Robotics and Drones program at Vattenfall

Vattenfall R&D

Anders Wik

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What is a robot?

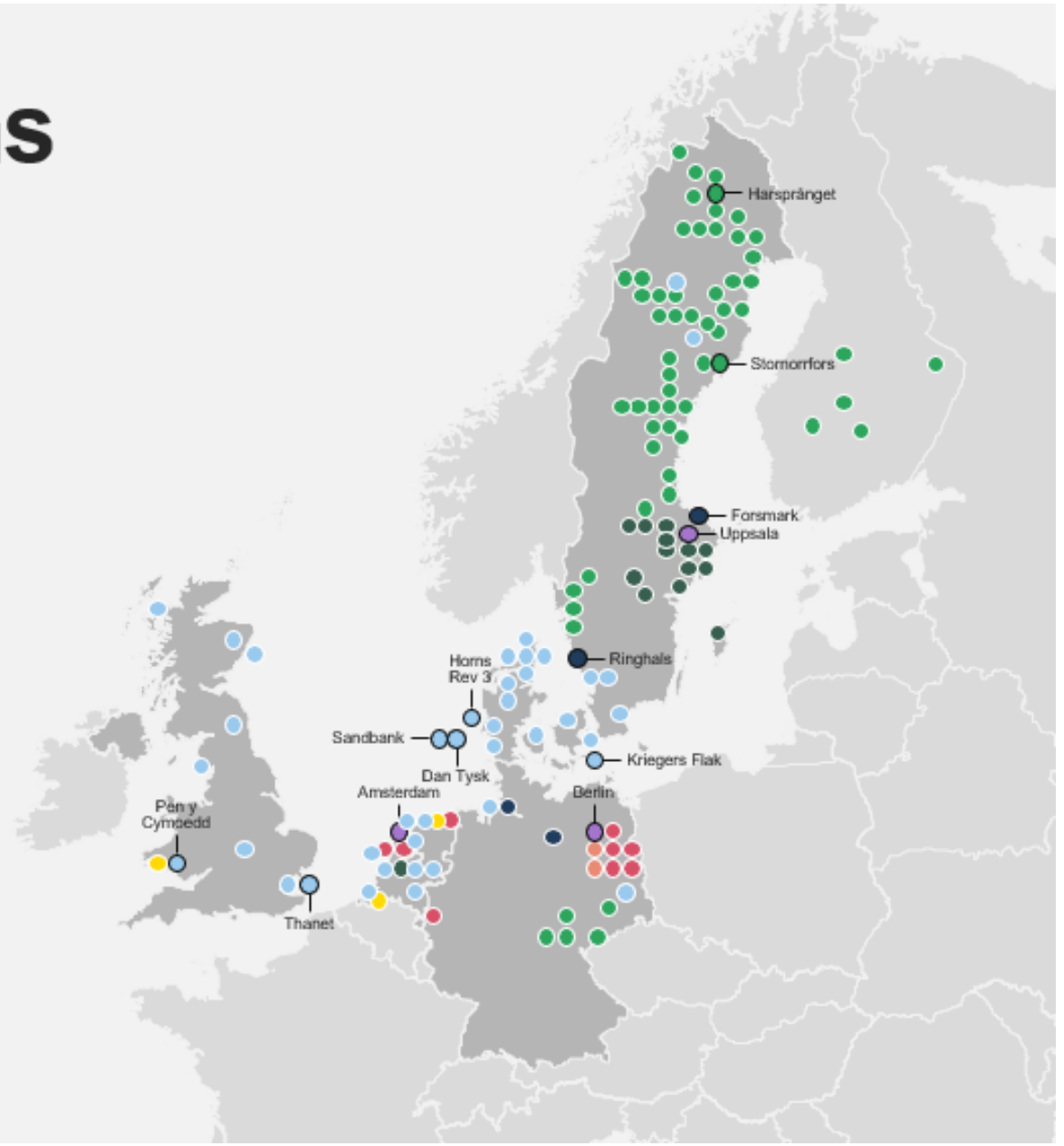
Location of our operations and major plants

Click on energy source to show locations

Wind ● Biomass ● Hydro ● Gas ●

Nuclear ● Coal ● Solar ● District heating ●

◯ Largest facilities marked with a circle



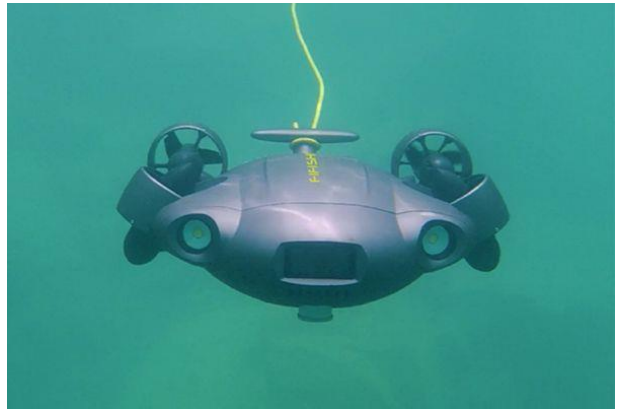
Following equipment is used (examples)

Vehicles

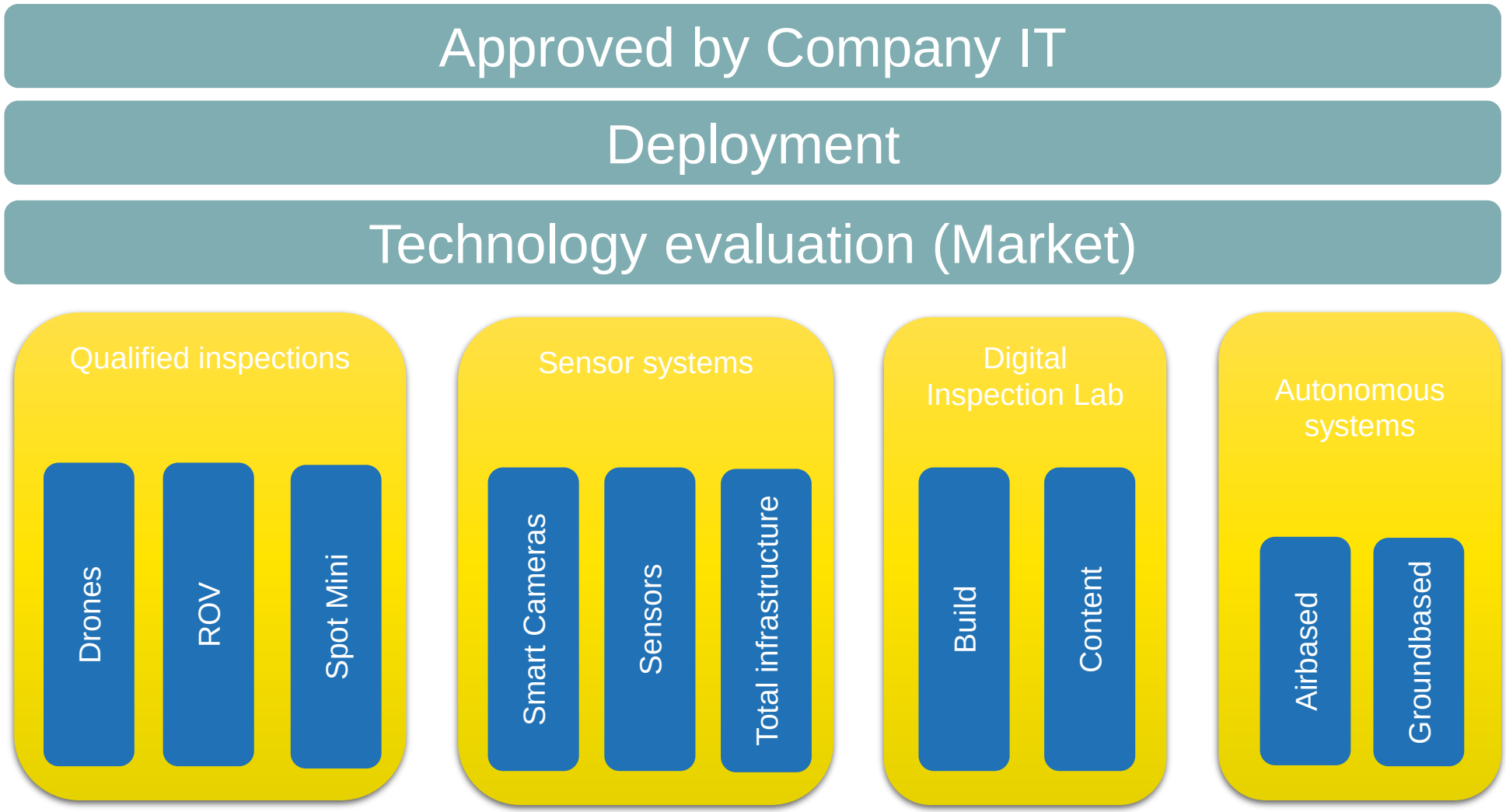
- Drones >200 drones in operation
- ROV´s (”submarines”) 5 ROV in operation
- Spot Mini (”Robot Dog”) 1 in early test phase

Payloads

- Sonars
- Optical and thermal cameras
- Stero camera with slam
- Radiation meters

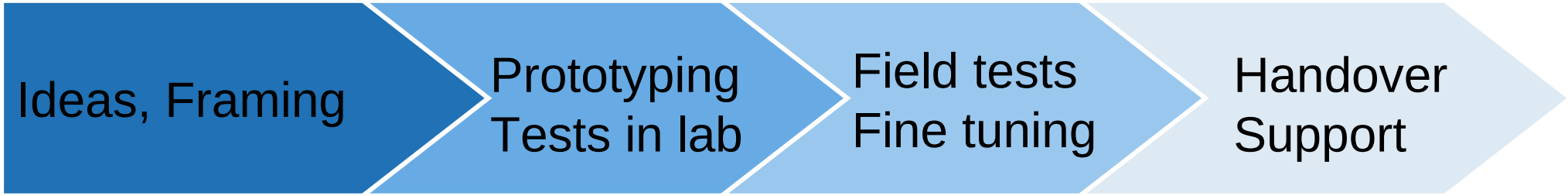


R&D Strategy Digital Inspections



Workflow R&D towards deployment

- Ideas are framed and goes through a screening process for Go/No Go
- Protypes are produced and tested in lab environment
- Field tests are conducted to see robustness and user friendliness
- Finally product/service is handed over to BA/BU for deployment. Support function remains for a certain time period by R&D



The colours indicate the involvement of R&D. The darker, the more involvement from R&D personnel and laboratory resources.

Training of site security personnel at NPP 2021

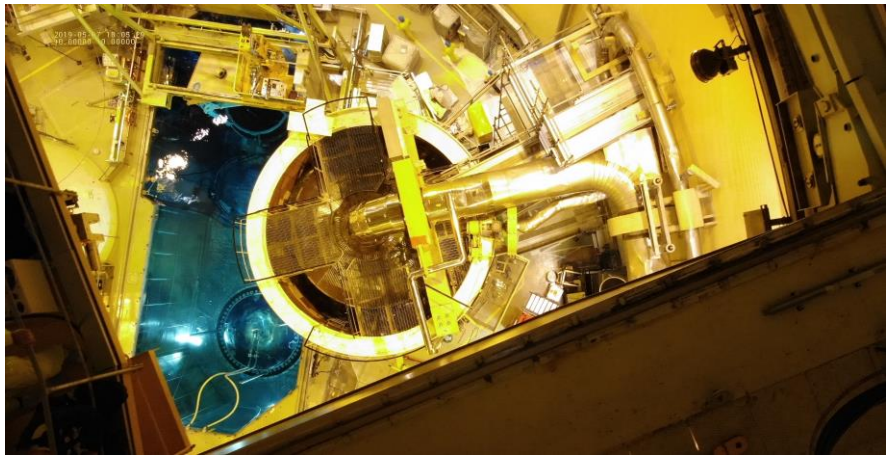
Work tasks:

- Perimeter surveillance
- Crowd monitoring
- Monitoring of sensitive assets
- Etc.

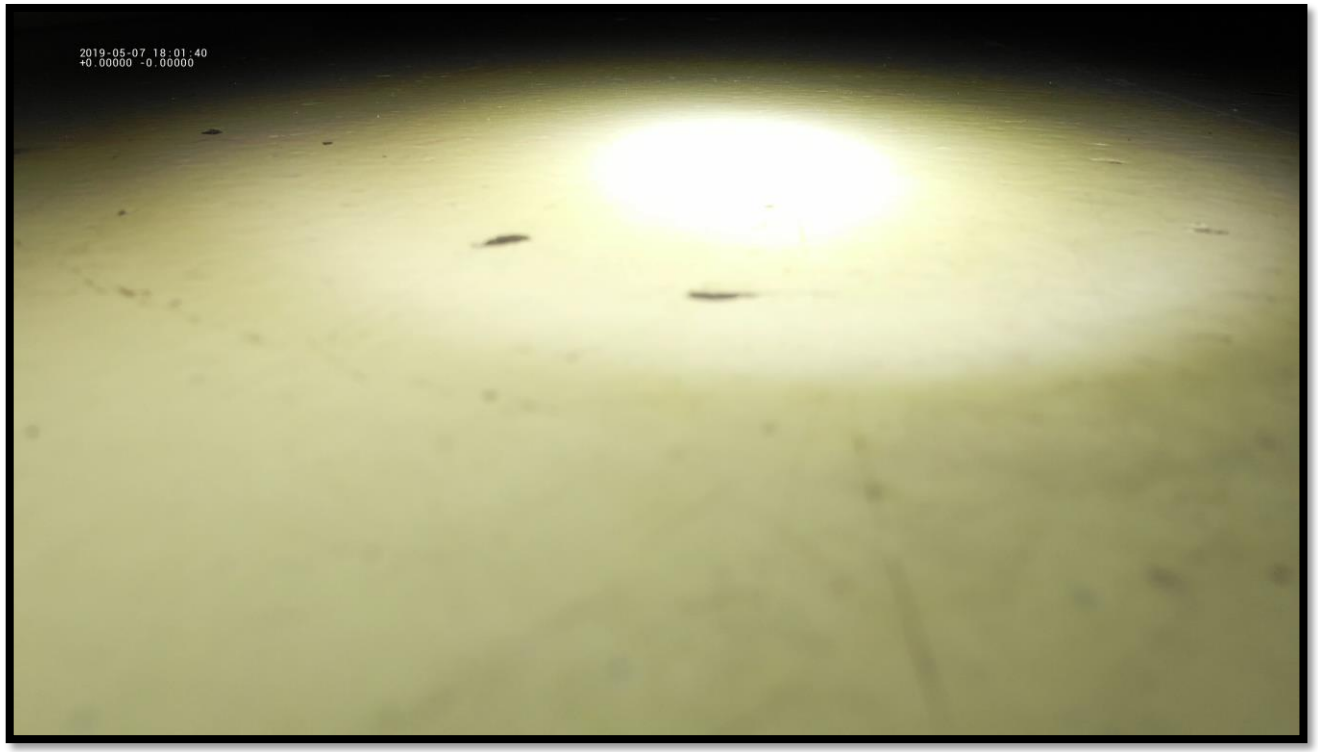
Training:

- Handling of equipment
- Risk reduction
- Practical flight training

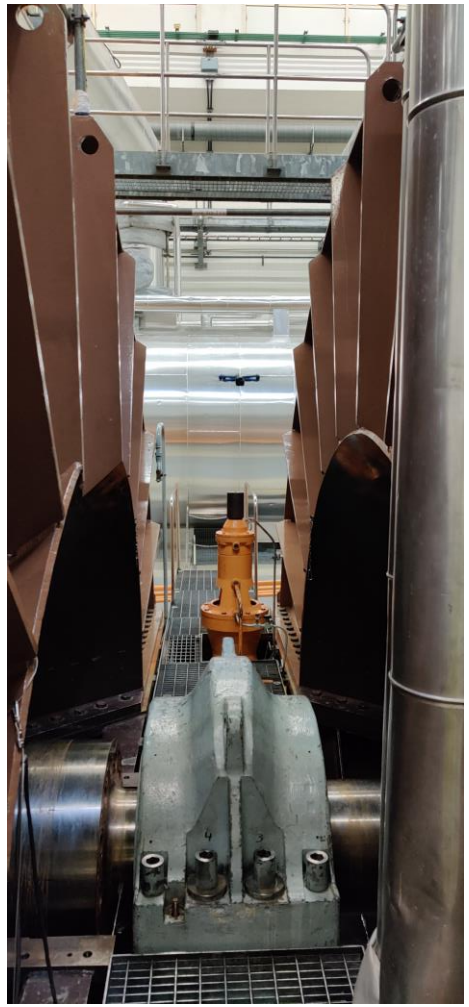
Dome liner inspection



- Inspections traditionally done with personnel on polar crane using a a camera on a ”selfie stick”.
- With drones you shorten the time, you avoid work hazards and can do it ”on-the-fly” with experts looking at video.



Drone inspection in BWR NPP 2021



- Drones makes inspections and monitoring possible at full load within the turbine island in BWR – Minimize dose and may also give the possibility to continue operate at full power

- In near future…
  - …Scheduled rounds possible in high radiation zones
  - …Radiation maps done with drone system

Customized vehicles #1
Birdflapper

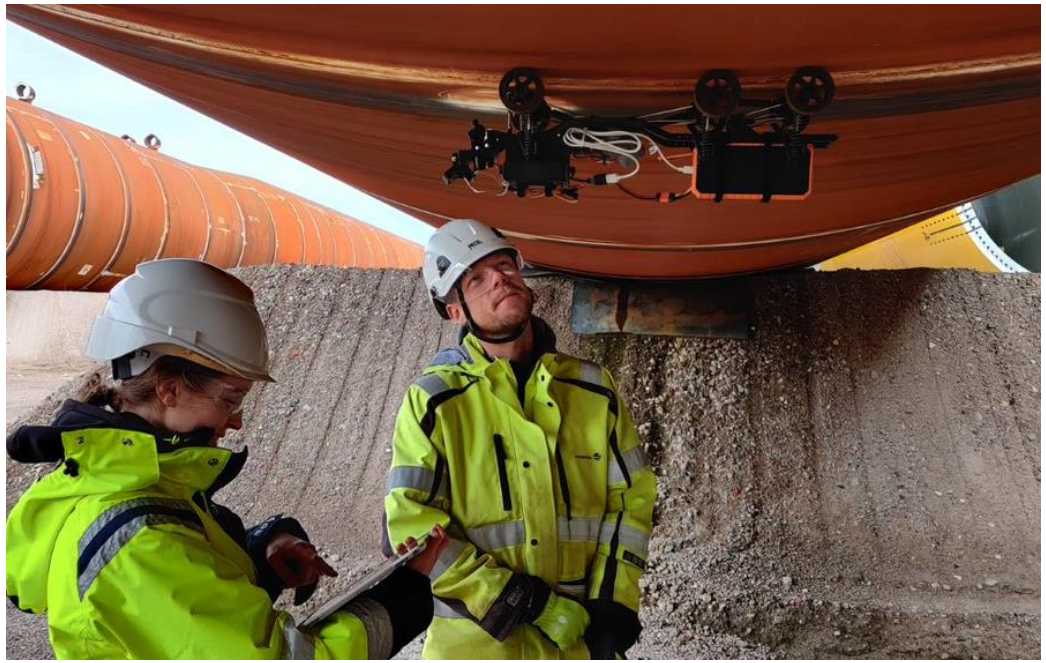
- Device for putting up ”scare crows”
- Commercial drone
- 3D-printed parts
- In house programming
- Tests in lab 2021
- Deployed 2022

[Birdflapper - Vattenfall RnD DigIn in cooperation with Vattenfall Service. – YouTube]

Customized vehicles #2

- Mini Sonar Boat
- RC car Welding Scanner

- Mini sonar boat for scanning shallow water in hydro power applications.
- The welding scanner is used for QA of windpower monopiles.
- The programming is done in-house for both vehicles.



Digital inspections value chain

Low focus	Intermediate focus	High focus	High focus
The Vehicle	**Instrumentation**	**Data collection & preparation**	**Evaluation**
• Drone • Boat • Submarine • Airplane • Robot • Fixed instruments	• Camera • IR • Lidar • Laser scanners • Other payloads	• Security • Quality • Storage • Image analysis • AI analysis • 3D-models	• Real-time evaluation • Expert evaluations • 3rd party • Asset health checks

Autonomous inspections

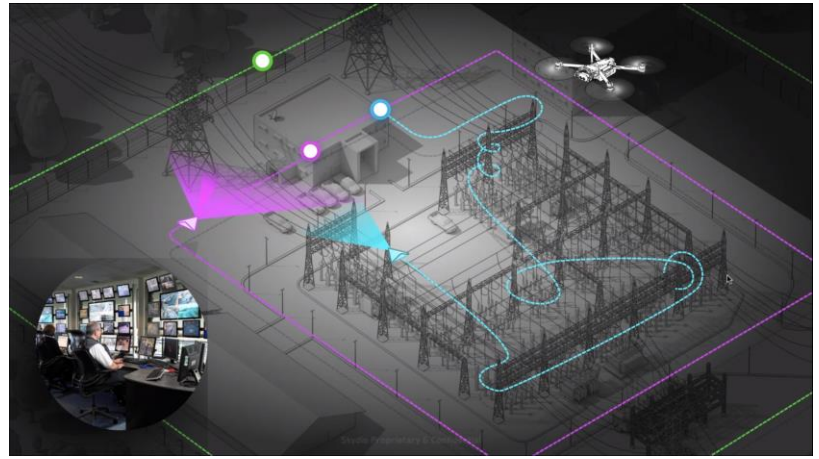
Numerous use cases within all of our generation assets

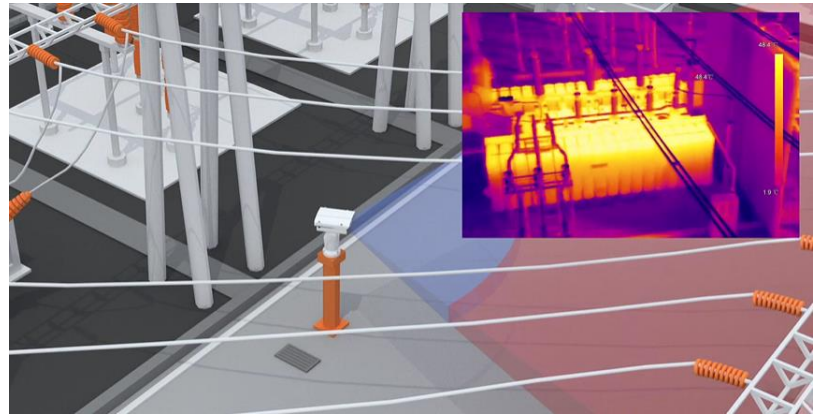
Aerial (”Drone in a box”) and Ground based (Spot Mini)

- Rounding
- Scanning
- Security (perimeter inspections)
- Many other use cases for hydropower, distribution etc

Robotics and AI, future work

- Image recognition, simple
- Image recognition, advanced
- Spot Mini (”Robot Dog”) in early test phase



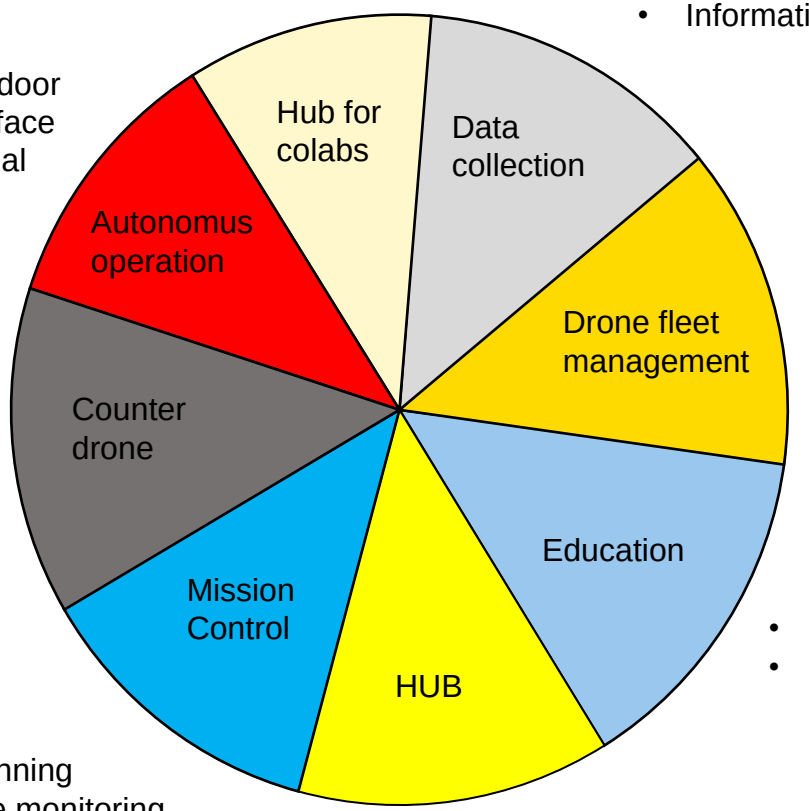


What is needed for success?

- NOA
- Police

- Processing capacity
- Information safety

- Outdoor
- Surface
- Aerial



- FW
- Maintenance
- Operating hours for pilots/drones

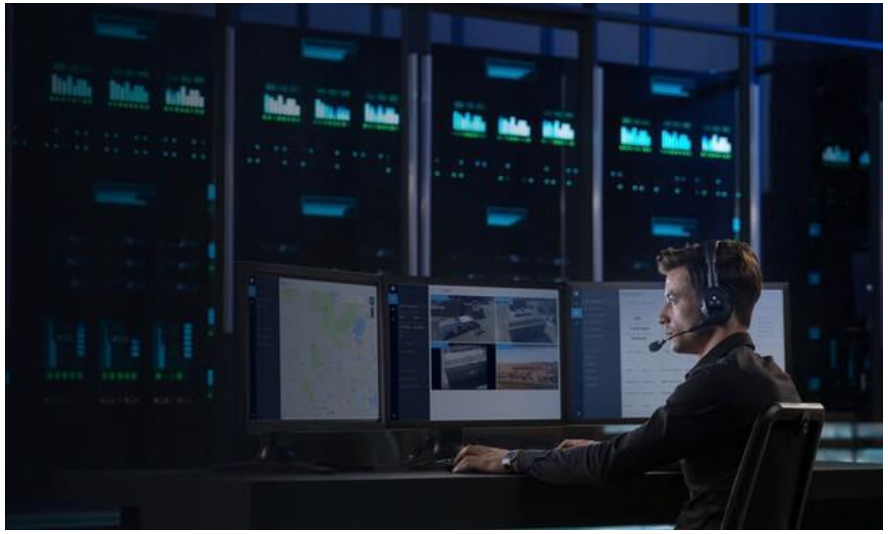
- Test installations

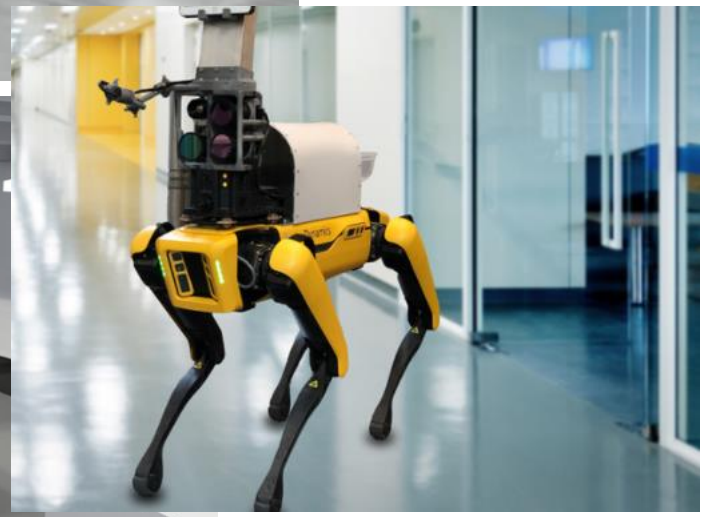
- Regulatory
- Operating (Simulator/Live)

- Planning
- Live monitoring

- Connection point for different systems/technologies for inspection

DIL Digital Inspection Laboratory (Operable Q3 2022)





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Lessons learned so far with Drones and Robots

Challenges

- Information security
- Organisational challenges
- Wide variety of services or solutions out on the market – Chose carefully!
- Chinese drones/technology – Who to trust!

Success factors

- A team with high competence when it comes to technology but also a network within the company.
- We have been given the opportunity to do real live tests!
- A good business case for our use cases (more safe, more efficient and with higher quality)

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Thank You for Your Attention

Deployment Strategy, from R&D to Business Units operations