

# Integration and standardization

Necessary evolution for cost  
effective monitoring solutions

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# Outline

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- Short description of OCTIO and Gravitude monitoring solutions and technologies
- Challenge 1: The world is analogue – computers are not
- Challenge 2: Multi Physics – primary and secondary data
- Challenge 3: Rapid technology evolution
- The way ahead

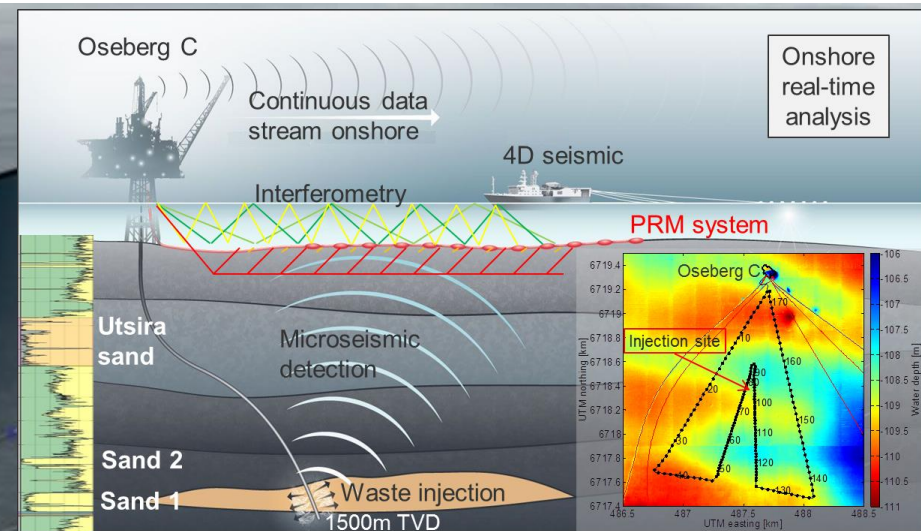
# OCTIO ReM

- PRM
- Caprock
- Drilling

## Ethernet on the seafloor:

- Open digital system
- Interfaces third party sensors
- Connects to subsea infrastructure
- Expandable, starting from a small focused system to a large full-field system

=>The digital oil field becomes a reality!



# OCTIO Gravitude

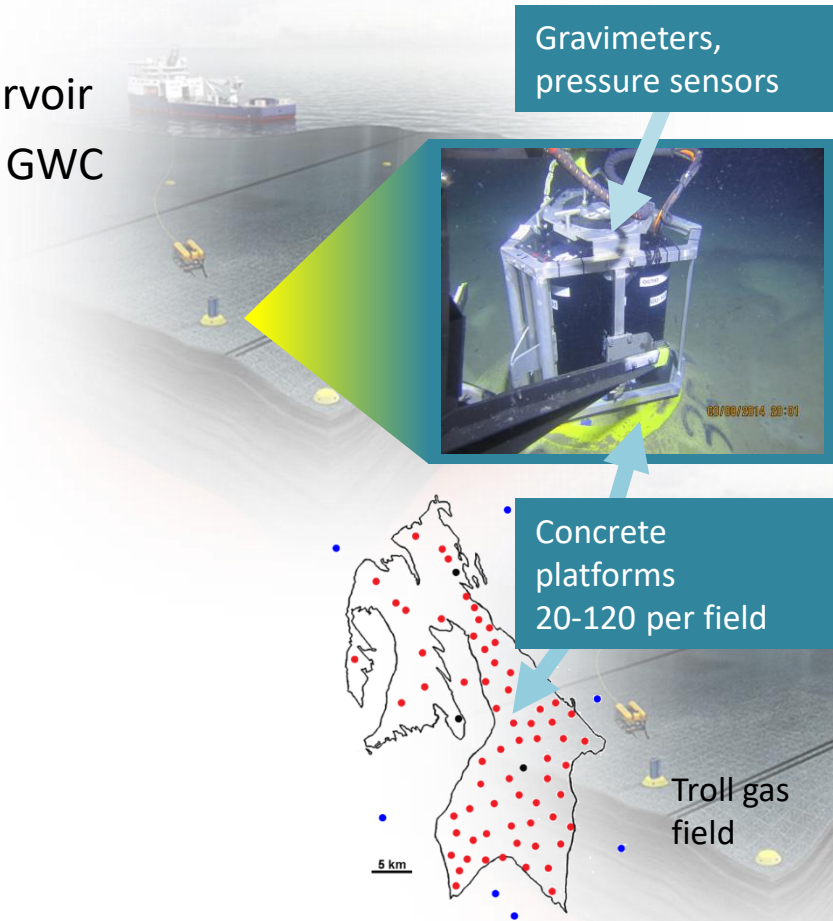
## 4D gravity and subsidence

- **Seafloor 4D gravity**

- Sensitive to density changes within the reservoir
- Monitors **fluid movements**: e.g. advance of GWC
- $\sim 1 \mu\text{Gal}$  accuracy:  $< 1$  meter sensitivity in movement of GWC!

- **Seafloor subsidence**

- Measured from seafloor pressure
- Sensitive to reservoir pressure drop
- Provides information on lateral compartmentalization, properties of the overburden
- Relevant for installation safety
- 2-4mm accuracy



# Challenge 1: The world is analogue – computers are not

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- The world is analogue and sensor signals must be digitized before computers can use numerical algorithms to solve complex equations
- Physical parameters must be sampled adequately in space and time to avoid aliasing of the signal
- For monitoring purposes, some signals must be measured over a long distance (kilometres) and time (years) but sampled at short distance (meter) and time (millisecond) – creating enormous amount of data to be collected, computed and stored

Challenge: Huge amount of data must be transmitted and stored in real time through several different transmission media and interfaces



## Challenge 2: Multi Physics – primary and secondary data

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- The world is complex and to be able to analyse the data of interest, these must be extracted from all the other data (also called noise....)
  - To be able to remove or use the “noise” we must also sample it adequately. Example:
    - To measure mass changes in the offshore gas reservoirs, we use a gravity meter (mass-spring principle)
    - To compensate for subsidence we measure depth (pressure sensor)
    - To compensate for changes in pressure we measure water temperature, water density, air pressure, drift in sensor due to temperature changes.....
    - You see where we are heading.....

Challenge: A system must be capable of integrating data from more sensors and new sensor types in a seamless and scalable manner



- Challenge 3: Rapid technology evolution

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- In the subsea world the monitoring solutions are required to collect and analyse data for many years. The latest PRM requirement is 50 years!!(?)!
- Electronic components used in sensing, digitization, data transmission, power distribution etc are being developed for other (much larger) markets where the lifespan of a specific component is very short, often less than a year
- New technologies must be integrated in existing systems, like IoT, AI, closed decision loops etc

Challenge: Modification and upgrades of parts and subsystems will be done with new components and modules. Keep compatibility while increase functionality



# The way ahead

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The solution is to use communication and interface standards to enable vendor integration and use of 3<sup>rd</sup> party components and subsystems

Integrated and scalable monitoring systems reduces infrastructure costs as well as lifetime costs. The systems will be fit-for-purpose at any time and can be scaled and modified as the requirements change over time

The industry must cooperate to establish wider accepted standards for sensor interfaces, data transmission, data storage formats and physical interconnection

