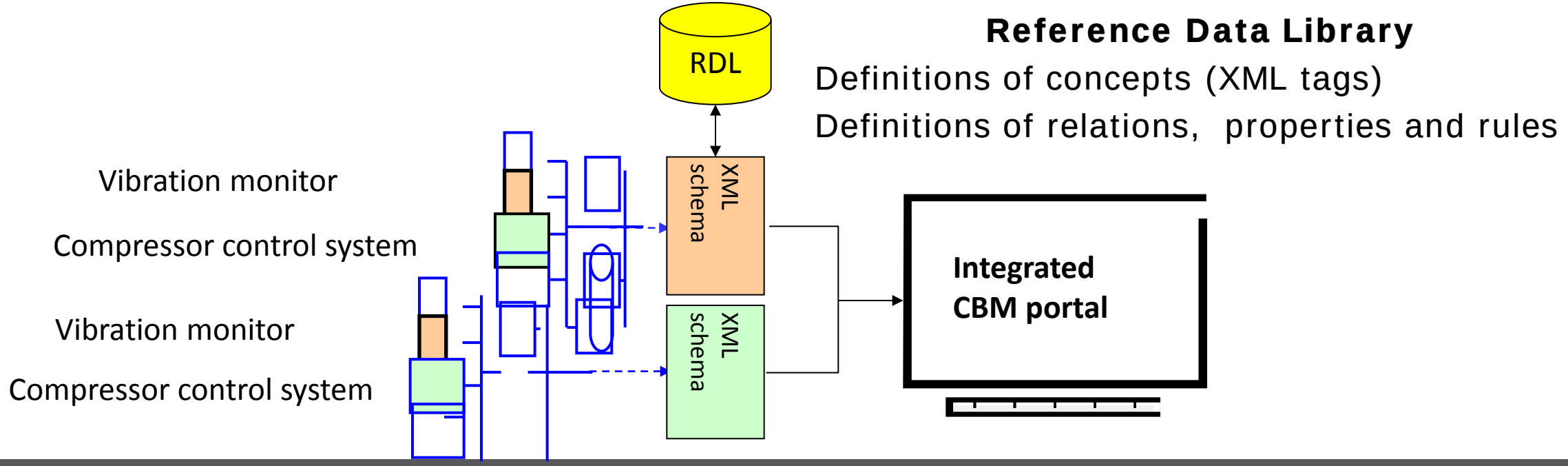
- Common definition of concepts
- Common XML schemas are implemented for the various domains
- There is one screen per domain, e.g., for analysis of vibration data
- The opportunity for concurrent analysis of vibration and compressor control data still is limited



Quality information: An example from the CBM area

Generation 2

- A common ontology ensuring that concepts are consistently defined across domains is implemented
- Reasoning software using data from several domains, automatically monitor and control equipment, order spare parts and prepare maintenance plans



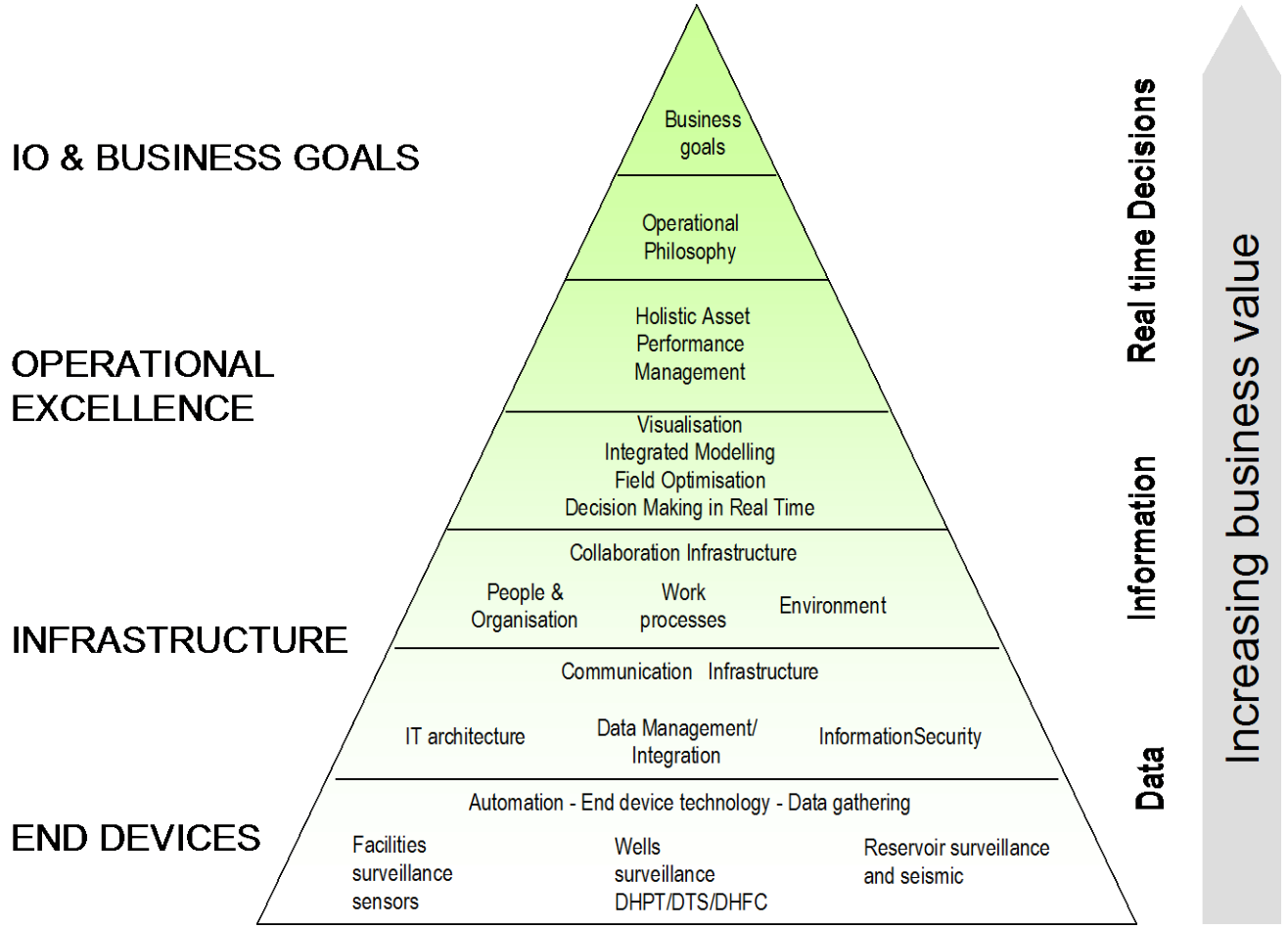
In projects (Greenfield, Brownfield and major modifications) a common communication platform reduce costs and increase flexibility

Integrated work processes require data integration

Operations philosophy drives the asset management solution

Data Integration

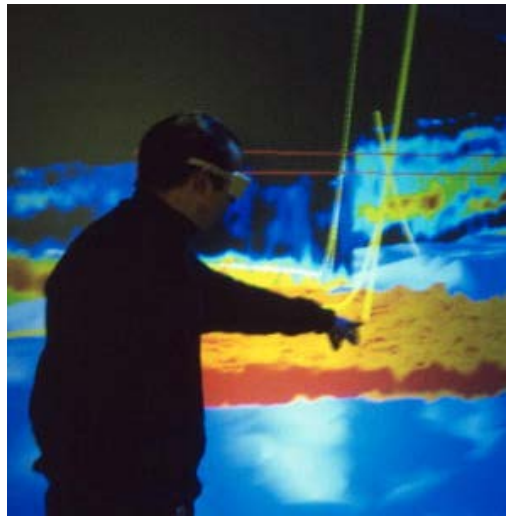
Automatic Identification and Data Capture (AIDC)



Drilling operations (IO G2)

Planning and execution

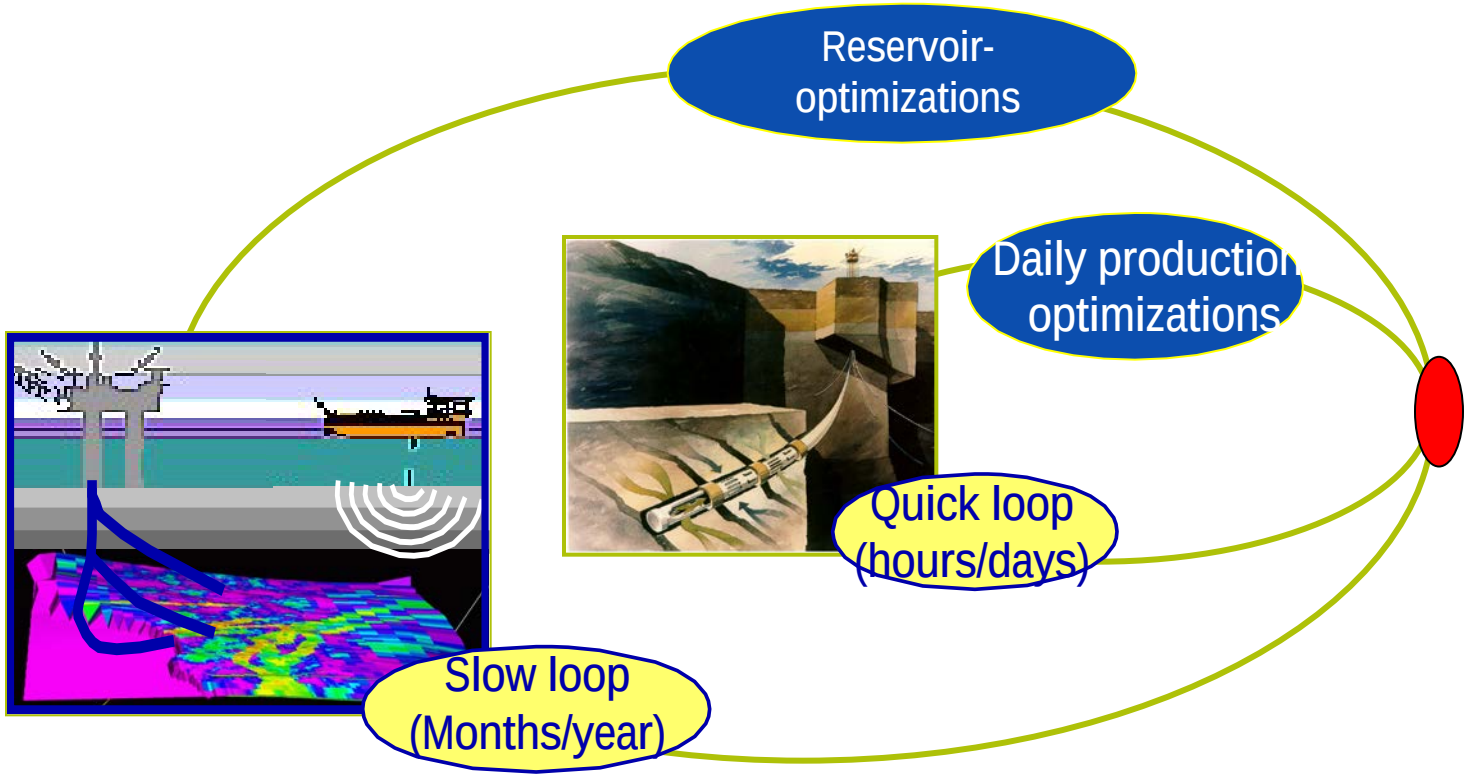
- ✓ Virtual support by vendors and specialists
- ✓ The decision process is automated - systems give prognosis and alerts, e.g., using artificial intelligence
- ✓ Drilling is optimized automatically from onshore
- ✓ Smart tools and neural networks are commonplace
- ✓ Data and information is automatically integrated in 3D models
- ✓ Information is displayed in a much more visual way



Completion

- ✓ Well completions are integrated parts of virtual reality reservoir models
- ✓ All work overs and well interventions are supervised by virtual reality models
- ✓ Wireless intervention tools are available

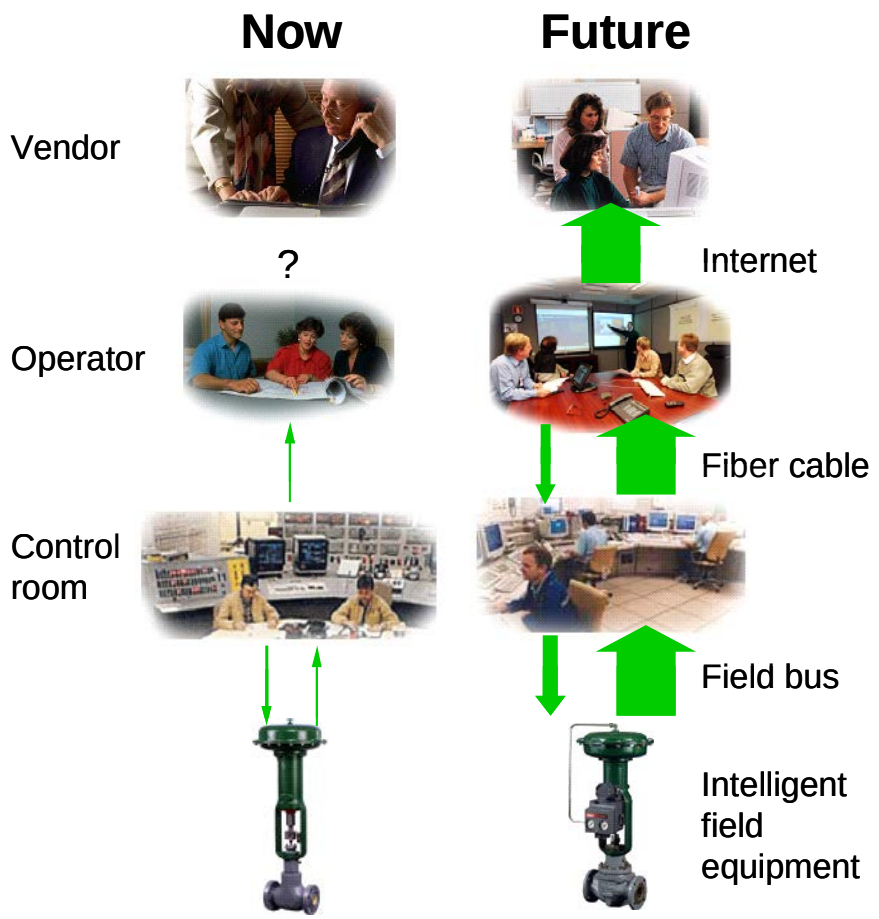
Production - integration of decision loops (IO G2)



Closer integration of the work processes between daily and longer time loops optimizations by linking episodic reservoir data with real time process and production data

Operation and Maintenance - a quiet revolution (IO G2)

- **Intelligent equipment, field-buses, and distributed control systems are revolutionizing operations**
  - ✓ Self-regulating equipment
  - ✓ Components for automatic detection of anomalies, handling of alarms and optimization of operations
  - ✓ Wireless networks
- **Large amounts of real-time information can be transferred to onshore operation centers**
  - ✓ Remote monitoring of performance and efficiency, corrosion and erosion
  - ✓ Remote administration of chemicals
- **Proactive maintenance concepts can be implemented**



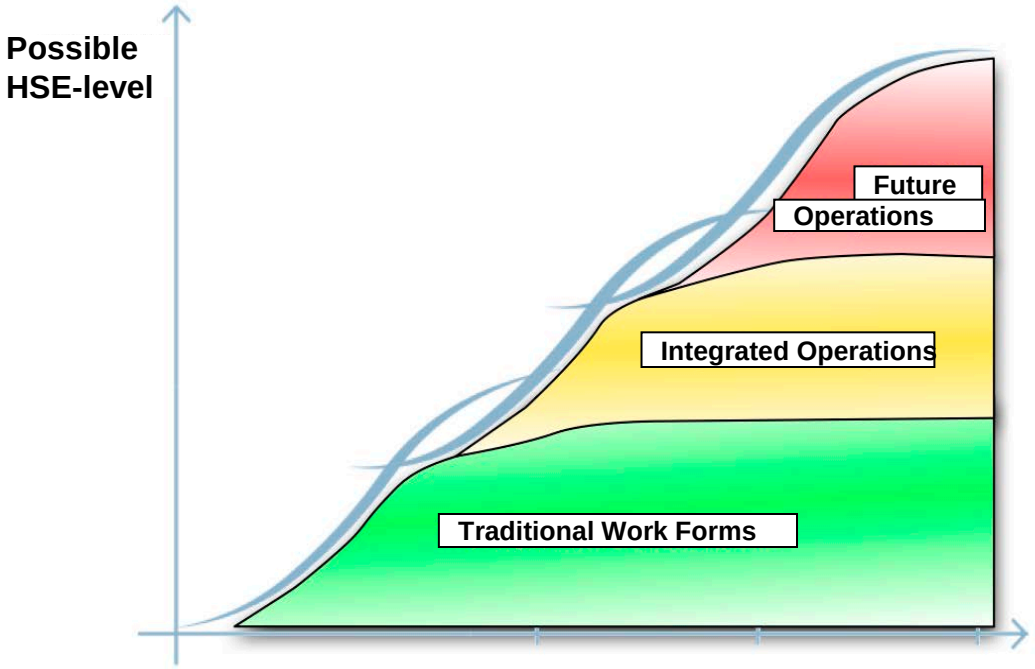
New technology in instrumentation, automation, communication and in real time data transmission make it possible to monitor and control equipment from onshore

Integrated Operations and HSSE

OLF recommendations:

- **HSE have to be one of the drivers for implementing IO**

- **Improve change processes by:**
  - ✓ **Secure trust on individual and group level**
  - ✓ **Increase investments in change management**
  - ✓ **Secure involvement by employees and users**
  - ✓ **Improve HSE and organizational culture**



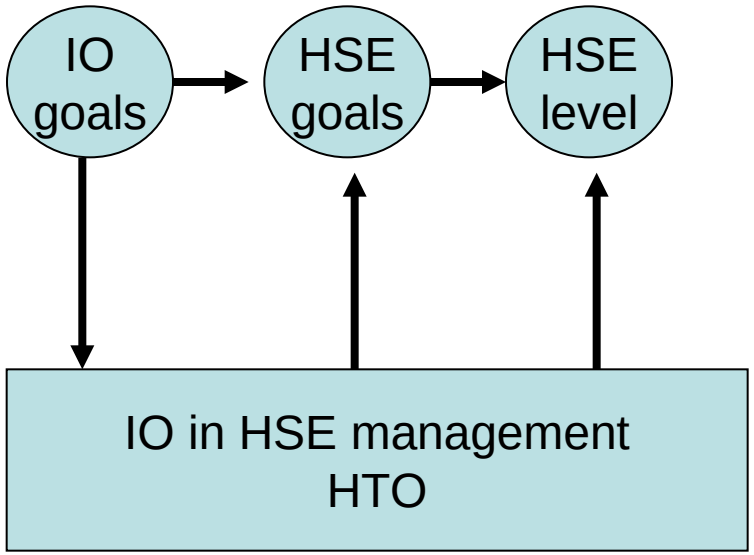
Two HSE challenges in IO: Manage the change process and change the management process

Manage HSE consequences of the change process:

Visible HSE goals for the change processes and the new solutions

Change the HSE management process:

Apply IO principles, methods and solutions for improving HSE management internal and in interface between all stakeholders



Integrated Operations reduce risks

- The Norwegian Snorre Field had an uncontrolled leakage of gas from a well in 2004
  - ✓ Maintenance of a well
  - ✓ A kick occurs and huge amount of gas leaks into the ground close to the sea bottom
  - ✓ The gas is also filling up the water below floating platform
  - ✓ Quite a few decisions were not according to regulations and good practices
  - ✓ It serious event that could have been a new Piper Alpha accident

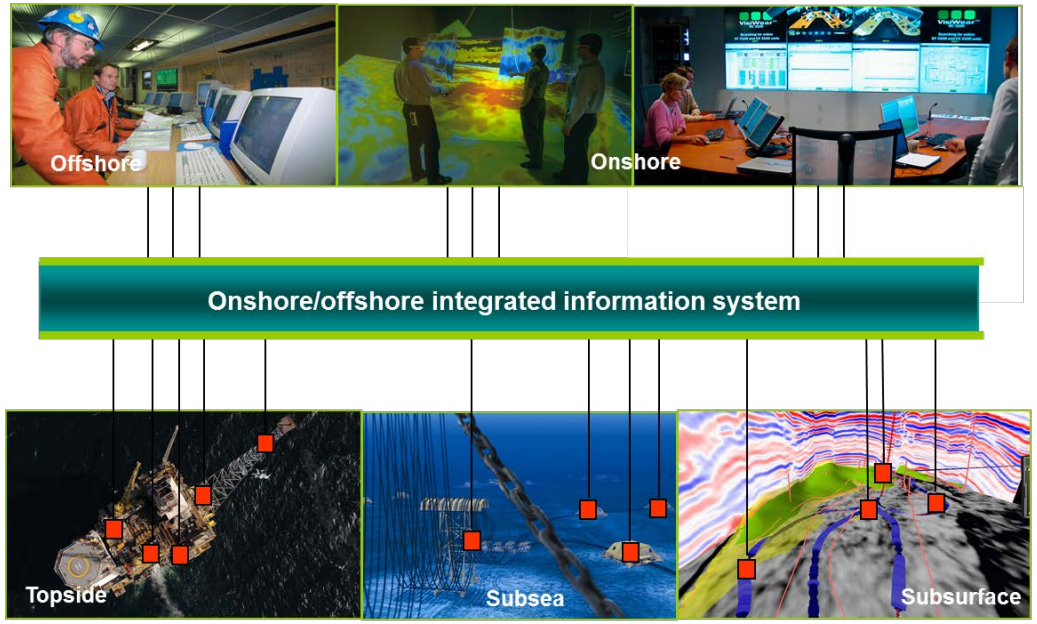
"The Snorre event would not have happened if Integrated Operations had been implemented"

Terje Overvik
Senior Executive Vice President, Statoil
(2006)

Integrated operations: Is co-working across all boundaries

IO provides:

- Transparency
  - ✓ Real time information shared offshore/ onshore
- Improved work processes
  - ✓ Onshore deciding
  - ✓ Offshore executing



Operations - Traditional, IO G1 & G2

Organizational changes

Generation 2

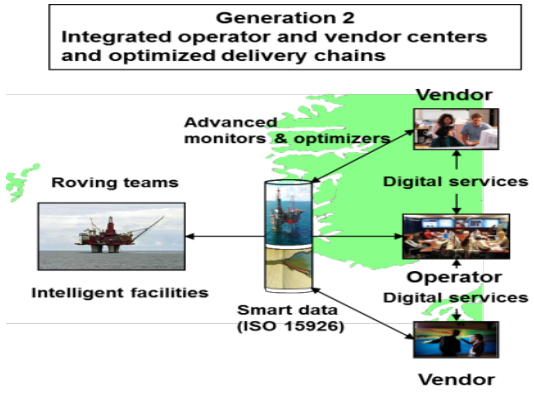
- Operation centers of operators and vendors are integrated
- Vendors are managing processes operators managed earlier
- Several tasks are automated
- The parties cooperate over “the net” (virtual teams, leadership, culture, compensation – new operational concepts, decision processes, roles and procedures have to be adapted virtual operation centers)
- The centers are operating 24/7 and tasks are carried out according to ”follow the sun” principles

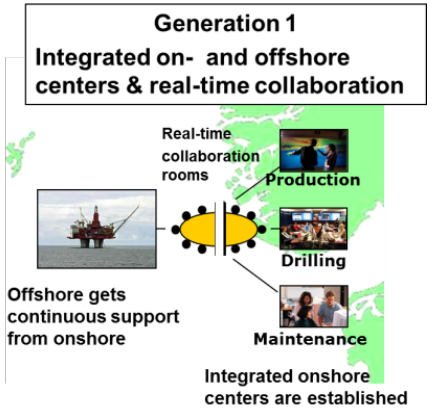
Generation 1

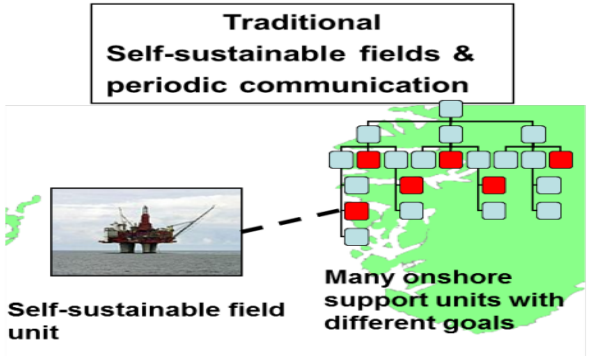
- Decisions are made jointly by teams onshore and offshore
- Personnel onshore monitor operations in real-time, identify operational and safety related problems, discuss actions with and support personnel offshore in the implementation phase
- For some areas like drilling onshore support is available 24/7, for other areas beyond normal work hours
- Off-the-shelf technologies like high quality audio and video systems are used extensively for real time co-operation

Traditional

- Daily operational decisions are made offshore with limited onshore support
- Personnel on- and offshore belong to several different organizational units
- Plans are made and changed fragmentally and at fixed times
- IT solutions are specialized and silo-focused
- Data necessary to optimize operations is time-consuming and difficult to gather





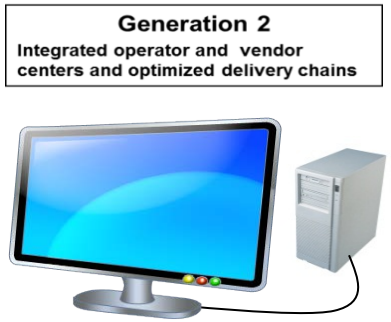


Operations - Traditional, IO G1 & G2

Degrees of real time data integration onshore

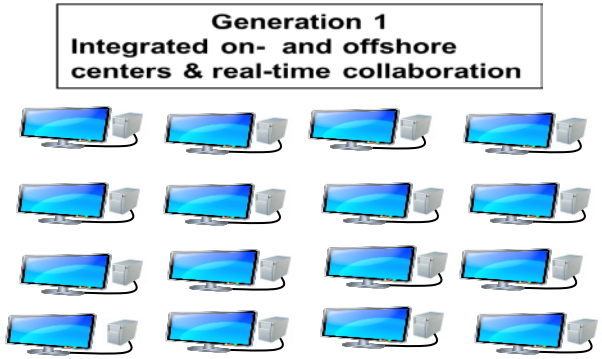
Generation 2

- A common terminology for E&P ensuring that concepts are consistently defined across domains is implemented (oil and gas ontology)
- Any business process or combination of business processes may be presented on one screen
- Reasoning software using data from several domains (drilling, production, logistics and operations and maintenance) are deployed and provide planning information and actions (automated or partially automated)



Generation 1

- Terminologies established for single domains
- The basis for XML schemas for automatic transferal of data between applications in same domain
- **There is one screen per domain**
- The opportunity for concurrent analysis of data from different domains are still limited



Traditional

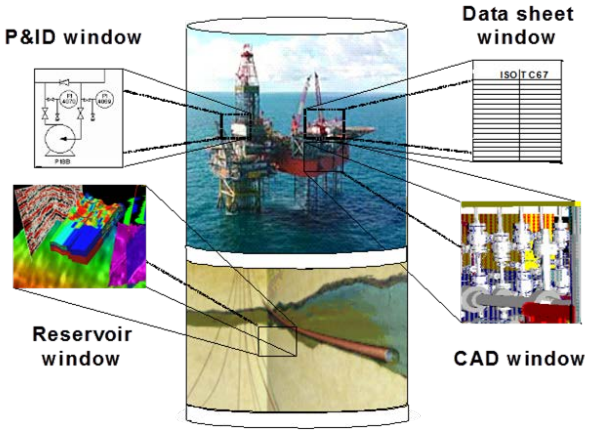
- Daily operational morning meeting week days
- No real time data available onshore
- Many applications are used offshore for the same purpose
- There are many screens per domain and data are “locked” in the various applications

3. Data integration

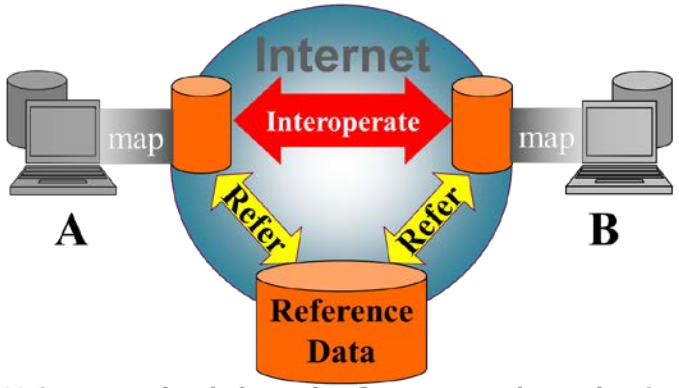
POSC Caesar Association (PCA)

- Founded in **1997**
  - ✓ **Reference Data Organization**
- **ISO 15926** "Integration of lifecycle data"
  - ✓ Documentation for Operations (DFO/NORSOK)
  - ✓ Integrated Operations (IO)
  - ✓ Asset Management
- **W3C Recommendations**
  - ✓ Semantic Web Technology
- **Generic Information Modeling** (**GIM**)
  - ✓ Modeling any type of data
- Competence in management, engineering, modeling, information management and IT

The vision of PCA is integration & interoperability of lifecycle data



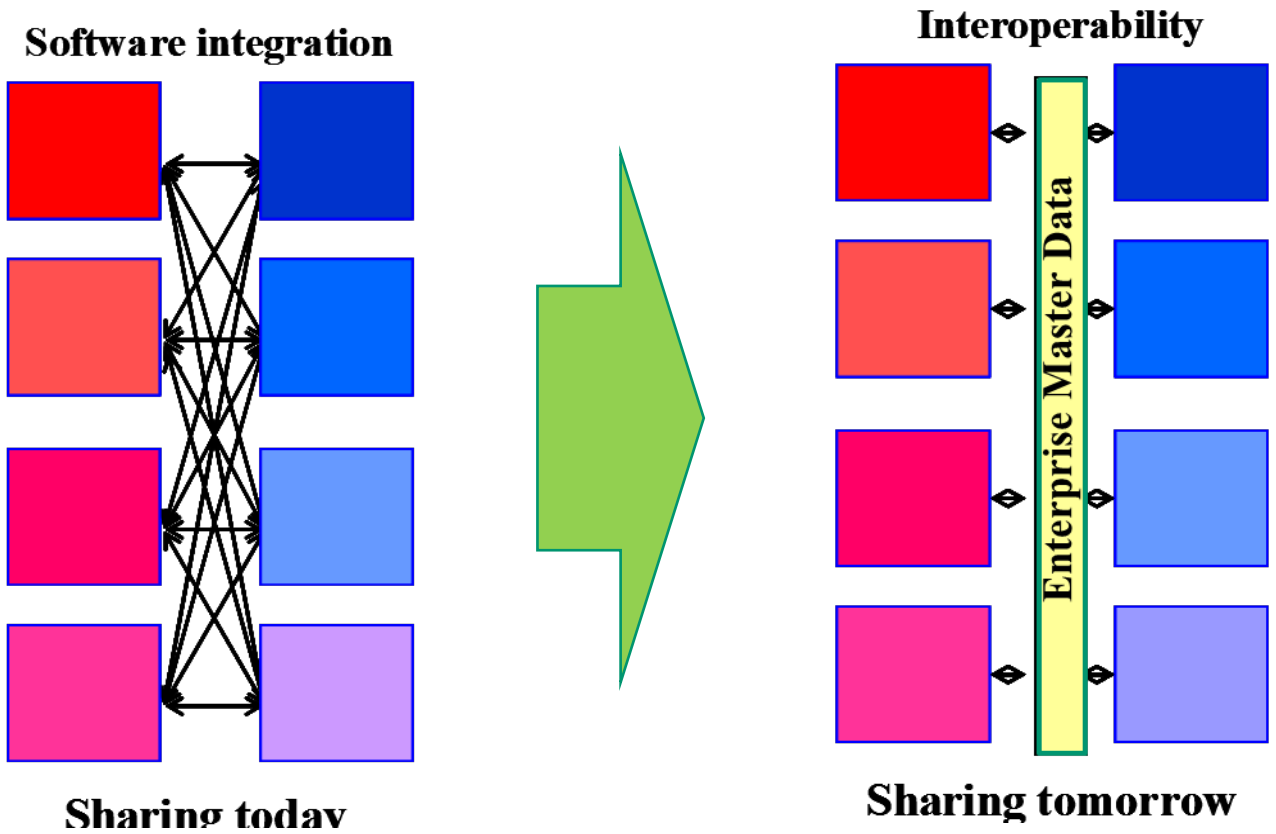
GIM interoperability at its simplest



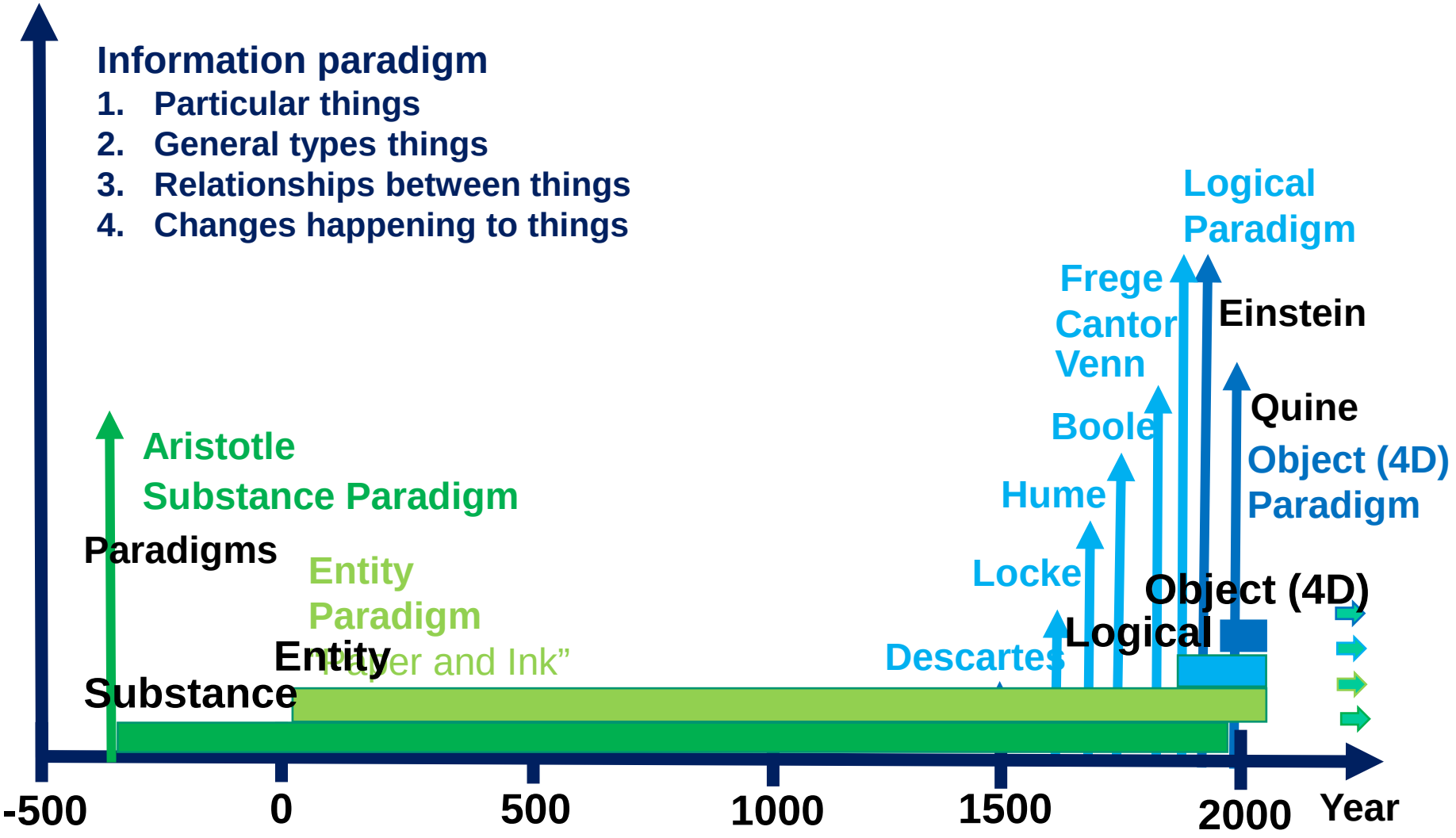
Using *standard shared references* reduces business ambiguity and reduces mapping overheads.

Systems versus data integration

Mapping is 50% of the IT costs



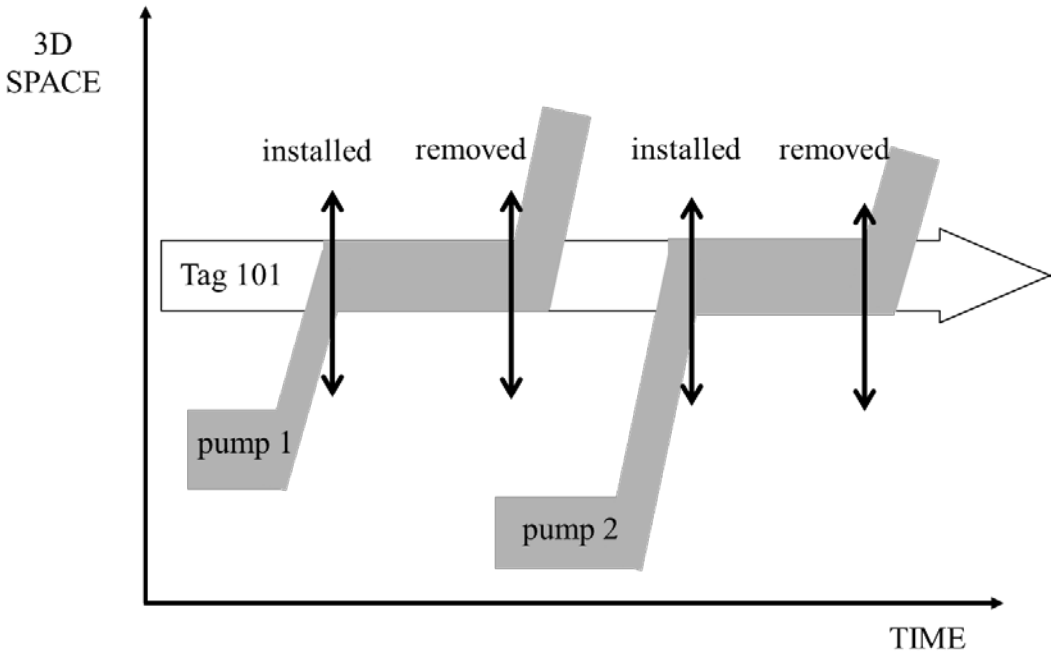
History of information paradigms



ISO 15926 Industrial automation systems and integration -Integration of life-cycle data for process plants including oil and gas production facilities

ISO 15926 Individual (pump at tag 101)
Region of space and time (and the matter therein)

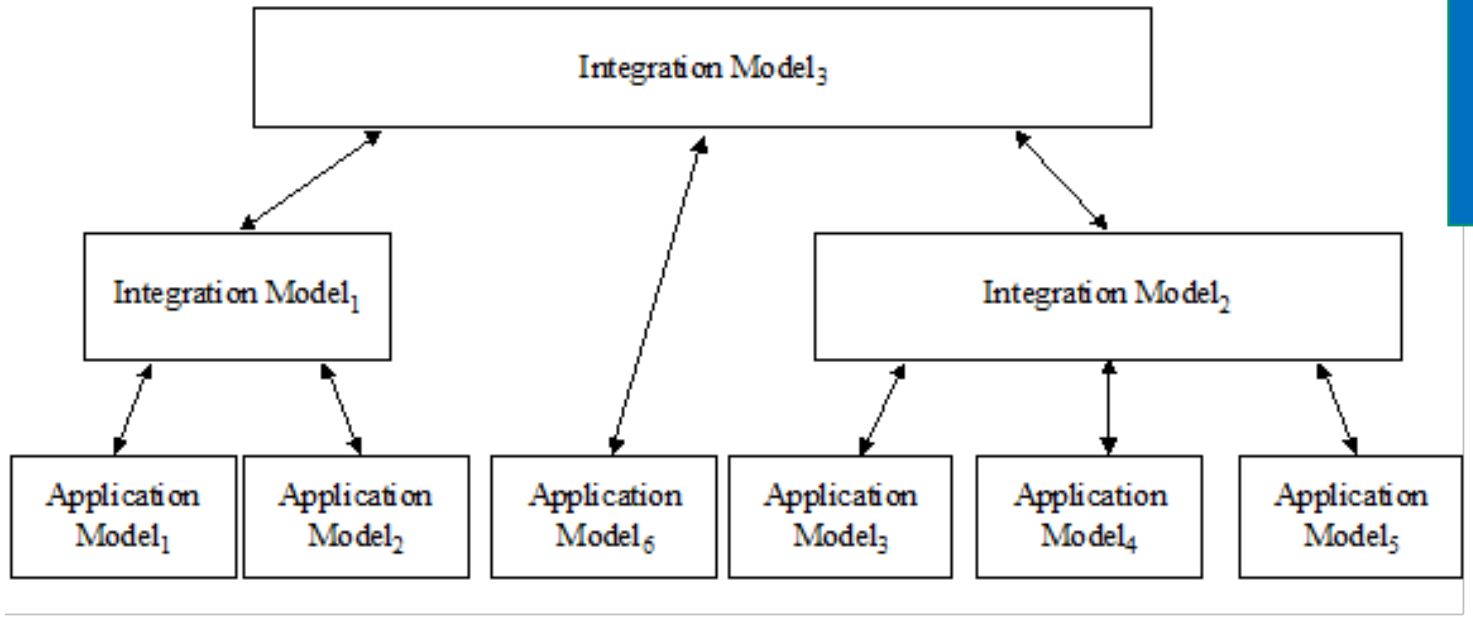
The data model in ISO 15926 is a 4-dimensional conceptual model based on set theory and logic

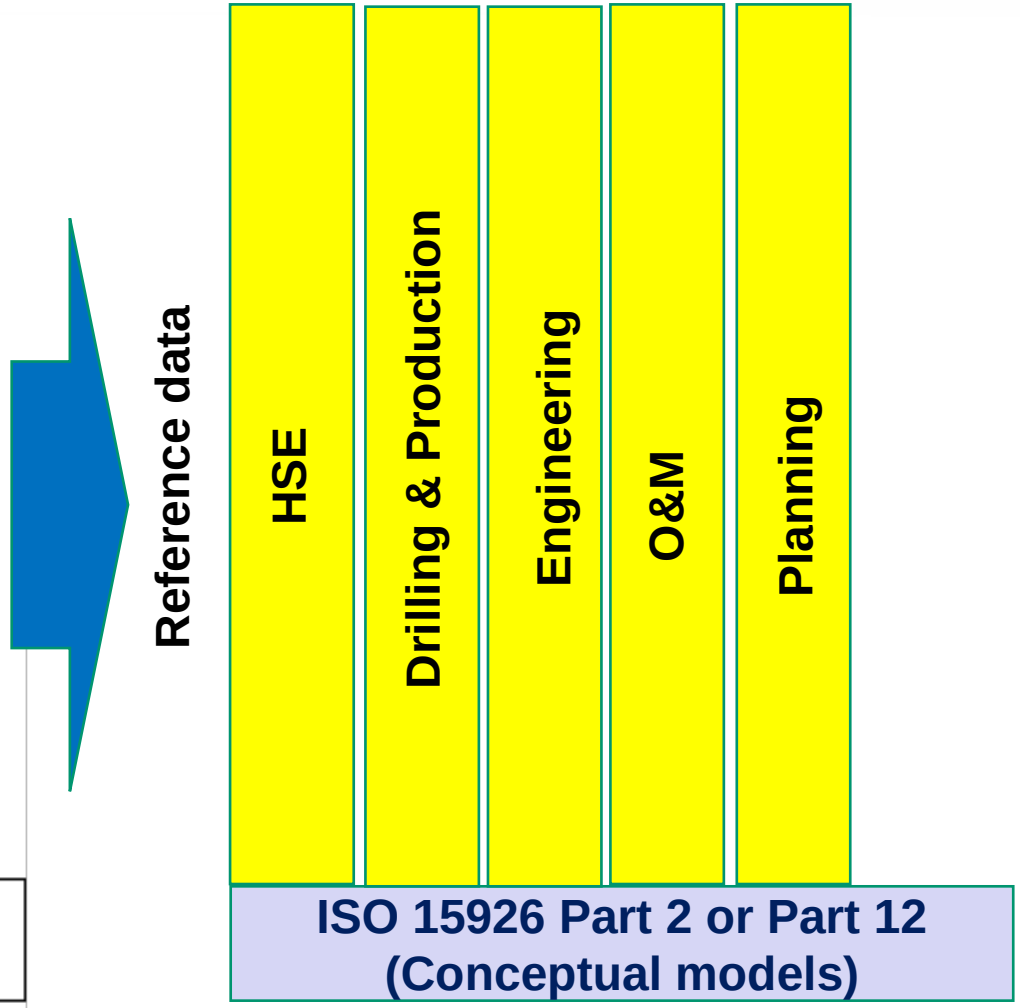


ISO 15926 Model and reference data

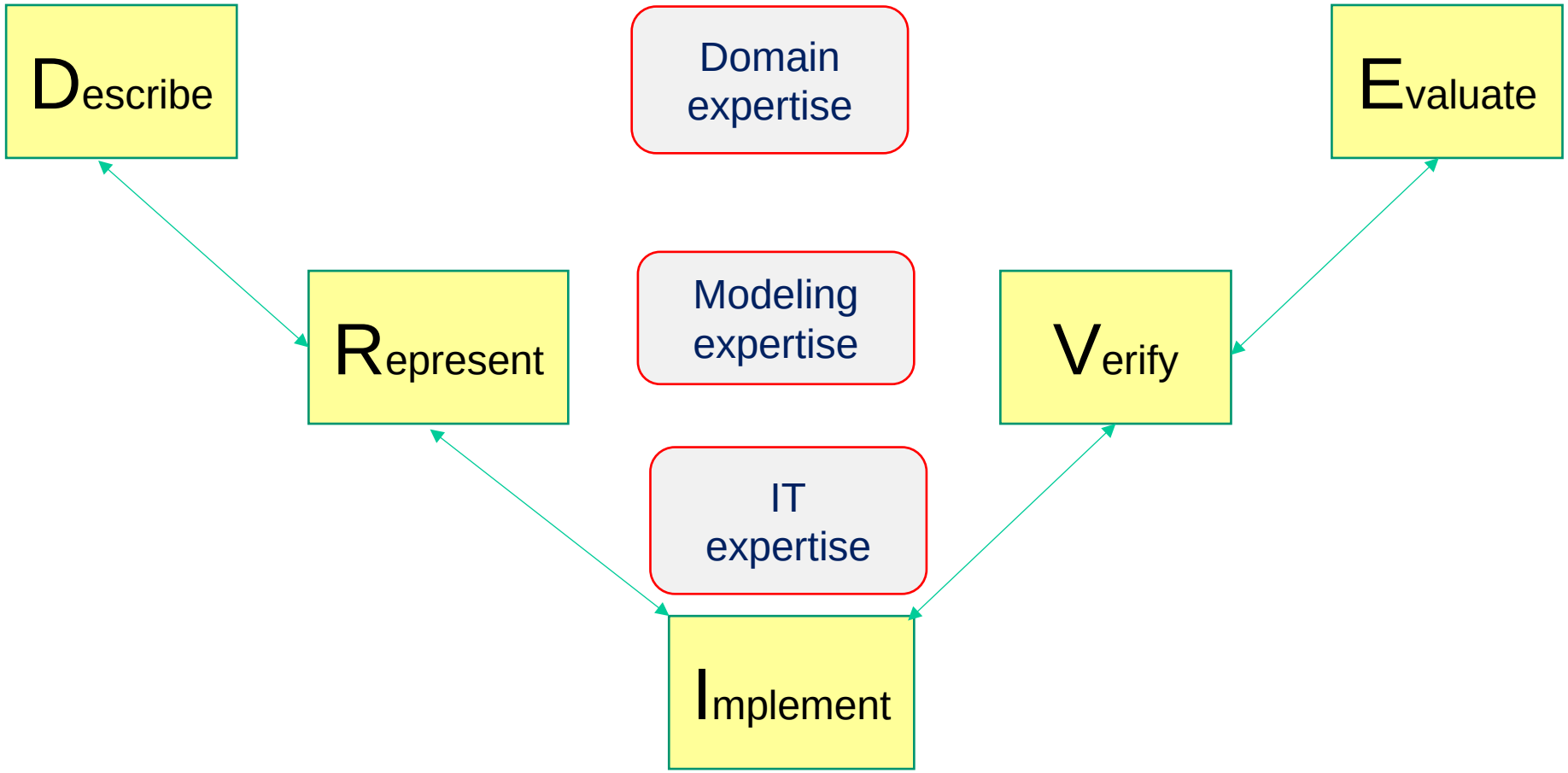
An integration model can be created if a common understanding of the application models to be integrated can be established.

The conceptual model is the integration model that is able to cope with all possible application model based 4D modelling plus required set of reference data.





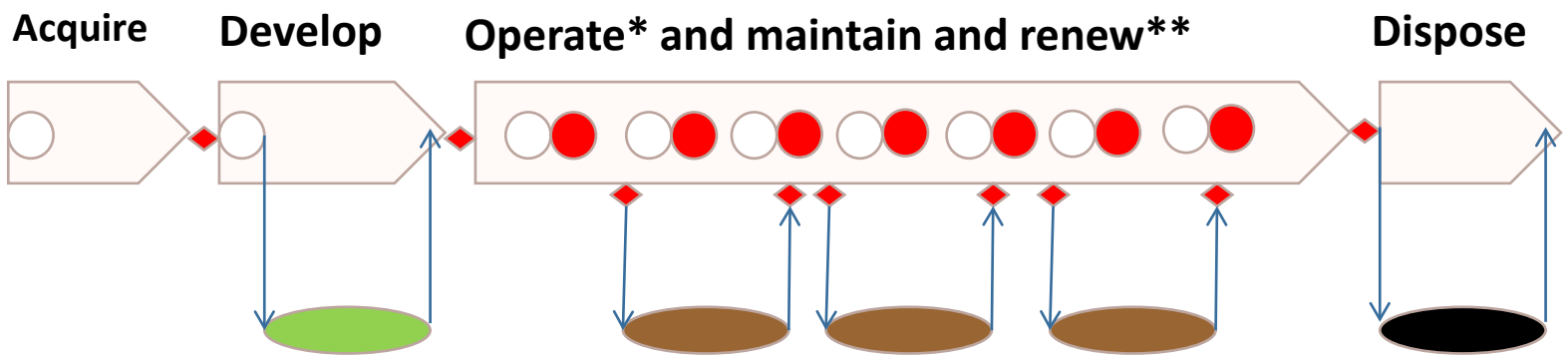
Generic Information Modeling (GIM)



GIM will DRIVE your knowledge into business

ILAP Asset Lifecycle Model

Asset Lifecycle Activities



* *Incl. drilling*

** *Incl. Turnarounds and High Activity Periods*

Governance

Go/no go decision

Study

Modification project

Greenfield development project

Brownfield redevelopment project

Disposal project

Governing, timing and classification of Asset Lifecycle Projects

Define one set of ILAP concepts (reference data) from many sources

ILAP

ILAP concepts

Creating on common set of concepts based on today's practices

Terminology used by the ISO and operators

ISO terms	PCA RDL terms	CoP terms	ENI terms	Statoil terms	VDT terms

Add relevant terms from various models here and use as basis for defining a unified set of Reference Data terms

For each of these reference data sources we need to identify,clarify and unify their models (documents and drawings) and extract all relevant terms and definitions

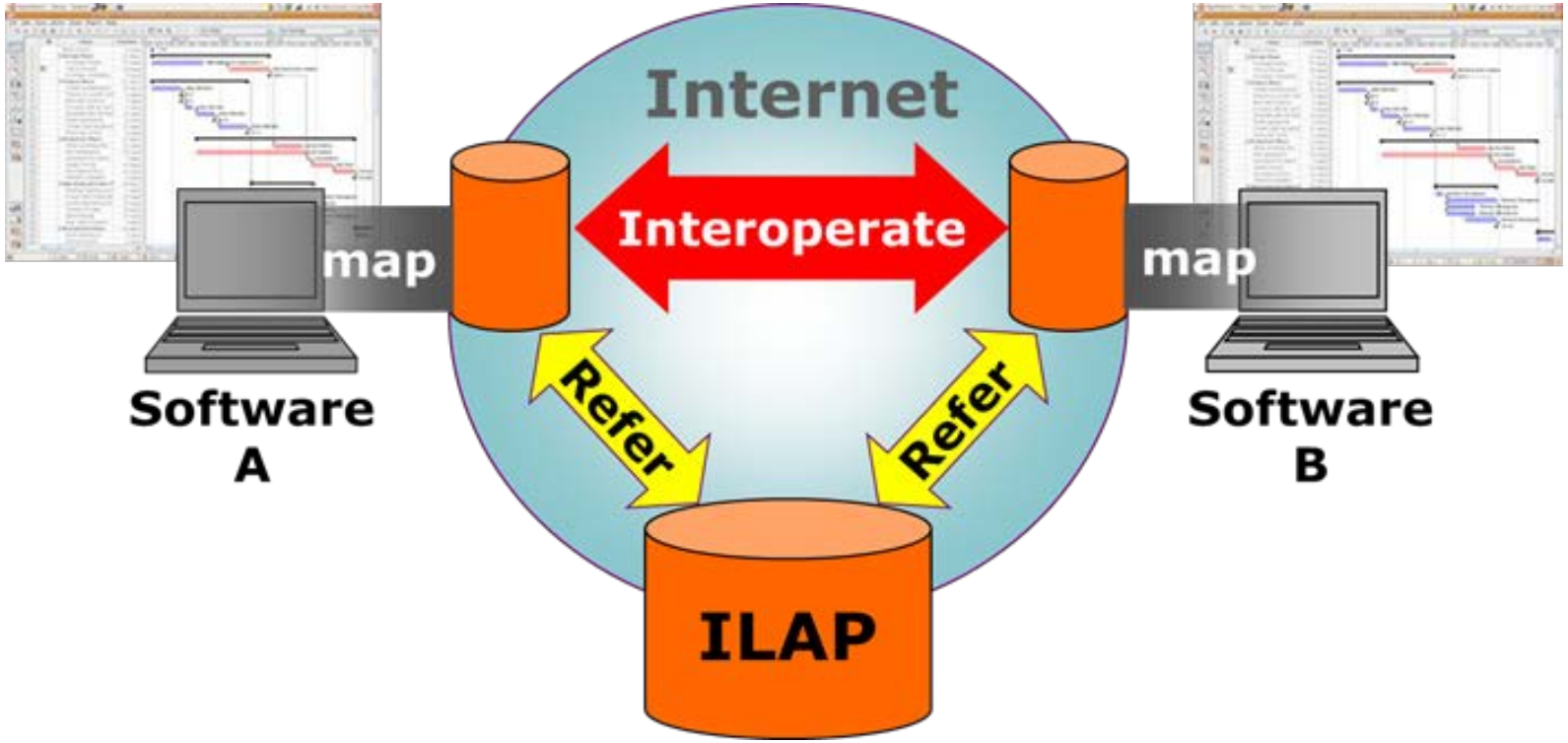
Terminology in planning tools

Safran	Primavera	MS Project	SAP	CoP plan tools	Top Quadrant

Add relevant terms from various tools here and use as basis for identifying translations from/to Reference Data terms

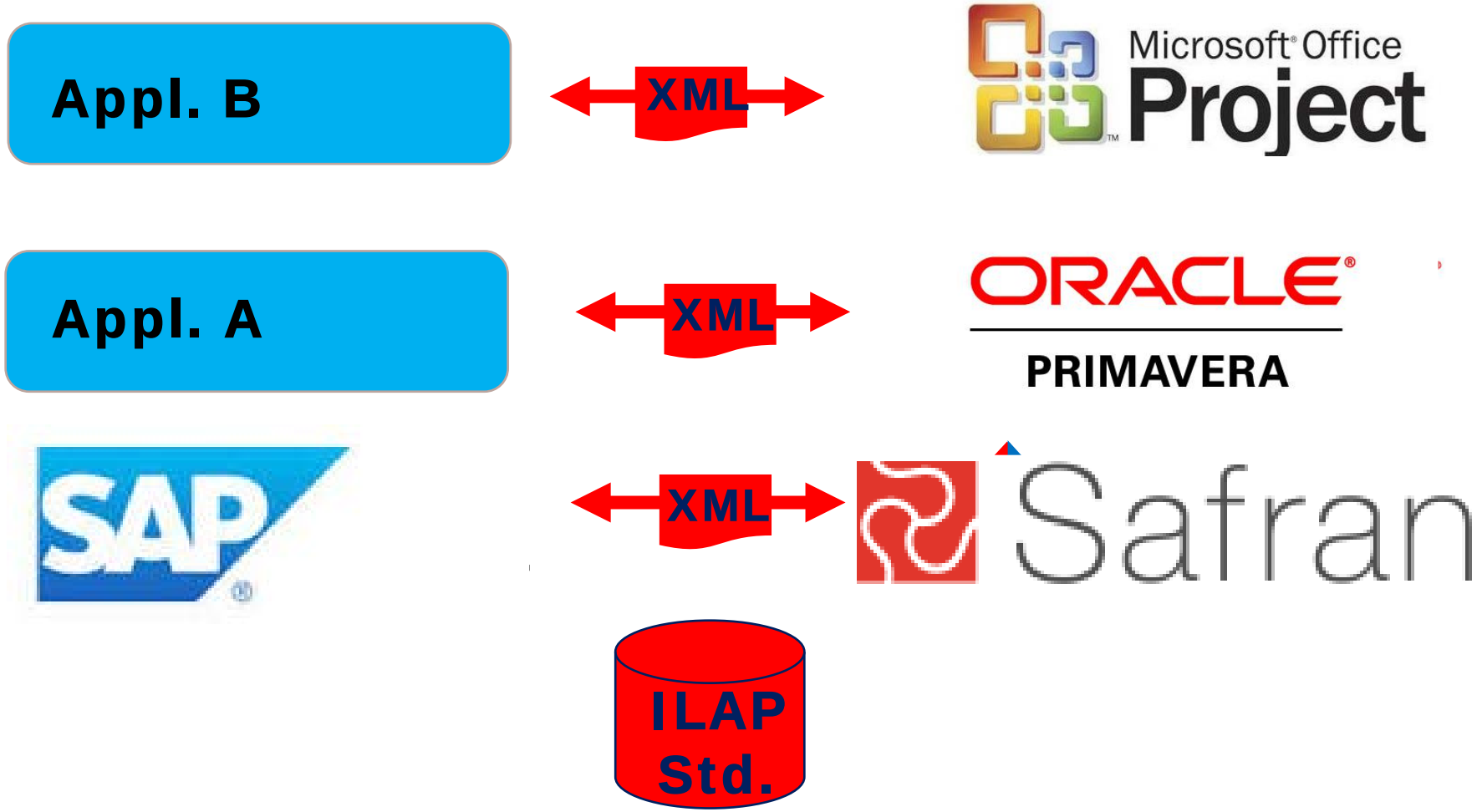
For each of these tools we need to identify,clarify and unify how these tools use terms (documents and drawings) and extract all relevant terms and definitions for use in the Reference Data Library

ILAP interoperability at its simplest



Using *standard shared references* & sharing references used, reduces business ambiguity & reduces mapping overheads. Makes interoperability easier and reduces risk & cost

The ILAP solution



Note that the application providers should build adapters for exchanging ILAP planning data

4. Common industry solutions

a) Connectivity
   - ✓ Internet
   - ✓ Topside
   - ✓ Subsea
   - ✓ Well
   - ✓ Drilling rigs

b) Content
   - ✓ OPC UA
   - ✓ WITSML
   - ✓ GIM

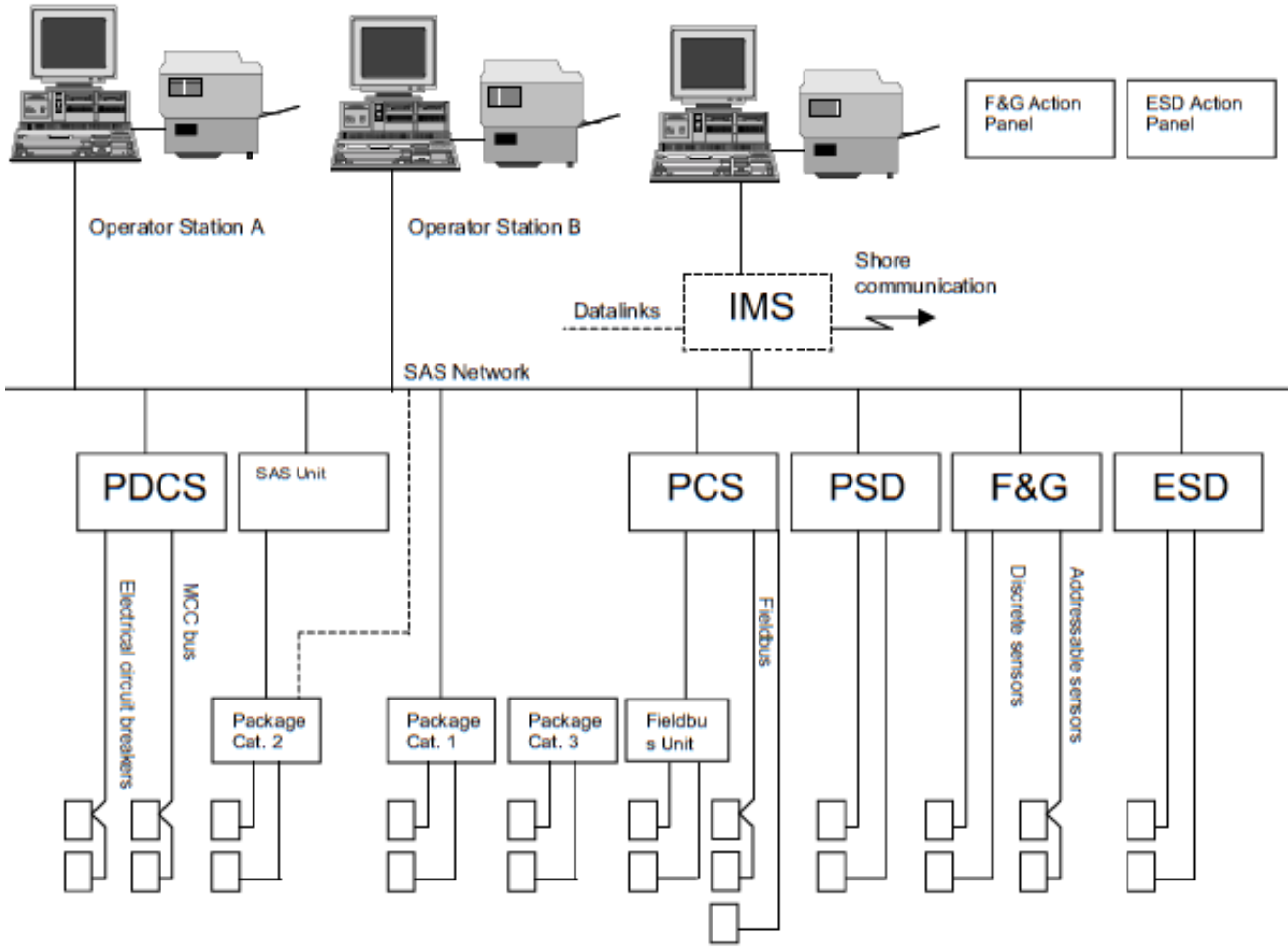
Topside

The SAS establishes secure industrial control and includes:

- ✓ Scada (supervisory control and data acquisition) systems,
- ✓ DCS (distributed control systems)
- ✓ ICSS (integrated control and safety system
- ✓ Control systems configurations

Separation of the Process Control, Safety and Support ICT systems with the office system is fundamental requirement.

Safety and Automation System (SAS)



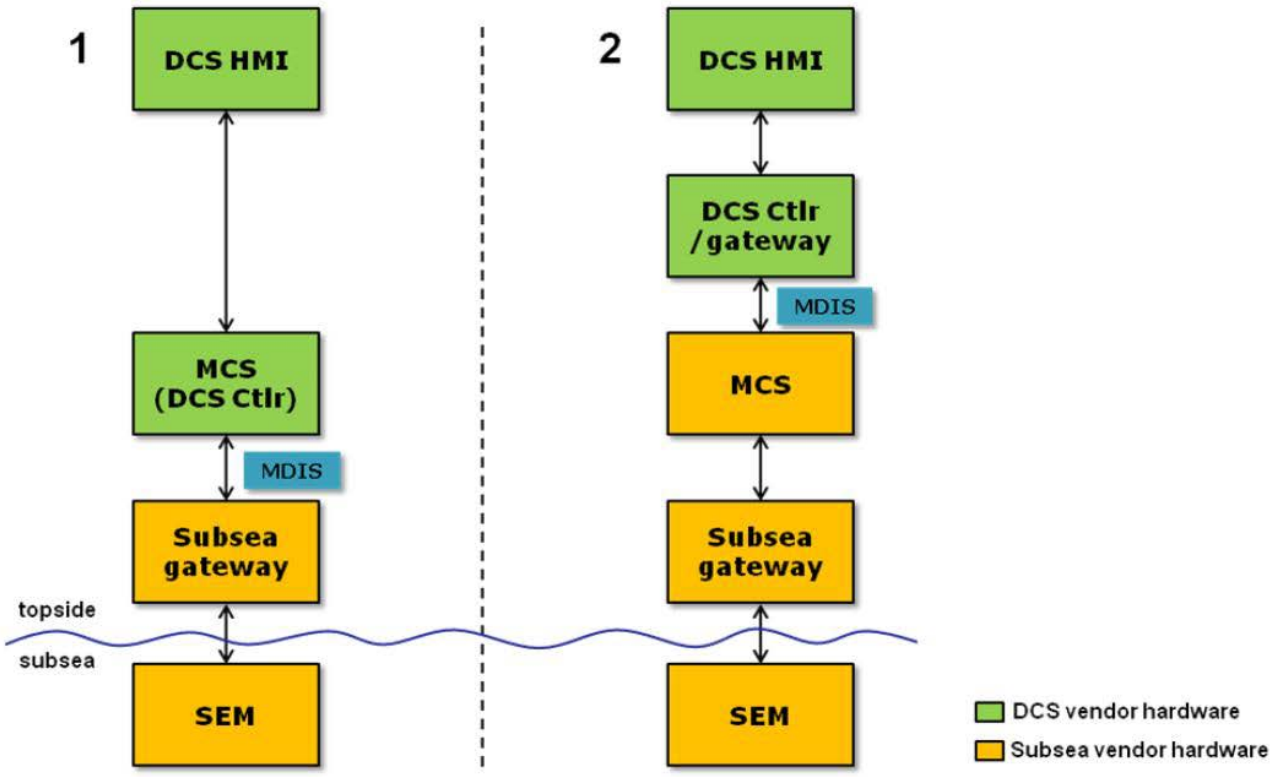
Connectivity of topside and subsea through MDIS

MDIS aim to provide

- ✓ Simplified implementation and testing of the interface
- ✓ Reduction in the risk of interface failures resulting in system faults and the cost of implementation due to delays and rework
- ✓ Ensure clear logic and control and status interface boundaries (aids future MCS/DCS logic development/implementation)
- ✓ Repetition of data use within objects is avoided
- ✓ Operator perspective i.e. to enable safe control and monitoring via the DCS
- ✓ To ensure flexibility for future vendor specific development and maintenance of subsea products

The MDIS standard is summited to ISO 13628-6.

MCS-DCS Interface Standard (MDIS)



Subsea Instrumentation Interface Standard (SIIS)

SIIS defines the interface between subsea production system instruments (sensors) and the Subsea Control Module (SCD). SIIS has developed a tri-level classification system for control system to sensor interfaces:

Level 1 – Simple instrument loop (4-20 mA)

Level 2 – CANbus (Fault tolerant) CANOPEN

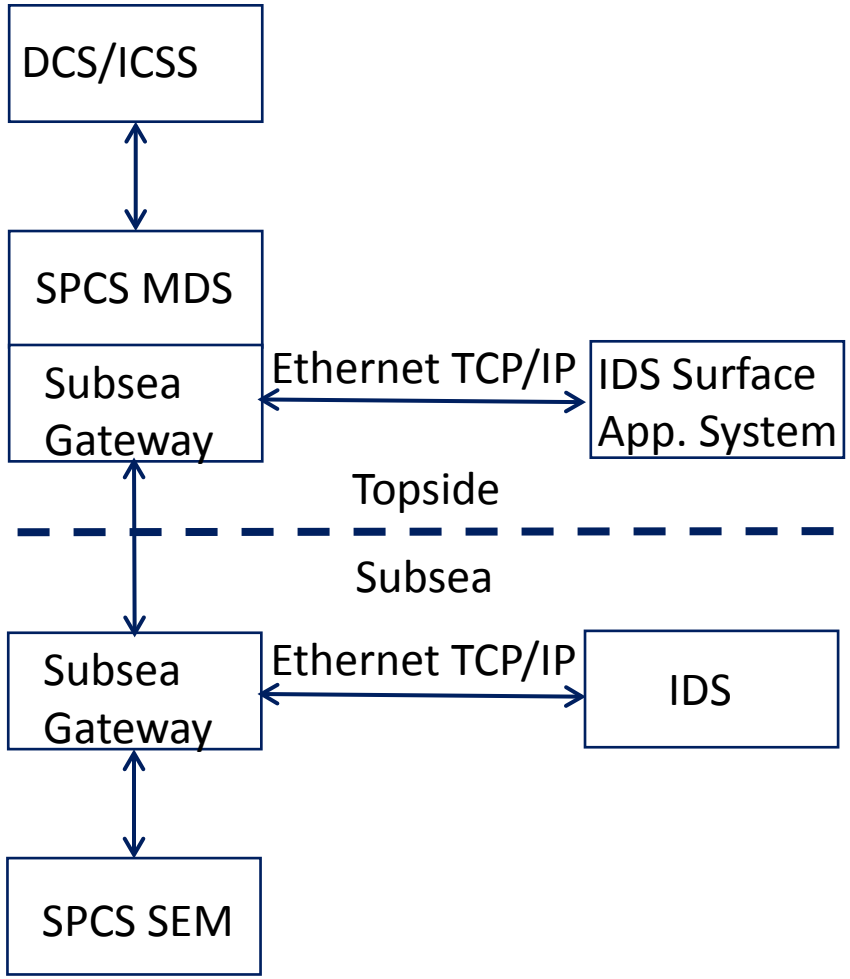
Level 3 – Ethernet TCP/IP

The SIIS standard is summited to ISO 13628-6.

Obsolescence Management

- ✓ Permanent transition from operability to non-functionality due to external reasons
- ✓ Co-ordinated activities to direct and control an organization with respect to obsolescence

SIIS level 3 communication links

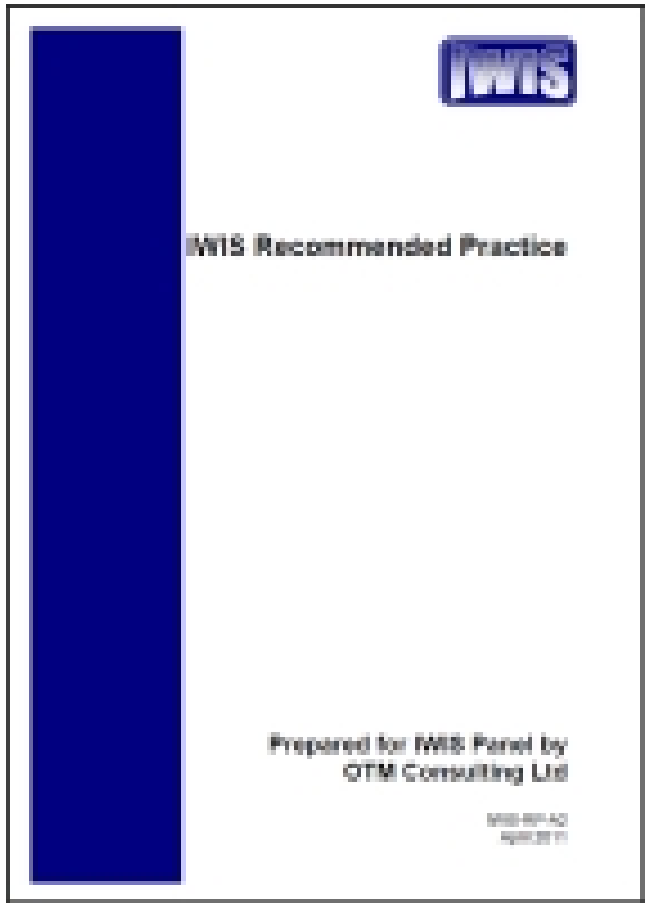


Intelligent Well Interface Standard (IWIS)

IWIS is a standard for integration of downhole power and communication equipment with subsea control systems to secure timely and cost-effective implementation of smart downhole equipment and defines interfaces between downhole vendor card and subsea control system with respect to:

- ✓ Communication
- ✓ Power
- ✓ Hardware

The IWIS standard available in ISO 13628-6.



http://www.iwis-jip.com/

Lacking similar connectivity solution for drilling rigs?

Today's practices for drilling facilities, for example BOP, is that testing and maintenance are performed according to a schedule between drilling the wells.

Modern drilling facilities from NOV and MH-Wirth might be remotely monitored and reprogrammed from a support center. But none of them are in operations on the NCS.

The IWIS, SIIS and MDIS solutions seems to unknown to people working within drilling.

Content

- WITSML (Wellsite information transfer standard markup language)– Energistics

  WITSML™ is an industry initiative to provide open, non-proprietary, standard interfaces for technology and software that monitor and manage wells, completions and workovers

- PRODML (Production Markup Language)- Energistics

  PRODML is an industry initiative to provide open, non-proprietary, standard interfaces between software tools used to monitor, manage and optimize hydrocarbon production

- OPC-UA - OPC Foundation
  - ✓
  - ✓ To be used on Johan Sverdrup Field

- ISO 15926 – EPIM/PCA
  - ✓ DDR
  - ✓ DPR
  - ✓ MPR-Authorities
  - ✓ MPR-Partners
  - ✓ Environment reporting
  - ✓ Logistics (tracking CCU + content)
  - ✓ Planning

One (important) comment to IO:

- ***Immature solutions***
- ***New solutions lacking support from organization***
- ***CBM – little useful information***

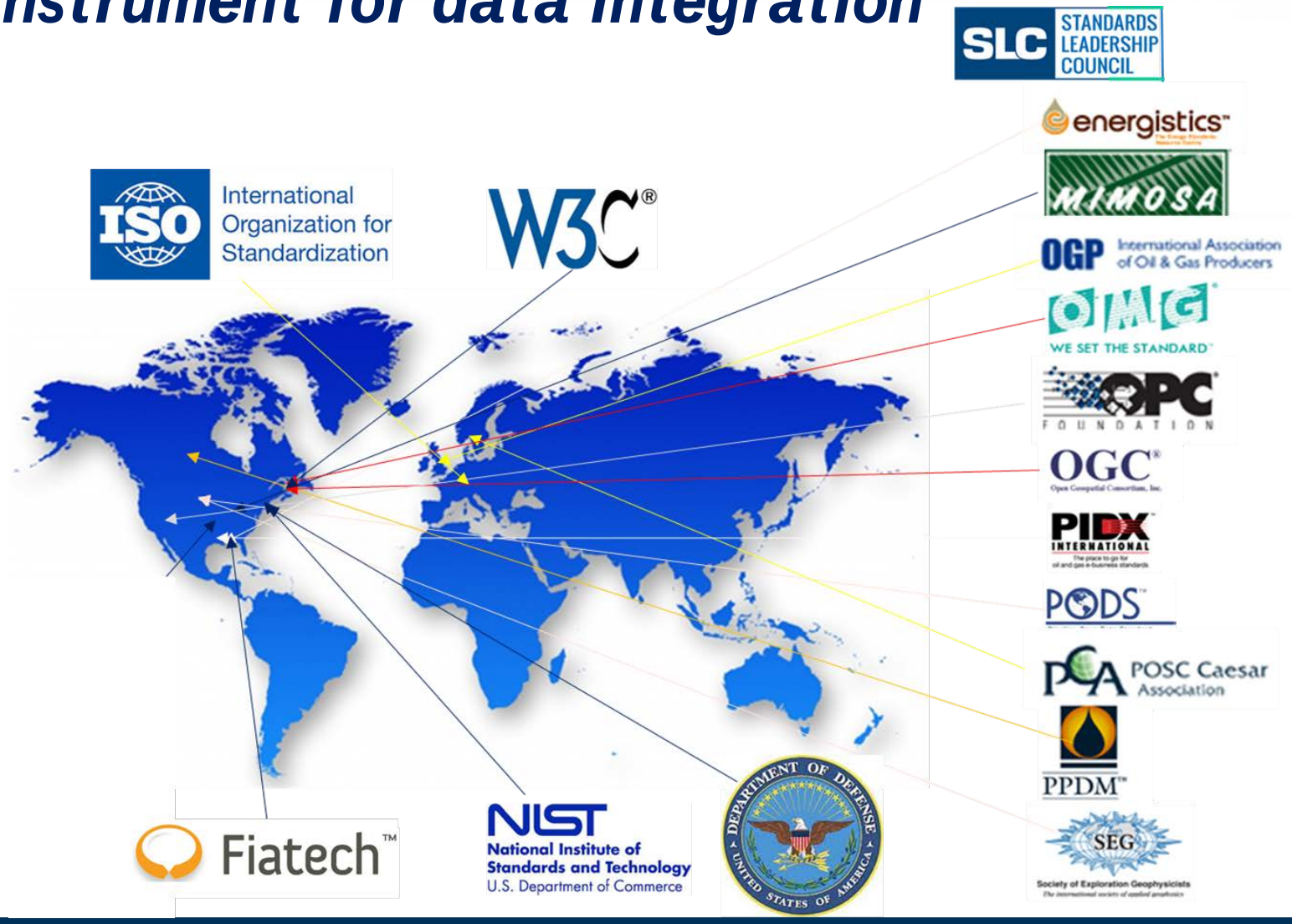
5. Looking ahead

Looking into the future

- Oil prices $30 per bbl the next coming years?
  - ✓ Reduced investment
  - ✓ Fewer employees – less competence
- Oil recovery factor up to 70%?
- No major accidents?
- Digitalization of the industry?
- Today's IT solutions have already major digestions problems – more data is coming around the corner
- In the future most of the communication will be between computers requiring logical languages interpretable by computers

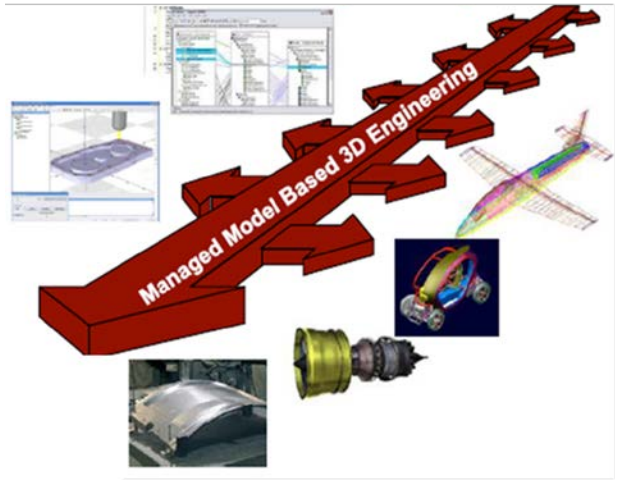
PCA Reference Data Library (RDL) - the instrument for data integration

- Yearly member meetings
  - ✓ Europe
  - ✓ Asia/Australia
  - ✓ America
- Collaborating with
  - ✓ Fiatech
  - ✓ ISO
  - ✓ MIMOSA
  - ✓ NIST
  - ✓ Standards Leadership Council



Common reference data across industries in ISO

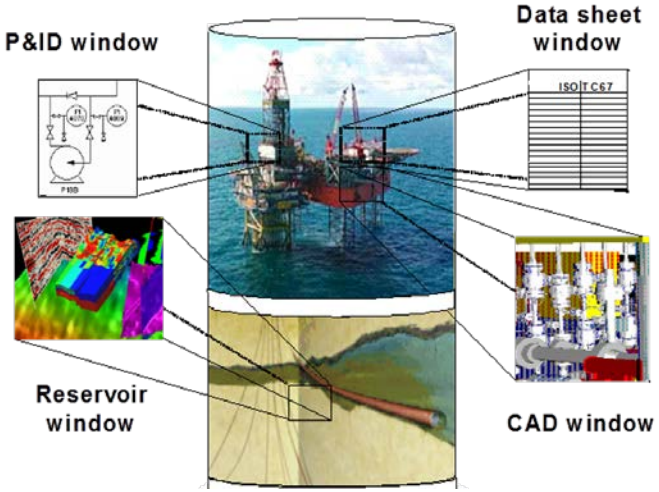
Aerospace and automotive joint effort
ISO 10303 AP242 Managed Model Based 3D Engineering



Business Problem addressed by PLCS
(ISO 10303 AP 239 Product Lifecycle Support)

How to keep the information needed to operate and maintain a product aligned with the changing product over its life cycle?

The vision of GIM (ISO 15926)
Data interoperability and life cycle



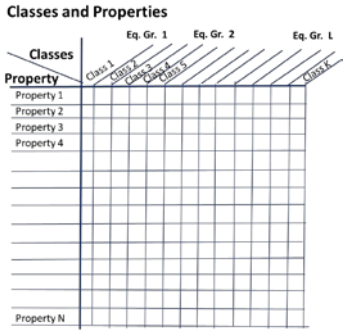
Common set of reference data across industries

ISO TC184/
SC4/WG22

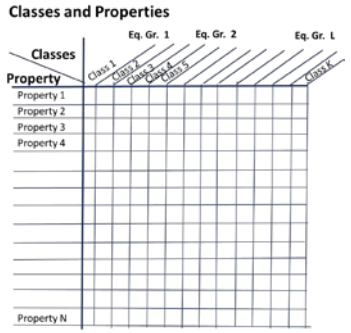
Global collaboration on common classes and attributes for offshore equipment

Data sheets
Common set of classes and attributes+

ISO 15926



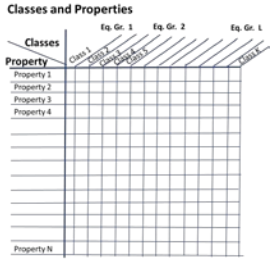
PCA RDL



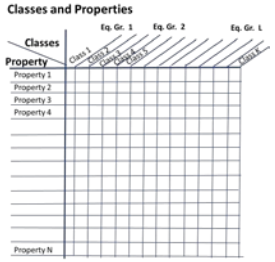
Creating data sheets based on today's practices

Terminology used by Norwegian Offshore Industry (STI project)

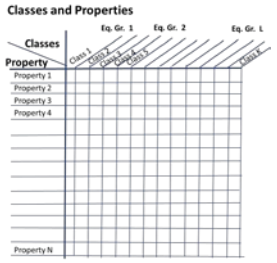
NORSOK



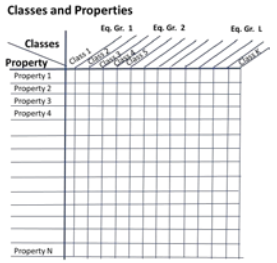
Operators



Contractors

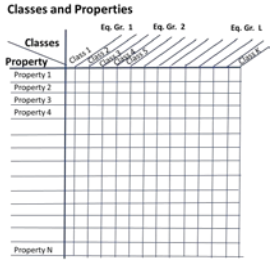


Other suppliers

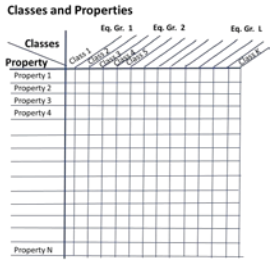


Terminology used by standard organizations (ISDD project)

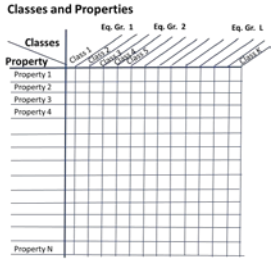
API



ISA



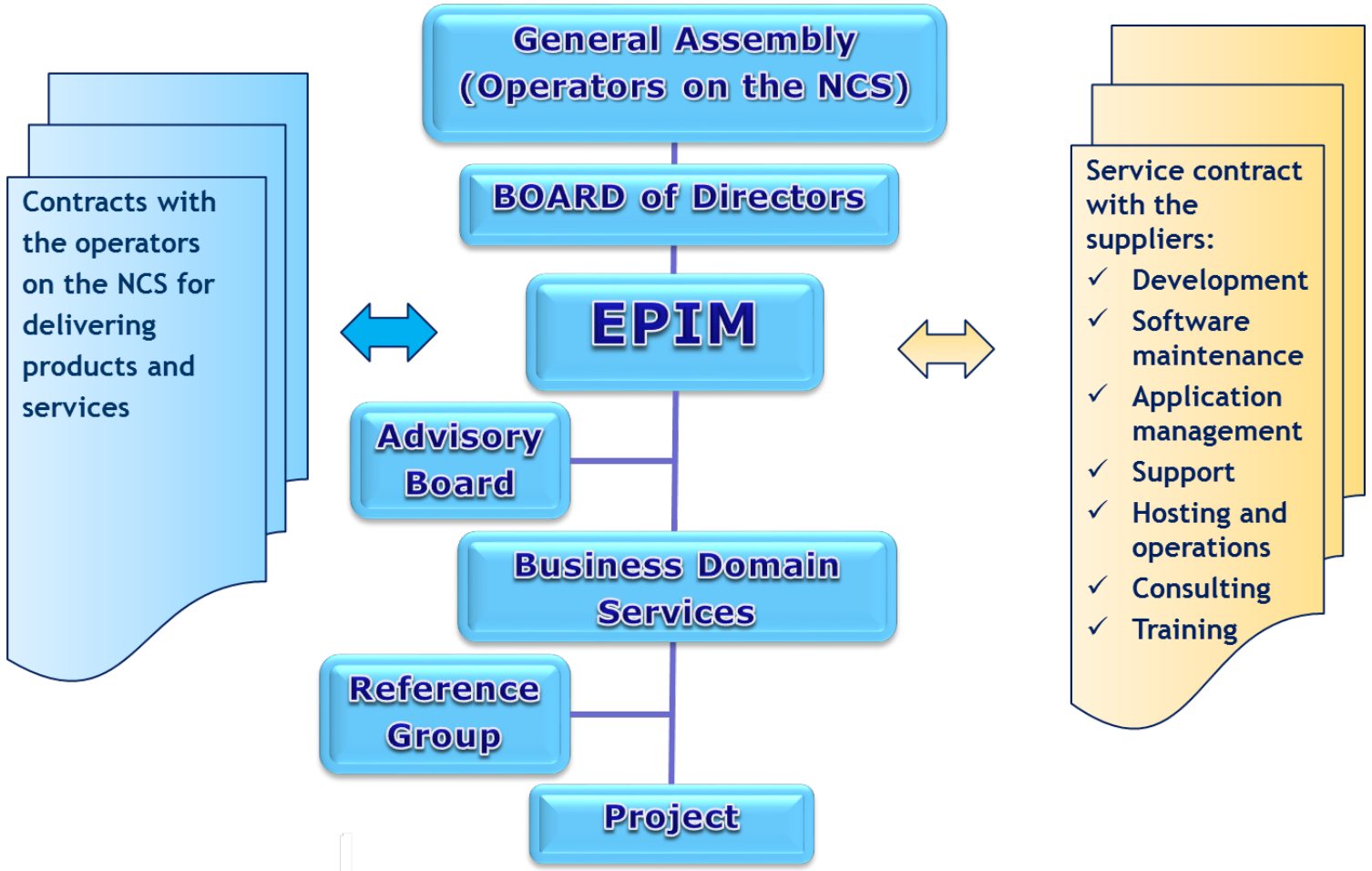
IEC



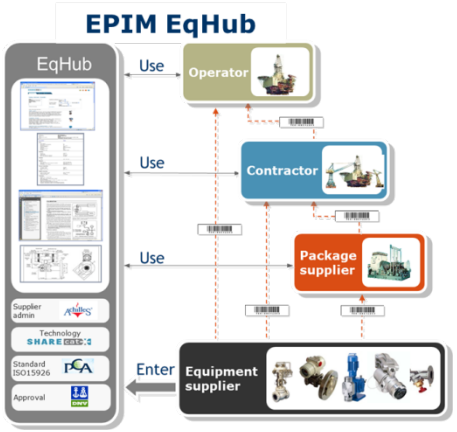
ISO

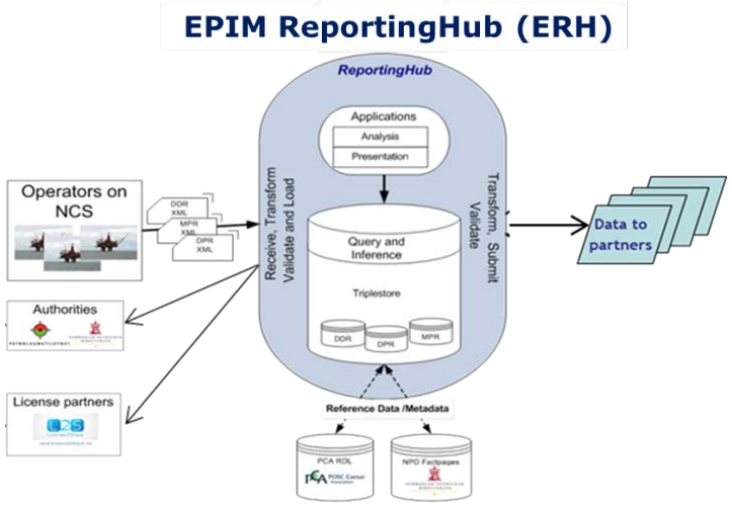
Exploration and Production Information Association (EPIM)

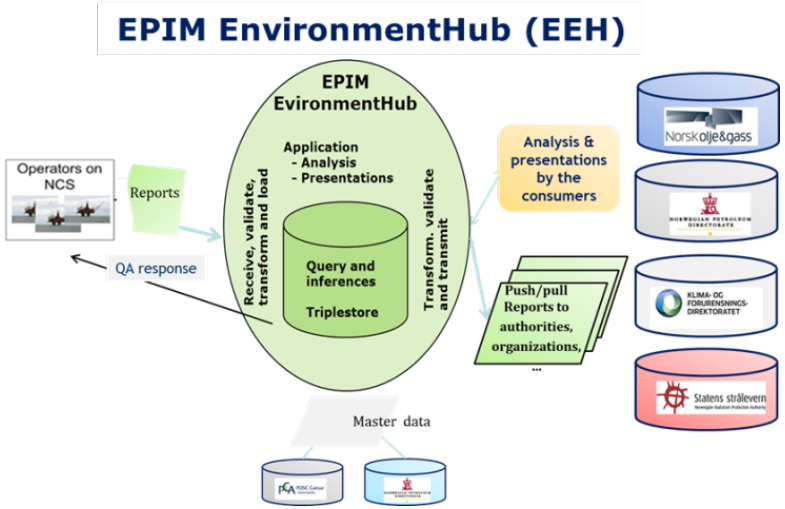
- ***EPIM*** is governed by the **operators on the NCS**
- **EPIM** shall facilitate IT solutions and services for the oil and gas industry through **standardization of requirements and processes**

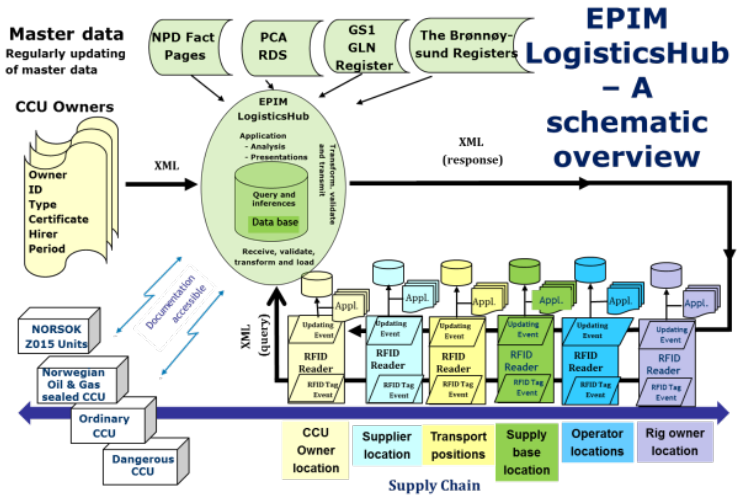


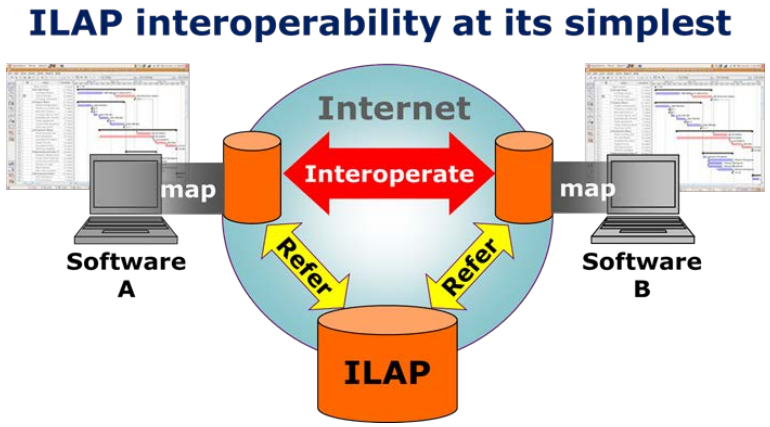
EPIM solutions based on the GIM standard



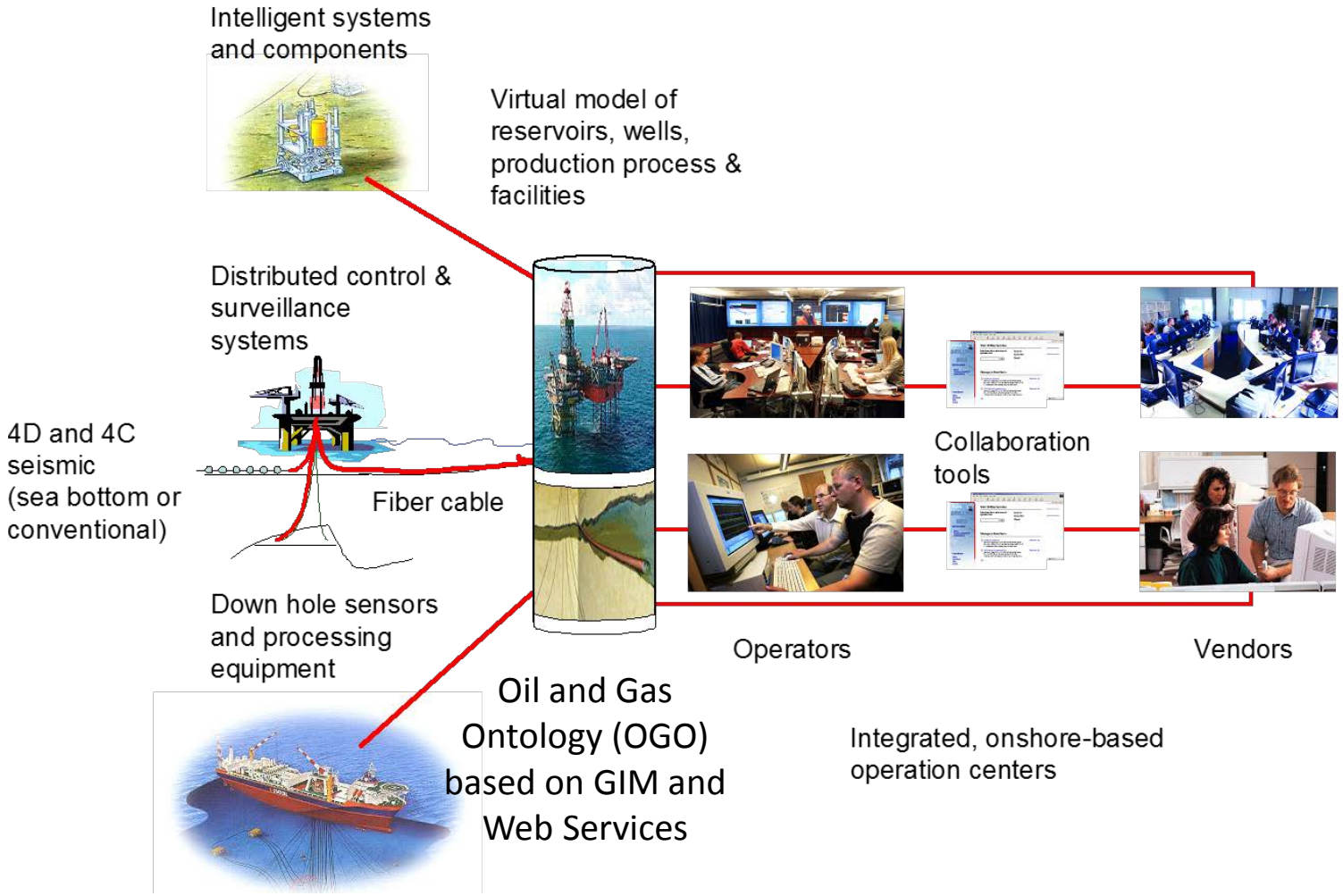






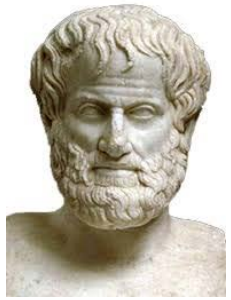


Information Strategy for IO for the future

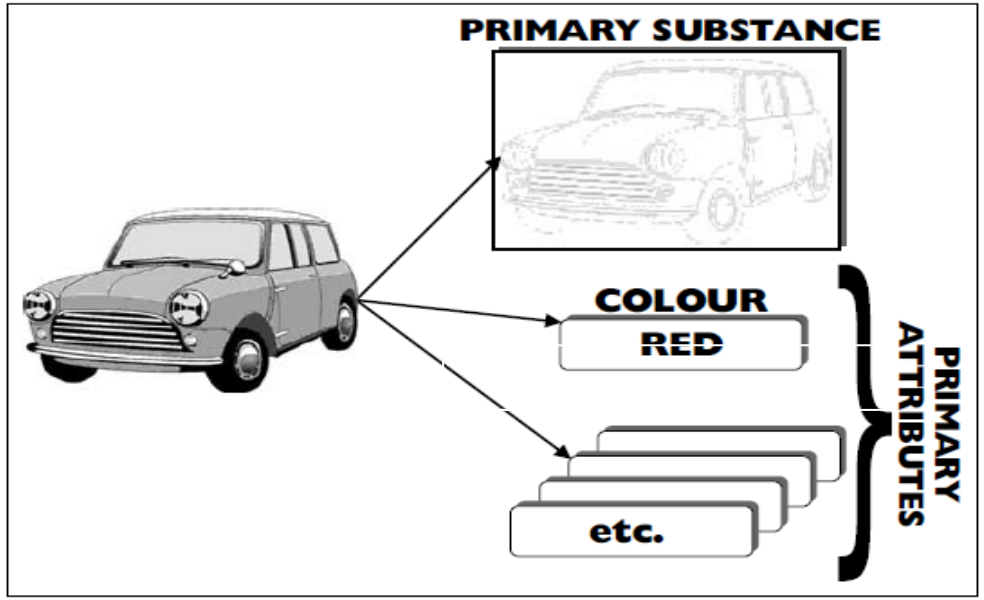


Thank you for your attention!

Substances paradigm



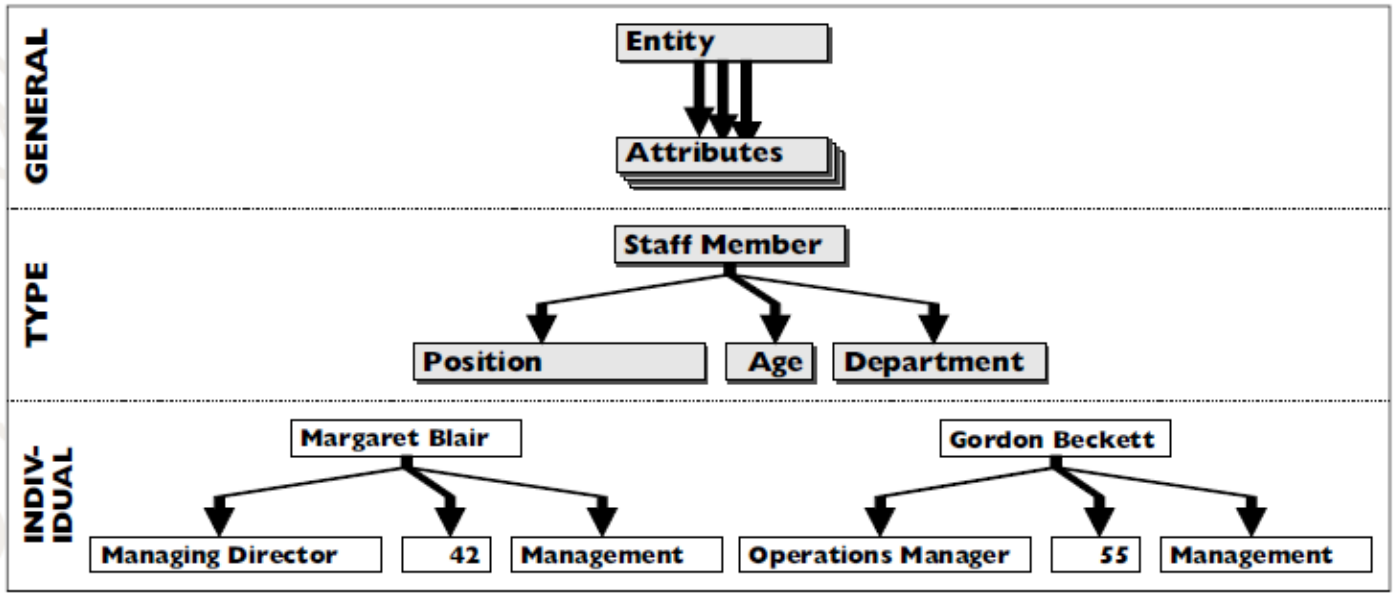
Aristotle's (384-322BC) was concerned with seeing the real world clearly and accurately. His "Organon" was the authority source on logic and classification up to the 19th century and he presented here the substance paradigm.



Substance was a neutral foundation for things.

Each thing was a single inert hunk of matter impregnated by a number of attributes.

The Entity (File-Record or Spreadsheet) Paradigm

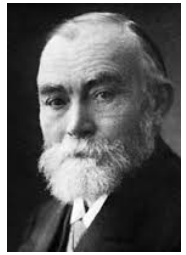


The simplification of the secondary hierarchy removes the possibility to manage more general types of things.

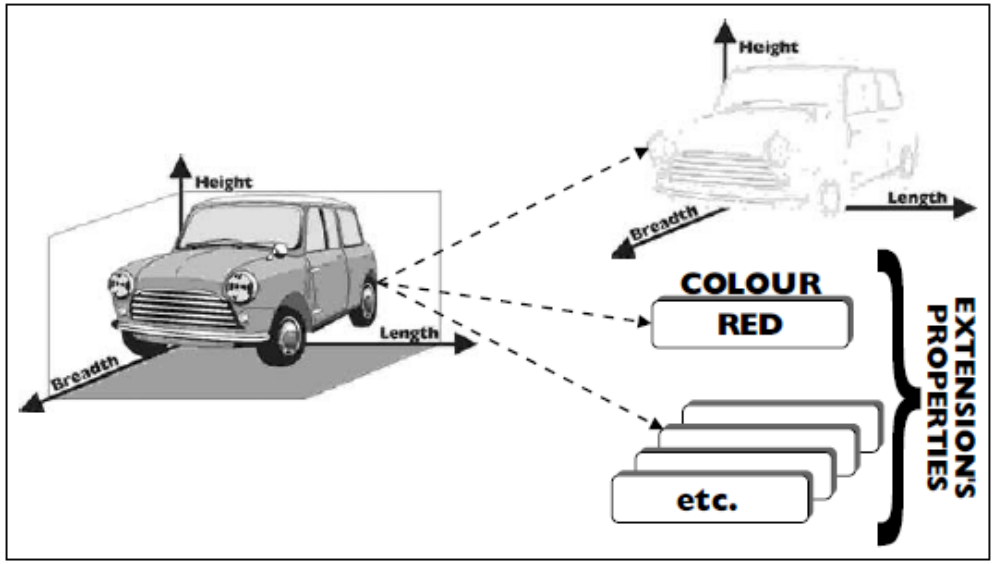
It is not any more possible to accurately reflect the distinction between entity and attributes.

The employees work with spreadsheet in almost all companies in the oil and gas industry showing the usefulness of the entity paradigm even today.

The Logical Paradigm



Frege (1848-1925) developed predicative logic in his book “The Foundations of Arithmetic” and is the founder of the logical paradigm. The paradigm is based on mathematics (logic and set theory), Frege’s reference principle and extension of an object (a property of things that can’t be doubt according to Descartes (1596-1650).

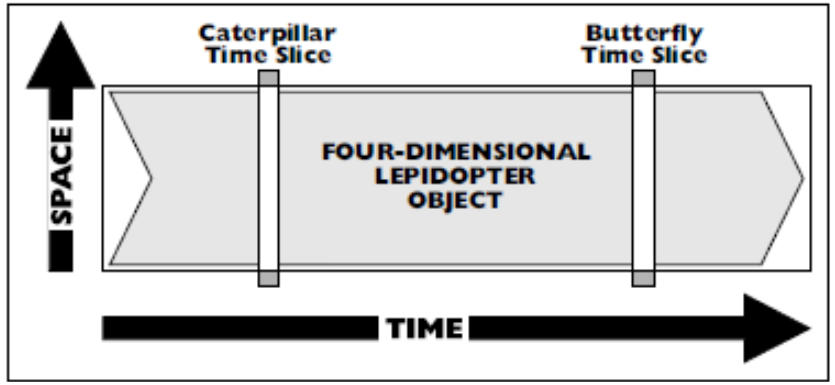


The substance concept in the substance paradigm is replaced by the extension (length, breadth, and height) in the logical paradigm and called an object.

The object, the car in the picture, is now defined with its length, breadth, and height. But what about the attributes? Due to the reference principle they need also extensions.

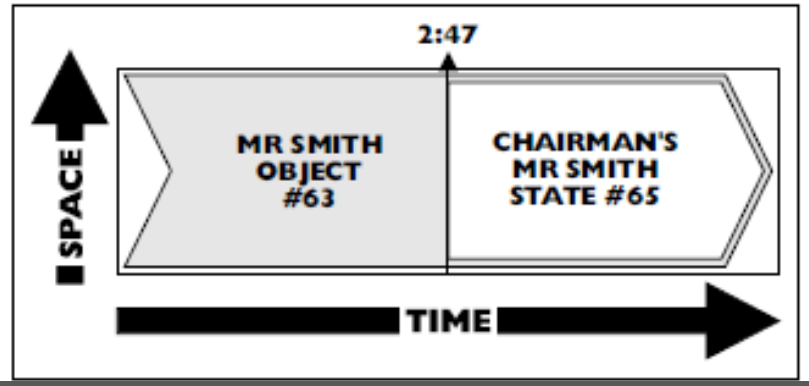
The Object Paradigm

Willard Van Orman Quine (1908 - 2000) noted in his book “Word and Object” that “Our ordinary language shows a tiresome bias in its treatment of time” and he recommend to follow Einstein and treat time as another dimension on par with space’s three for the objects.



4 dimensional object does solve the identity issue of the physical bodies. States of physical bodies persist through time. This gives two important characteristics:

- ✓ timelessness
- ✓ whole-part patterns



Events are 3 dimensional object with zero thickness along the time dimension. They do not persist through time.