Poll Questions

Before we start please let me know if you have any questions to me or about the Kongsberg Maritime.

There will be a Q&A at the end of the presentation to cover the slides and the specific of this presentation.

Poll Question

What is your area of work related to AUV/USV?

Poll Question

What is your job title?

Eelume SUBSEA INTERVENTION

Poll Question

Who is your employer?

Eelume SUBSEA INTERVENTION

Poll Question

How many years of experience do you have?

Eelume SUBSEA INTERVENTION

Poll Question

What geographic region are you from?

Eelume SUBSEA INTERVENTION

Agenda

Kongsberg Maritime and Eelume AS is developing a new type of Autonomous Underwater Vehicle for residency on subsea structures, USV and even on moored Power buoys.

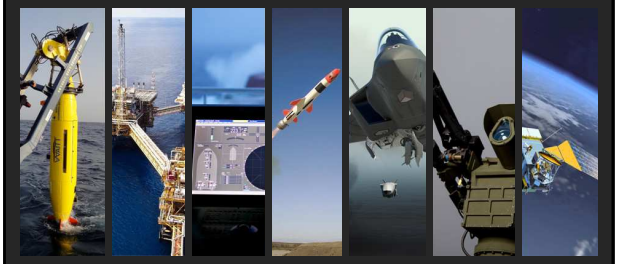
Thi new AUV can be used as a resident AUV on subsea structures. Todays talk is an introduction of how this vehicle came together and where we are now and the plans for further development.

- Who is Kongsberg Maritime.
- Autonomous Vehicles
- Eelume partners. Statoil pilot project.
- How the Snake / Eeel concept came to life.
- The first Prototype
- Tools and plans.
- The Statoil project. Morin field
- Why use Eelume and what can it do.

Eelume SUBSEA INTERVENTION

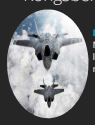
Kongsberg Group 200 Years of Innovation

KONGSBERG

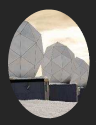


From Deep Sea to Outer Space

Kongsberg Group Industries



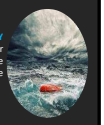
DEFENCE
Modern product portfolio with world leading positions in defence and aerospace niches

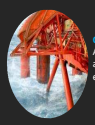


SPACE & SURVEILLANCE
Niche products and solutions to the entire value chain; from launch to data download services

MERCHANT MARINE
Scalable automation and control, safety, energy management, navigation and cargo handling solutions

SUBSEA TECHNOLOGY
Marine robotics and underwater sensor systems for naval applications, fishery, offshore operations and underwater science

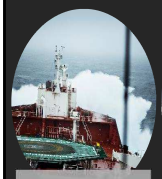




OFFSHORE, OIL & GAS
A global supplier of integrated automation and control systems and engineering services

INDUSTRIAL DIGITALIZATION
Staying ahead of the curve on industrial software solutions for efficient operations

Kongsberg Group Business Areas



KONGSBERG MARITIME

Global market leader within offshore, merchant marine and subsea applications

KONGSBERG DEFENCE SYSTEMS

Modern product portfolio in growing defence and aerospace niches

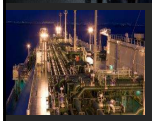
KONGSBERG PROTECH SYSTEMS

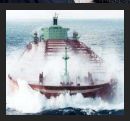
Unrivalled global market leader in remote weapon stations

KONGSBERG DIGITAL

Developing the next generation of digitalized products and services

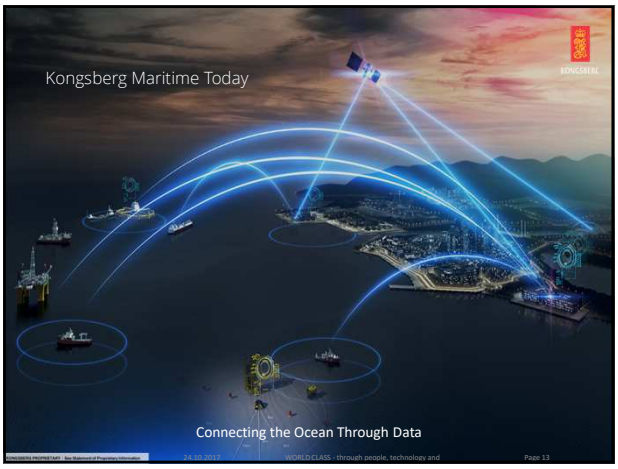
Kongsberg Maritime Overview

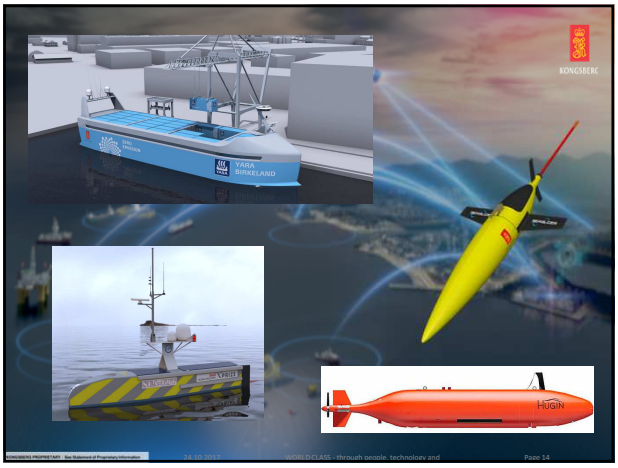


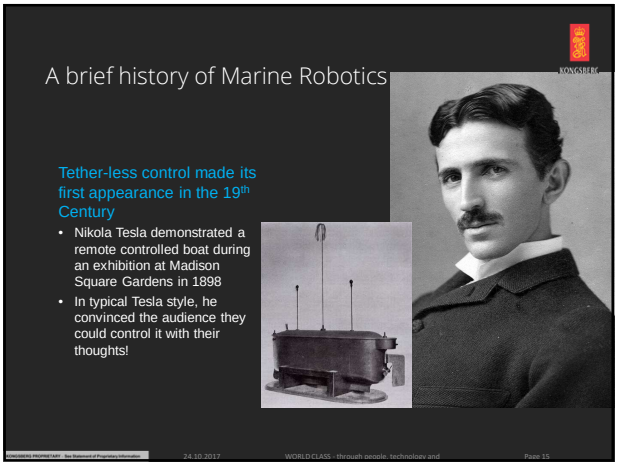


Offshore – Merchant Marine – Subsea – Emerging Business

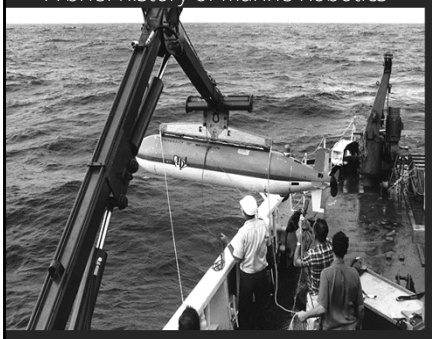
- 59 offices in 20 countries
- KM systems installed on more than 17,000 vessels
- Dynamic positioning, navigation, automation, simulation, Subsea and seismic instrumentation and fisheries


Kongsberg Maritime Today
Connecting the Ocean Through Data


YARA BIRKELAND
HUGIN


A brief history of Marine Robotics
Tether-less control made its first appearance in the 19th Century
• Nikola Tesla demonstrated a remote controlled boat during an exhibition at Madison Square Gardens in 1898
• In typical Tesla style, he convinced the audience they could control it with their thoughts!

A brief history of Marine Robotics



1957 University of Washington SPURV

First tether-free underwater vehicle developed in 1957

- Universities led the way: Special Purpose Underwater Research Vehicle (SPURV)
- Research gave way to defence applications in the early 1980s
- First AUV developed by a commercial company 1983 (ARCS)

1980 Ifremer Epaulard

THE HISTORY OF EELUME

Eelume SUBSEA INTERVENTION

PARTNERS

Statoil — *LOOP Agreement Demanding customer*

- **Demanding customer**
- User requirements
- Extensive subsea operation experience
- Access to Statoil's partners
- Pilot customer

Eelume SUBSEA INTERVENTION — *Experience, Marketing & Sales*

- Development of Eelume vehicles
- Technology IPR, patents
- Research projects
- **Dedicated team**

KONGSBERG

- AUV technology and experience
- **Industrialisation and manufacture**
- **Supply chain**
- **Marketing and sales**
- Investments

Expertise, theory, algorithms

The Research Council of Norway

NTNU AMOS
Centre for Autonomous Marine Operations and Systems

- World class research expertise snake robots
- Theory, algorithms
- MSc, PhD and Post Doc projects and people

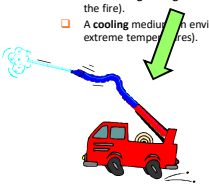
Innovation Norway

RESEARCH ON SNAKE ROBOTS - THE BEGINNING (2003)

Several major city fires in Trondheim

A **self-propelled fire hose** where water is used as:

- A **hydraulic** medium (for enabling the hose to move).
- A **fire extinguishing** medium (for fighting the fire).
- A **cooling** medium (in environments with extreme temperatures).



EARLY THEORETICAL RESEARCH ON SNAKE ROBOTS

M6

M1

AIKO
Obstacle-aided locomotion

M5

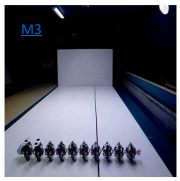
SINTEF

M2

WheeKo

SINTEF NTNU

M3



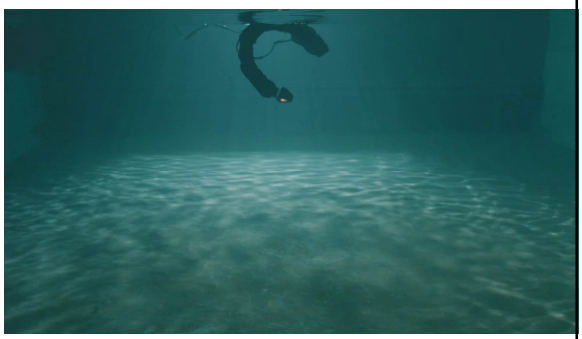
M4

KulKo

SINTEF NTNU

FROM 2011: SUBSEA APPLICATIONS OF SNAKE ROBOTS

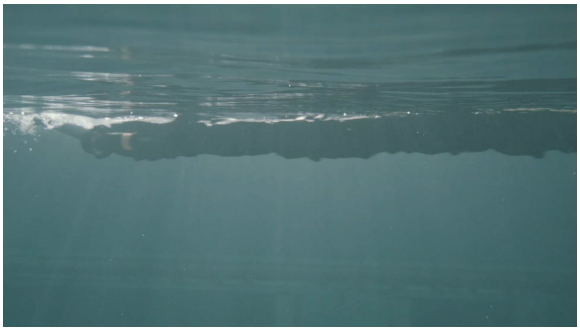
Media7



FROM 2011: SUBSEA APPLICATIONS OF SNAKE ROBOTS

- World's first swimming snake robot with thrusters.

Media 8



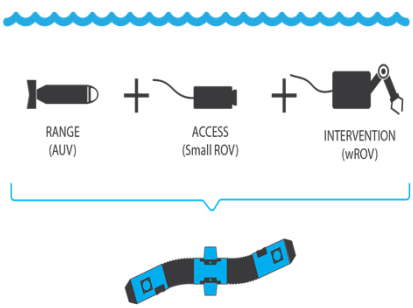
Eelume SUBSEA INTERVENTION

EELUME AS

2015

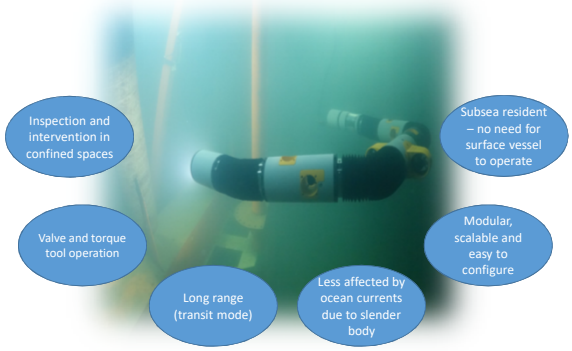
Eelume SUBSEA INTERVENTION

THE EELUME CONCEPT

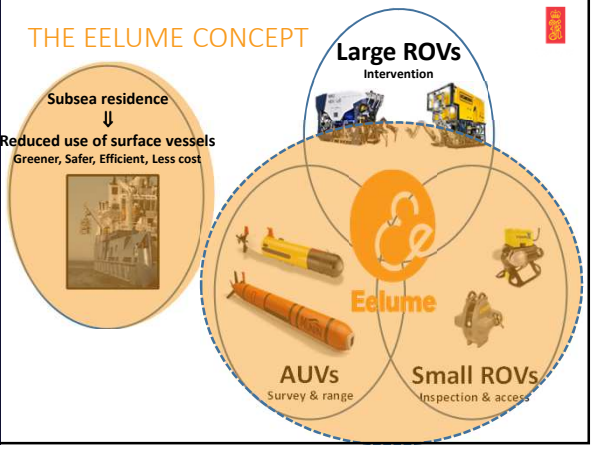


Eelume SUBSEA INTERVENTION

FEATURES OF EELUME



THE EELUME CONCEPT

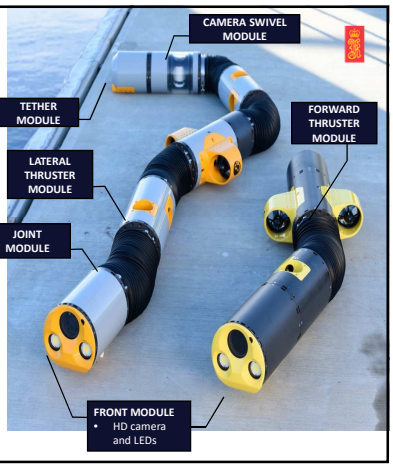


PROTOTYPE 1

2016

PROTOTYPE 1

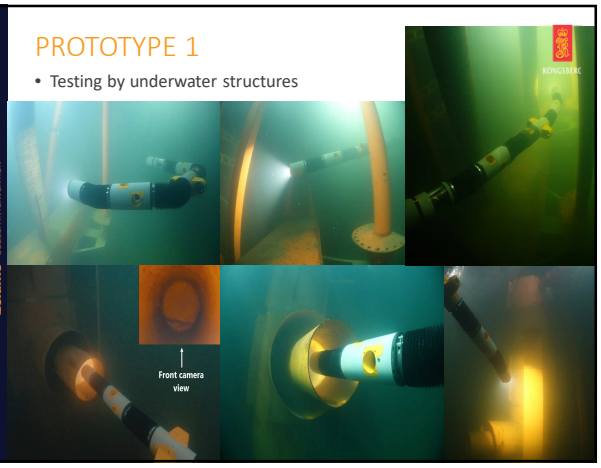
- **Diameter:** Ø180 mm
- **Depth rating:** 150 m



Eelume SUBSEA INTERVENTION

PROTOTYPE 1

- Testing by underwater structures



Eelume SUBSEA INTERVENTION

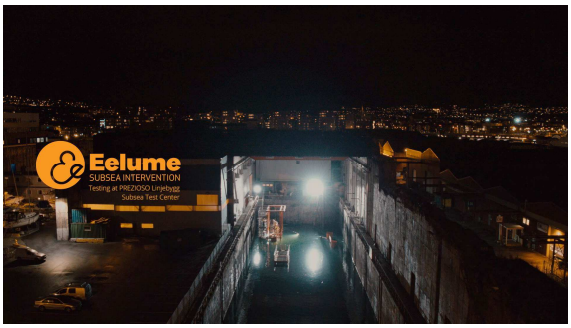
PROTOTYPE 1

- Extensive sea testing

Eelume SUBSEA INTERVENTION

Dry dock Testing

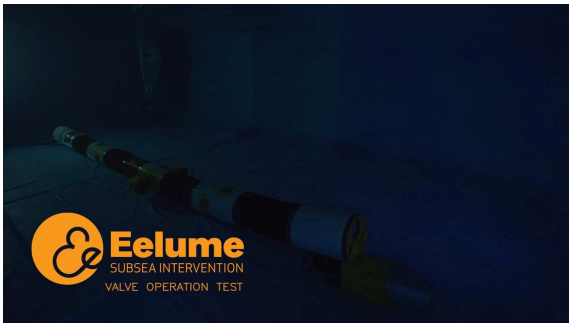
Media9



VALVE OPERATION USING PROTOTYPE 1

- Eelume is currently developing a custom class 3 tool to be demonstrated with P2 in 2017.

Media 10



PROTOTYPE 2

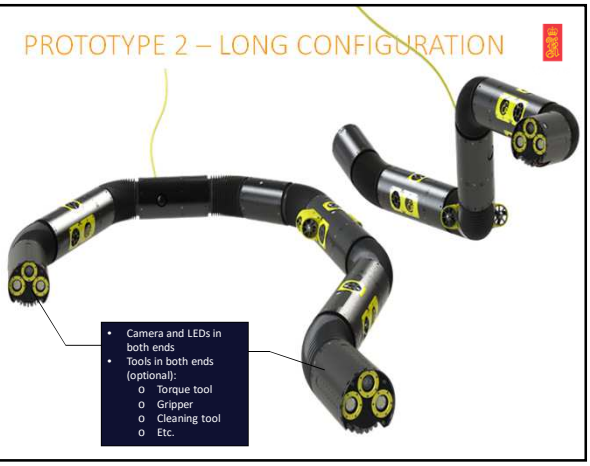
2017

PROTOTYPE 2 – MINIMAL CONFIGURATION

- **Diameter:** Ø200 mm
- **Depth rating:** 500 m

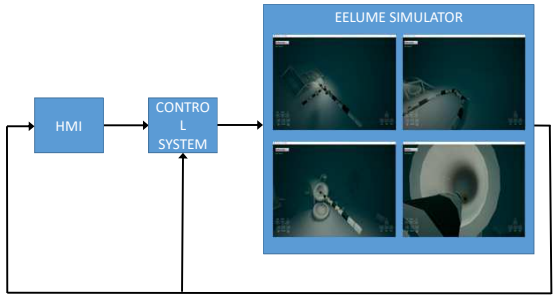
PROTOTYPE 2 – MINIMAL CONFIGURATION

PROTOTYPE 2 – LONG CONFIGURATION

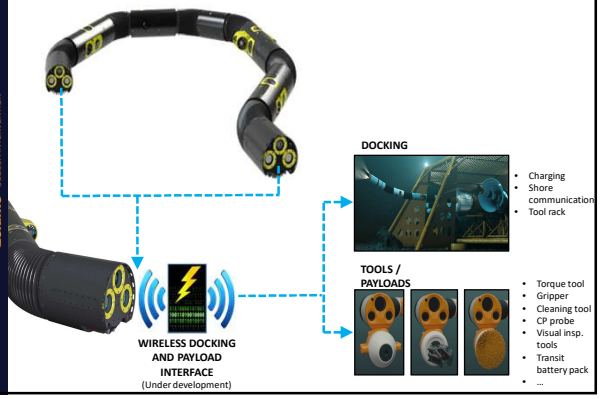


SIMULATOR

- Purpose: Test user interface, control strategies, vehicle configurations, camera views, etc.



DOCKING AND PAYLOAD INTERFACE

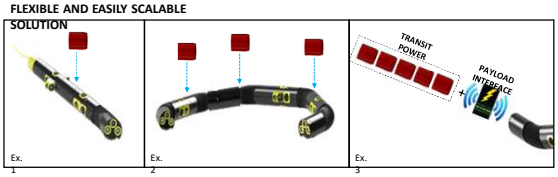


BATTERY SYSTEM

BATTERY MODULE
(Under development)

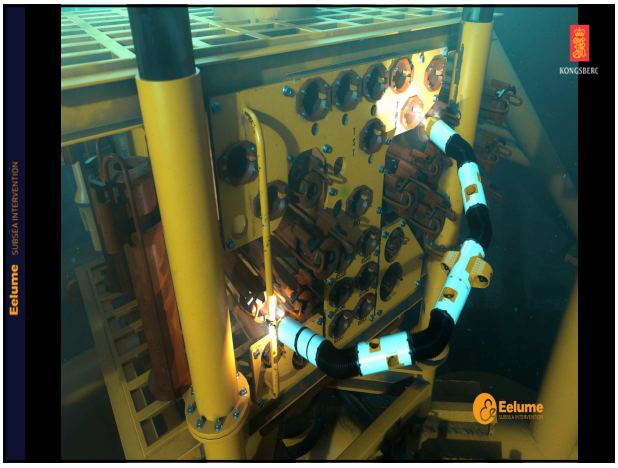
- **Diameter:** Ø200 mm
- **Length:** 200 - 300 mm
- **Max load:** 1-2 kW
- **Capacity:** 1-2 kWh
- Neutral water weight
- Stand-alone and stackable module

FLEXIBLE AND EASILY SCALABLE SOLUTION



APPLICATIONS


Eelume
SUBSEA INTERVENTION
KONGSBERG
Eelume


Eelume
SUBSEA INTERVENTION
KONGSBERG
Eelume

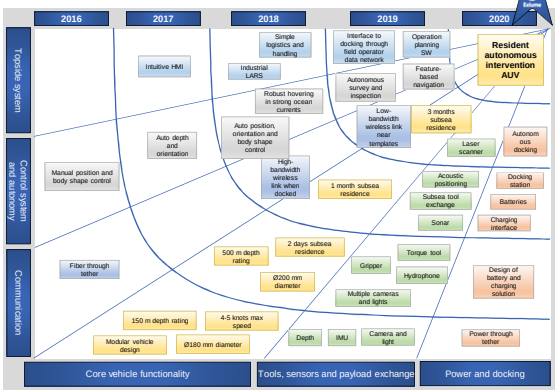

Eelume
SUBSEA INTERVENTION
KONGSBERG
Eelume

EELUME AS WROV SUPPORT TOOL

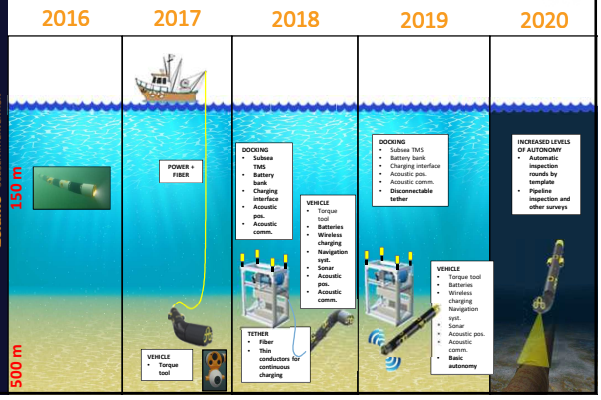
- Docked in skid of WROV
- Tethered or untethered
- Cameras
- Lights
- Tools

ROADMAP AND DEMO PLANS

TECHNOLOGY ROADMAP

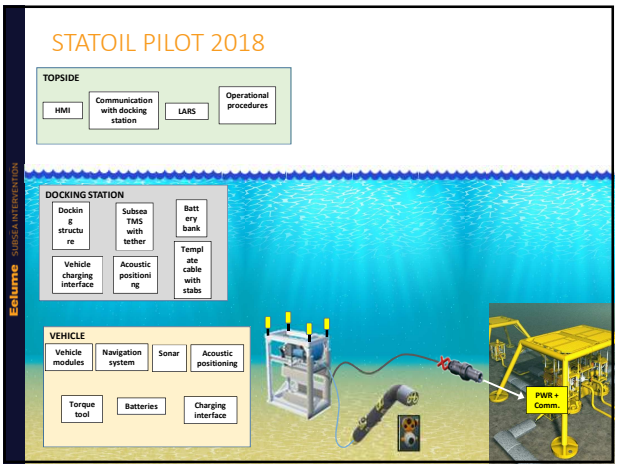


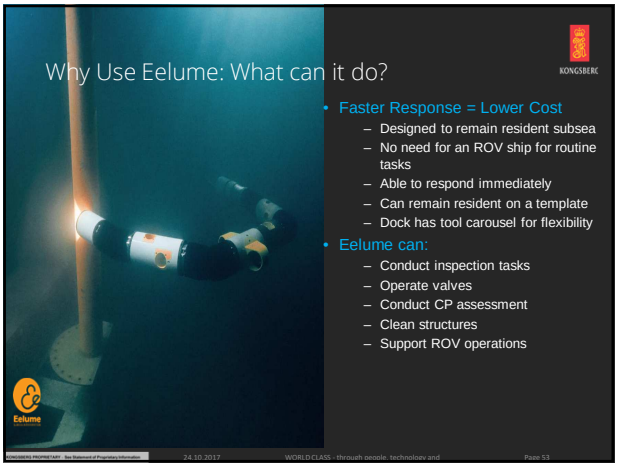
TECHNOLOGY ROADMAP



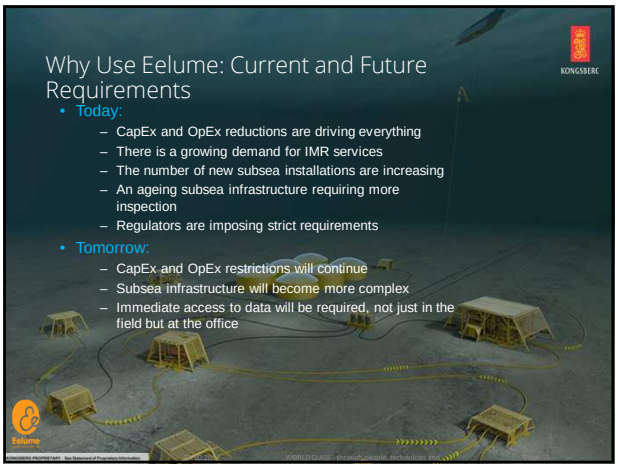
STATOIL PILOT 2018

- **Target field:** Morvin (2 templates, 4 production wells)
- **Location:** 20 km west of the Åsgard B platform
- **Depth:** 350 m
- Power and fiber available through stab connectors.


STATOIL PILOT 2018
TOPSIDE
HMI
Communication with docking station
LARS
Operational procedures
Eelume SUBSEA INTERVENTION
DOCKING STATION
Docking structure
Subsea TMS with tether
Battery bank
Vehicle charging interface
Acoustic positioning
Template cable with stabs
VEHICLE
Vehicle modules
Navigation system
Sonar
Acoustic positioning
Torque tool
Batteries
Charging interface
PWR + Comm.


Why Use Eelume: What can it do?
KONGSBERG
• Faster Response = Lower Cost
– Designed to remain resident subsea
– No need for an ROV ship for routine tasks
– Able to respond immediately
– Can remain resident on a template
– Dock has tool carousel for flexibility
• Eelume can:
– Conduct inspection tasks
– Operate valves
– Conduct CP assessment
– Clean structures
– Support ROV operations
Eelume
24.10.2017
WORLD CLASS - through people, technology and
Page 53


Why Use Eelume: Cost Benefit Analysis
• Standby Time is expensive
– Mobilization
– Transit
– Wait on Weather
– Standby
• Instant response
– Resident on template
– Conduct routine inspection
– Respond to anomalies
– Can be operated from platform, FPSO or shore
– Service it from a small inexpensive vessel of opportunity
– Being available instantly is more cost effective
Eelume
24.10.2017
WORLD CLASS - through people, technology and
Page 54


Why Use Eelume: Current and Future Requirements
• Today:
– CapEx and OpEx reductions are driving everything
– There is a growing demand for IMR services
– The number of new subsea installations are increasing
– An ageing subsea infrastructure requiring more inspection
– Regulators are imposing strict requirements
• Tomorrow:
– CapEx and OpEx restrictions will continue
– Subsea infrastructure will become more complex
– Immediate access to data will be required, not just in the field but at the office
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Thank you
www.eelume.com