

A drone is flying in the sky above an industrial facility. In the foreground, there is a large silver cylindrical tank with a 'Total TADI' logo. To its right, there are yellow metal stairs and walkways. The background shows various industrial structures, including tall chimneys and distillation columns, under a clear blue sky.

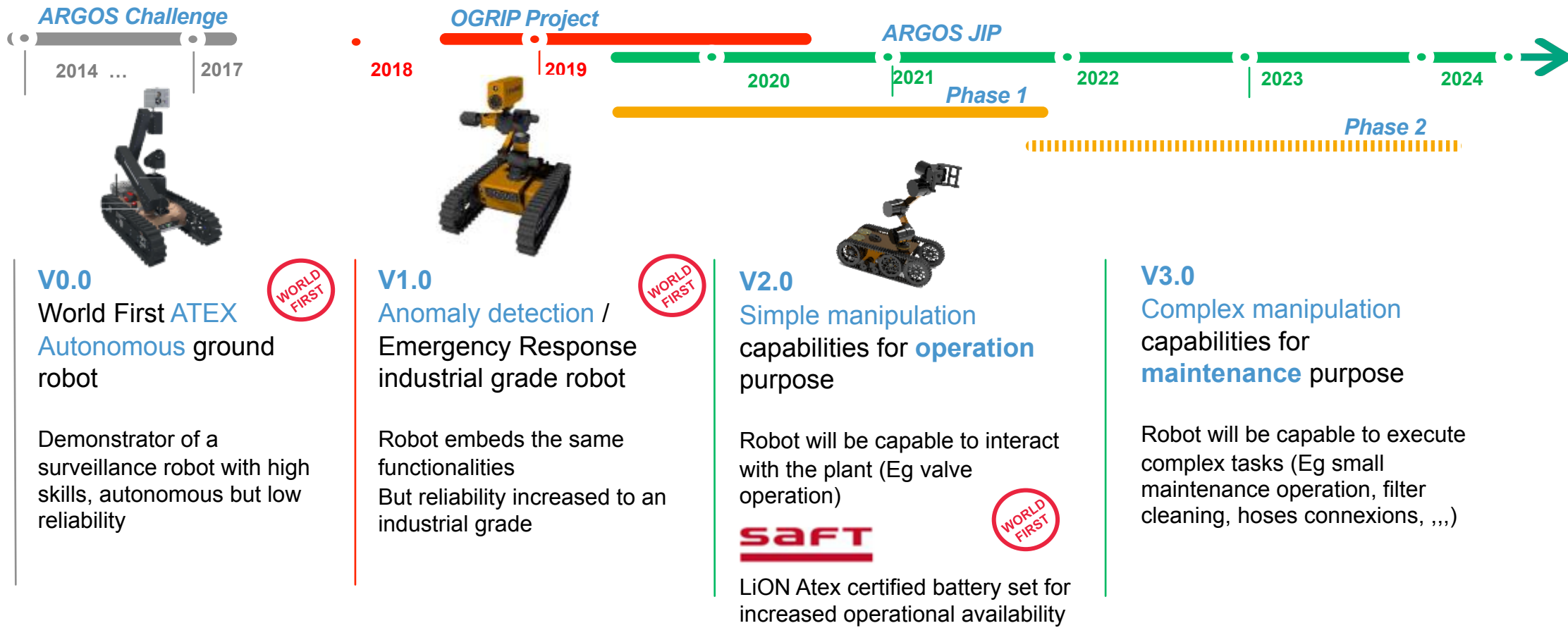
GROUND ROBOTICS ENABLER FOR THE PLANT OF THE FUTURE

Jean-Michel Munoz, Next-Generation Facilities R&D Project Manager, Total

European Forum on New Technologies, Sept 11th 2020

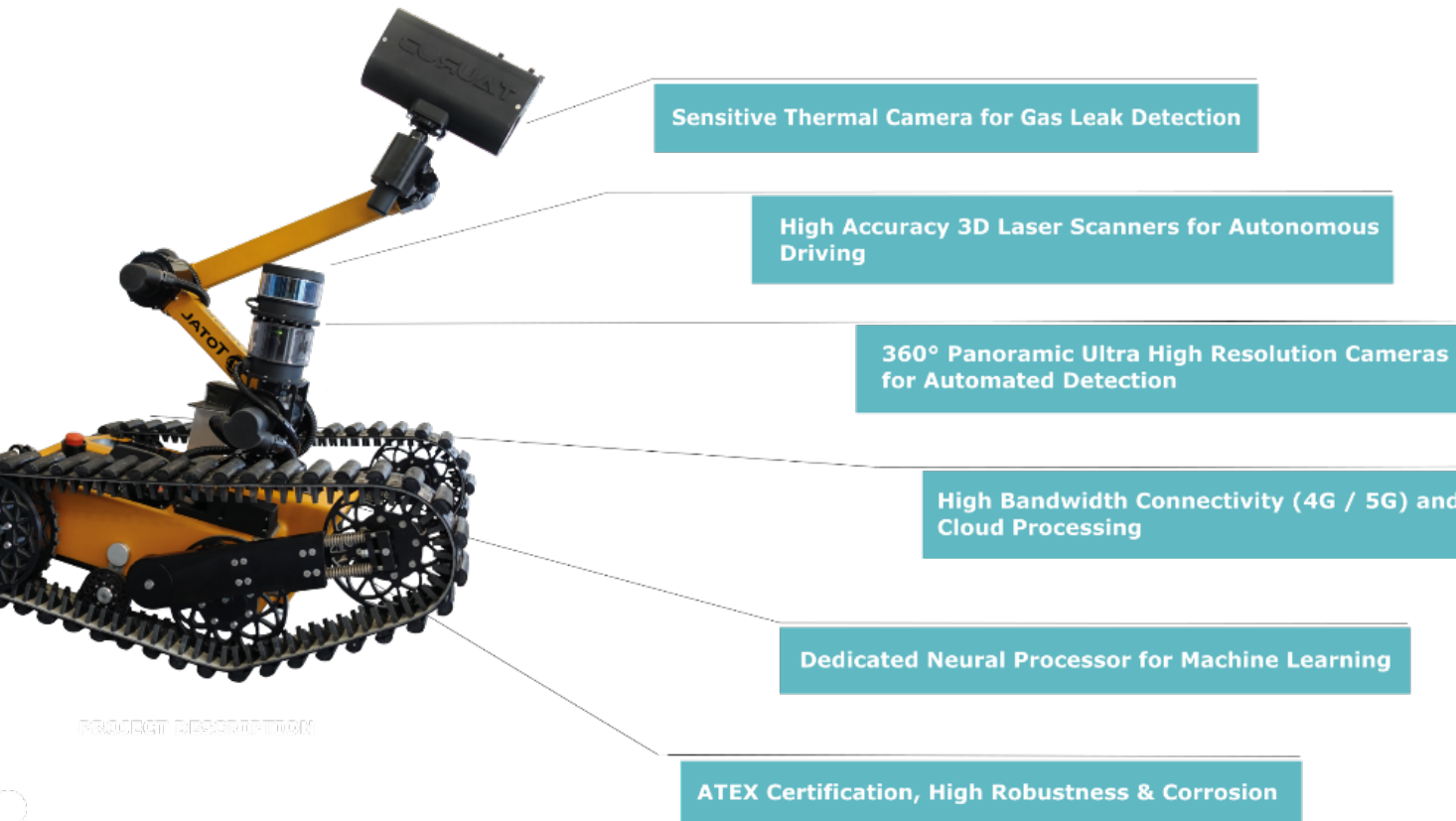
ROBOT DEVELOPMENT ROAD MAP

Autonomous - ATEX - Water Resistant - Mobile - Multipurpose - Remotely Monitored - 24/7 Service



Design & qualify autonomous ground robots able to operate remote sites

ANOMALY DETECTION ROBOT (V1.0 – OGRIP*): GENERAL ARCHITECTURE



Anomaly detection

- Audio (leaks, signature)
- Hot spots & fugitive emissions
- Gas detection
- Obstacles (+/-)

Process

- Dial gauge reading
- Valve position

Mapping - Creation of 3D m

P: Offshore Ground Robot Industrial Pilot, commercial name The Taurob Inspector

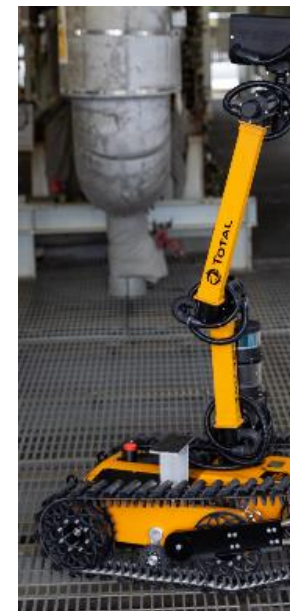
TESTS IN SHETLAND (UK): SITE DESCRIPTION

Shetland Gas Plant

- Gas treatment for Laggan Tormorre subsea fields
- Condensate extraction, gas drying (MEG), compression (3 turbo compressors, LM2500)
- Start up in 2016

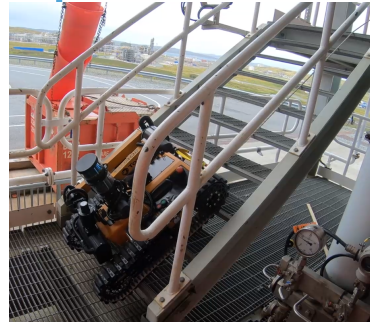
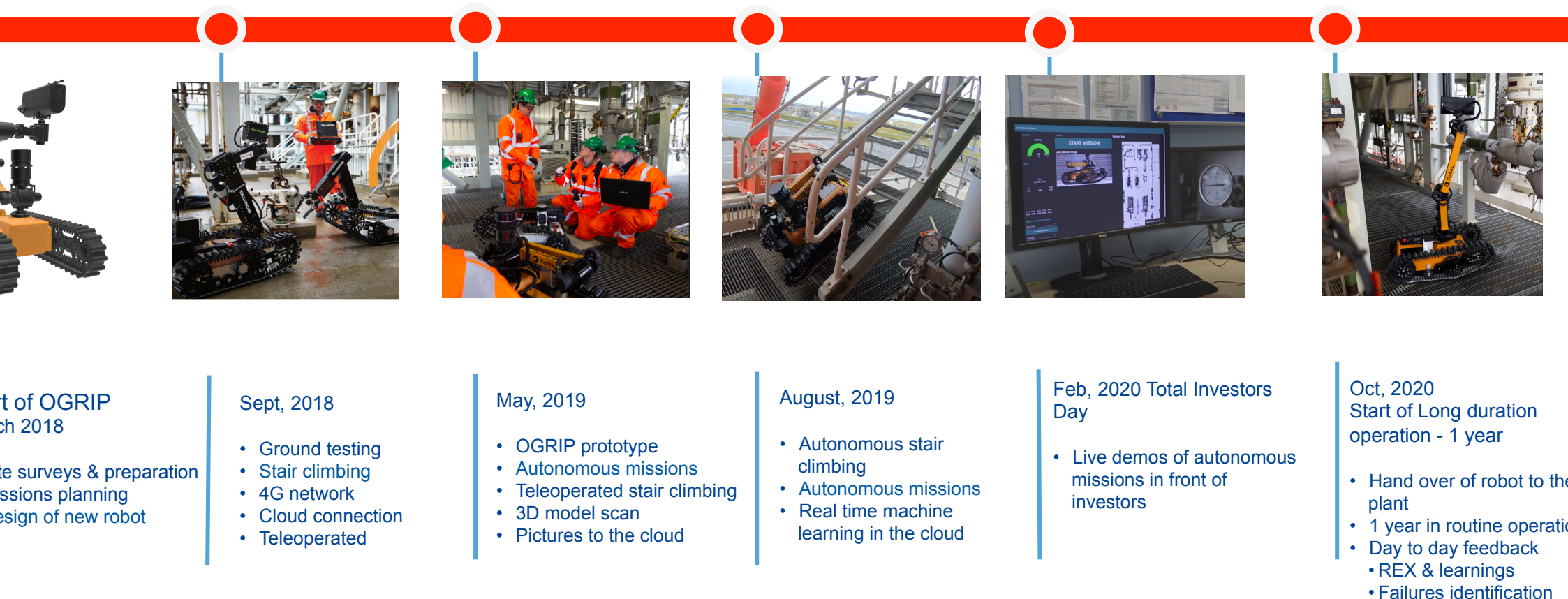
Climatic conditions

- Windy and exposed to sea water (spindriffs)
- Good candidate to simulate offshore environment



TIMELINE OF SHETLAND GAS PLANT PILOT

OGRIP project



Start of OGRIP
 March 2018

- Site surveys & preparation
- Missions planning
- Design of new robot

Sept, 2018

- Ground testing
- Stair climbing
- 4G network
- Cloud connection
- Teleoperated

May, 2019

- OGRIP prototype
- Autonomous missions
- Teleoperated stair climbing
- 3D model scan
- Pictures to the cloud

August, 2019

- Autonomous stair climbing
- Autonomous missions
- Real time machine learning in the cloud

Feb, 2020 Total Investors Day

- Live demos of autonomous missions in front of investors

Oct, 2020
 Start of Long duration operation - 1 year

- Hand over of robot to the plant
- 1 year in routine operation
- Day to day feedback
 - REX & learnings
 - Failures identification

TESTS ON K5 (OFFSHORE NETHERLANDS)

K5CC

- Gas production platforms with condensate recovery
- Located Offshore the Netherlands

Tests performed:

- Conduct autonomous missions in condensate recovery area
- Conduct a Proof Of Concept for external corrosion and painting inspection
- Evaluate use cases on the platform

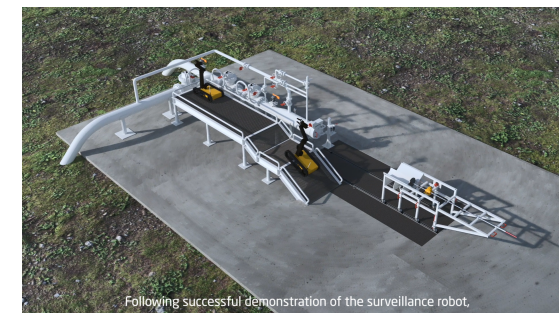


*World First
Autonomous Robot on an offshore O&G platform*

ARGOS JIP PHASE 1 - SIMPLE MANIPULATION ROBOT EXECUTING ROUTINE PRODUCTION OPERATION TASKS



- Operating valves designed as per API REC 6D (up to 150 Nm)
- Pushing any buttons (e.g. ESDV reset)
- Sampling
- Cleaning cameras, fire detectors
- Moving Objects - Placing sensors (Eg: vibration)
- Opening pig trap doors
- Depressurization of well annulus
- Chemical transfer from tote tank - Connecting Hoses
- Exchanging Spare Parts



Typical use cases for wellhead platform or wellpad in NUF mode

TESTS IN TADI (LACQ, FRANCE)

Objectives

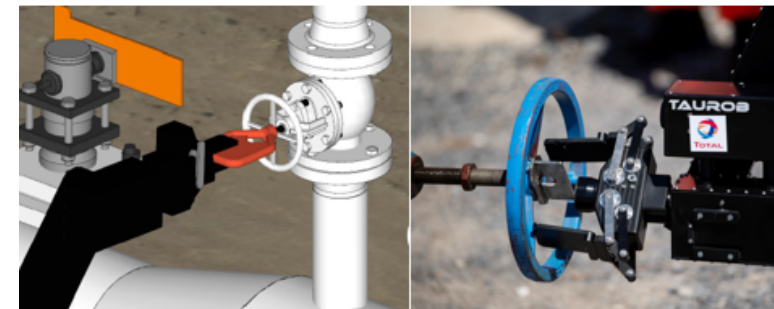
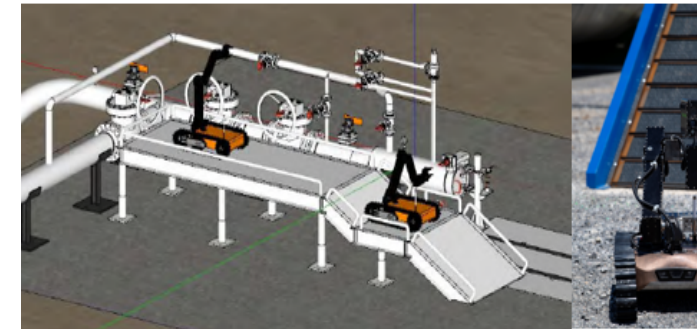
- Intensively run and test robots on a specifically created obstacle course site
- Test robot's adaptation to an EP environment (specs & new site ergonomic)
- Test integration of robotics in Total digital environment
- Test of new HMI for robot supervision by operators
- Map operating envelop – deliver robots handbook

Opportunities

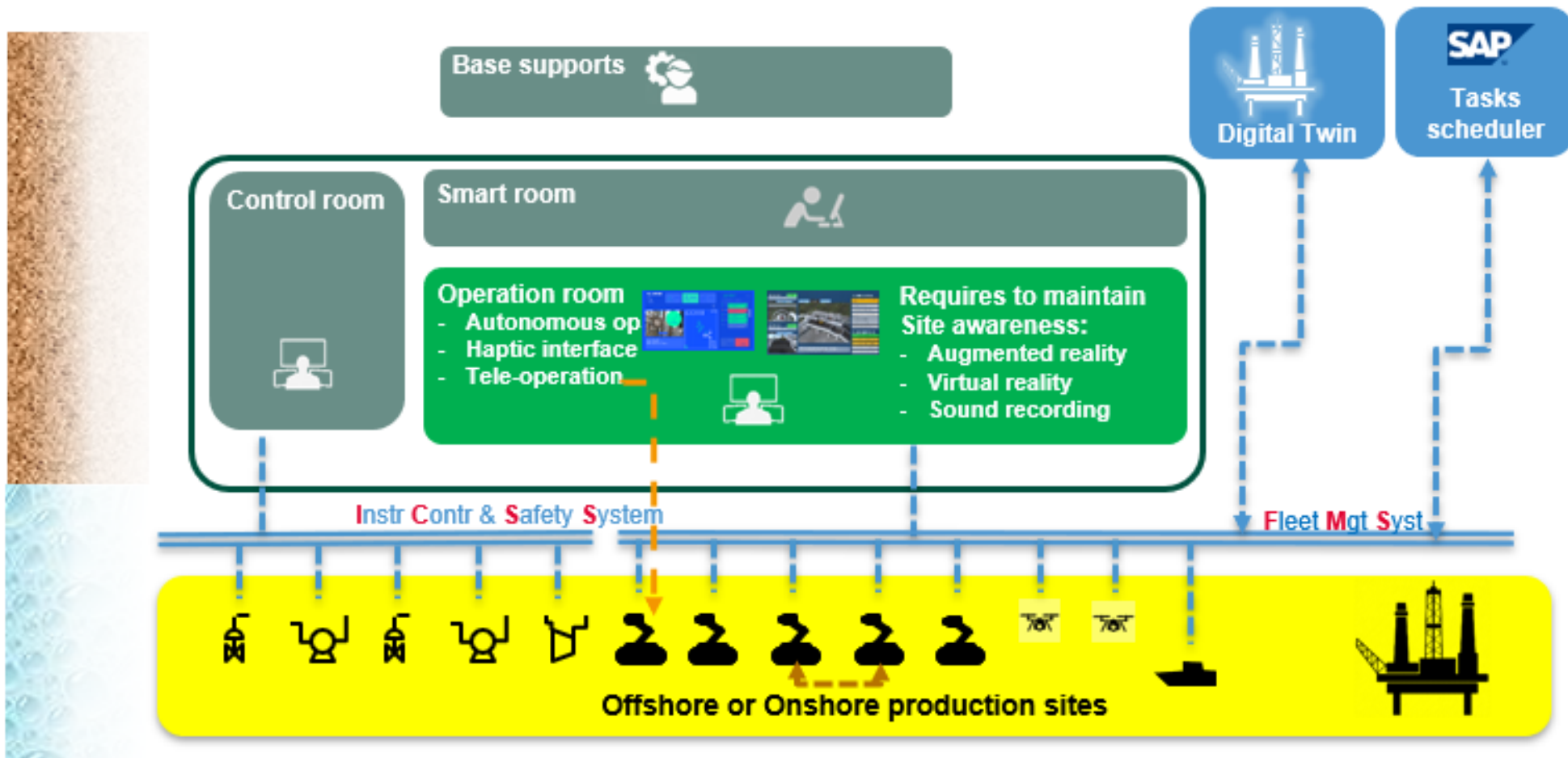
- Trials & errors
- Training
- Be a showroom

Examples of Tests

- Mobility and battery: stairs climbing optimisation, battery duration, new design for installations
- Operating envelop measurement
- Gas leak: emergency response support
- Operation reporting - reliability

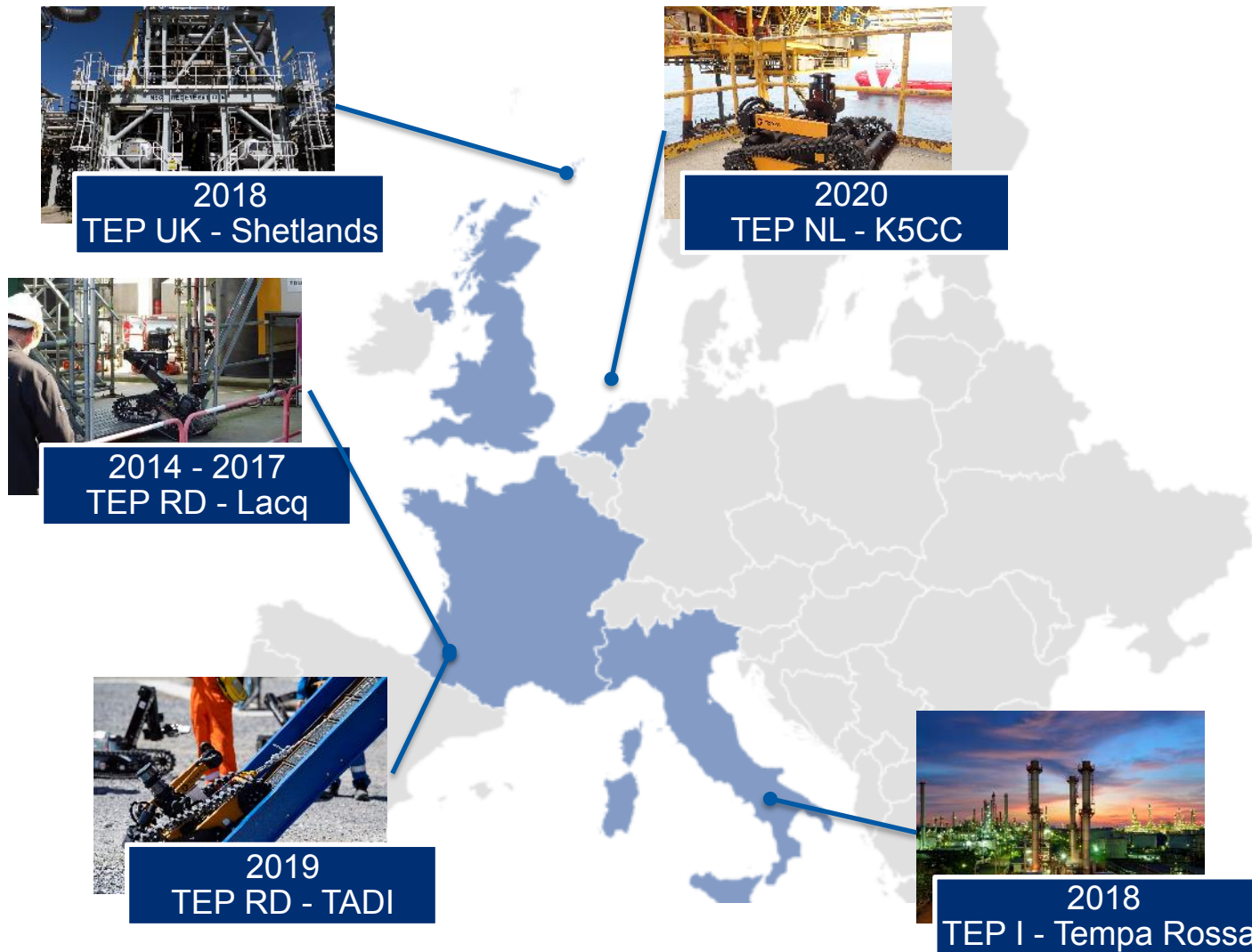


REMOTE OPERATIONS FOR NUF - FLEET MANAGEMENT



Supervision Context :
 Routine Operation / Anomaly Management / Emergency Response

LOCATION OF DEPLOYMENT OF ROBOTS FOR TESTS ON TOTAL'S FACILITIES



- **Lacq:** 2014 – ARGOS Challenge
- **Shetlands:** 2018 - OGRIP
- **Tempa Rossa:** 2018 - JIP technical preparation
- **Lacq:** 2019 - Launch of Robotics Development platform
- **Netherlands:** 2020 - First autonomous ATEX robot offshore in O&G

QUESTIONS ?



REINVENTING OPERATIONS

BACK UP: FEW PUBLICATIONS & USEFUL LINKS

ADIPEC 2019: presence, publications & presentations

- ✓ SPE-197620-MS: Ground Robotics Enabler for Normally Unattended Installations
- ✓ SPE-197513-MS: Normally Unattended Installations, the New Frontier for Cost Reduction
- ✓ Robot on Total stand with videos, live demos from Taurob lab in Vienna (our robotic partner)

ARGOS brochure: Ground Robotics For Next-Generation Facilities 2014-2019

CNBC article and video “Getting ready for robot-operated oil rigs” in June 2019

<https://www.cnbc.com/advertorial/2019/08/12/getting-ready-for-robot-operated-oil-rigs.html>

Articles & Videos on Total site “Ground Robots: Technological Building Block for the Surveillance of Oil and Gas Sites”

2019: <https://www.ep.total.com/en/innovations/research-development/ground-robots-key-future-architectures>

2017: <https://www.total.com/news/argonauts-robot-wins-argos-challenge>

Video Meet OGRIP V1.0 Oct 2019: <https://www.youtube.com/watch?v=E7svE6ITN-g>

Video TOTAL ARGOS Challenge: Winning Team, July 2017: <https://www.youtube.com/watch?v=-jPL-bSj0TY>

The Press release made by our JIP sponsor OGTC and few articles that followed the release, Oct 2019

<https://www.theogtc.com/newsroom/news/2019/industry-innovators-and-key-technology-developers-lead-the-way-with-robotics-development/>

Oilfield Technology - <https://www.offshore-technology.com/news/ogtc-offshore-robot-development/>

Rigzone - https://www.rigzone.com/news/offshore_robot_initiative_wins_pledges_from_operators-21-oct-2019-160112-article/

Offshore Magazine - <https://www.offshore-mag.com/business-briefs/article/14068984/equinor-enters-offshore-robotics-consortium>

Launch of OGRIP project, April 2018

DIGIT: Article and Video, - <https://digit.fyi/ogtc-robotics-trial/>

Partner Web site

<https://taurob.com/>

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