Project Sense

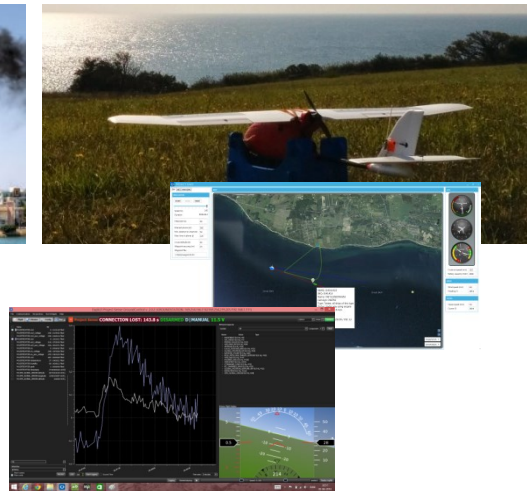
Environmental monitoring of ship emissions using drone technology

Danish Maritime Authority, October 2014

Explicit I/S
Argentinavej 12
DK-2800 Kgs. Lyngby
Denmark
+45 28 14 80 50
www.explicit.dk

© 2014 Explicit I/S

Introducing Project Sense



- **Objective:** To monitor sulphur emission compliance at sea
- **How:** Using self-guiding, low-cost drones equipped with 'sniffer' sensors to intelligently **seek out**, **detect** and **document** ships that don't comply with emission regulations.
- **Key features of the technology:**
  - 'Smart flight' based on ship position data (AIS), plume spread and weather data.
  - On spot sampling and analysis: **CO_2, SO_2, NO_2** and **NO**
  - Cloud-based data acquisition platform
  - Easy to use cloud-based reporting platform

Like this! ... but for ships

© 2014 Explicit I/S

The challenge...

International shipping is a major contributor to global air pollution !

- **+70,000** premature deaths p.a.
- **$130-160 billion** in health costs p.a.
- **7-12%** of total health costs p.a.
- ... just in Europe and the US

... and the actions expected

- **MARPOL Annex VI:**
  - International UN Convention for the Prevention of Pollution From Ships
  - **Global limits** on **SO_x**, **NO_x** and **particle** emissions from ship exhausts, etc.
  - Defines **Emission Control Areas** (ECAs) with stricter controls on emissions.
  - Commits Member States to take action to enforce limits.

If only we had the technologies to enforce the regulatory actions !

© 2014 Explicit I/S

Sources: Centre for Energy, Environment and Health (Denmark), US Environmental Protection Agency, International Maritime Organization – UN special agency

The challenge of enforcement

Result: Less than 1:500 ships are inspected!

Key problem: Ships are difficult to access during cruise (when they pollute), so most technologies today focus on land-based enforcement:

Fuel delivery notes (in port):

- Cheap, already in place
- 'Self-reported' fuel consumption, low credibility

Fuel samples (in port):

- Accurate, legal document from certified lab
- 'Post-violation', causes delays, also burdens 'good' ships, only captures port traffic and not transit

Land-based fixed installations

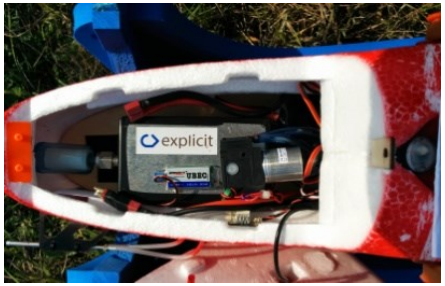
- High sample volume, limited manpower, sampling during cruise.
- Costly to install, can be circumvented, limited range, difficult to scale

'Sniffer' airplanes/helicopters

- Range. High sample volume
- Costly to equip and deploy, requires licensing/clearance of both aircraft and pilot, difficult to scale

© 2014 Explicit I/S

Project Sense



- On spot sensing
- **Cheap**
- Quick to equip and deploy
- Potentially high volume of samples
- Slow flight = multiple data points
- Mobility and scalability
- Limited licensing required

- Battery endurance
- Range from coast (VLOS)

Key specs:

- **Cruise speed**: 25 - 45 km/h
- **Max. speed:** 90 km/h
- **Take-off weight**: 2.7 -3.1 kg
- **Flight time**: Up to 2 hours
- **Operational range:** Up to 25 km

Patent Pending

- EPO patent pending on method of smart flight and sampling.
- PCT in early 2015

© 2014 Explicit I/S

Why Project Sense is different

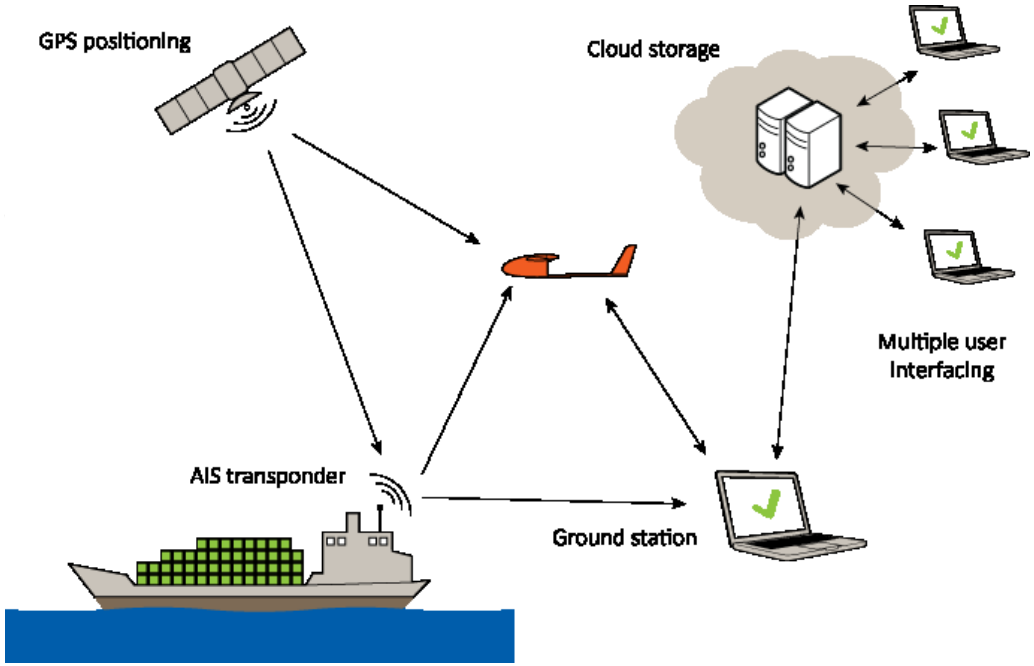
1. Accuracy and sensitivity are unnecessary
2. Sampling does not need precise distance
3. Low-cost components can do the job

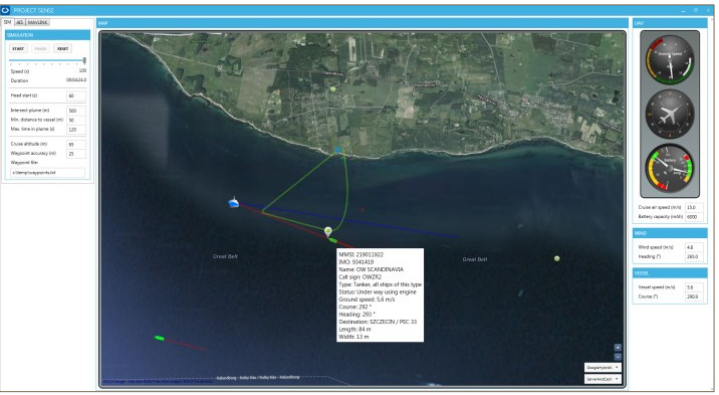
Cost-efficient, reliable and highly scalable method for detecting non-compliance

© 2014 Explicit I/S

Principle of flight

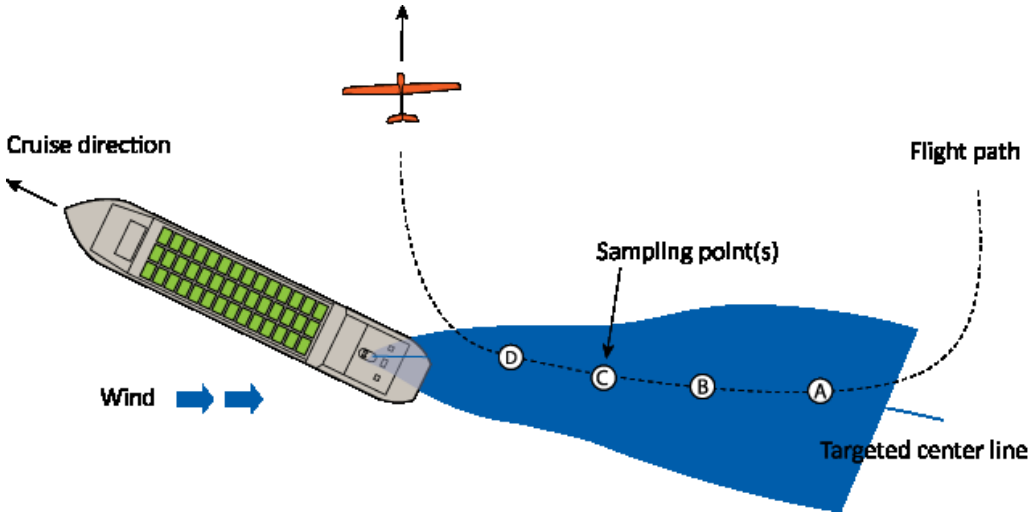
- **'Smart flight':**
  - **AIS:** Position, course, speed
  - **Drone:** Position, course, speed,
  - **Wind:** Speed, direction
  - **Plume:** Spread model





© 2014 Explicit I/S

Principle of sampling



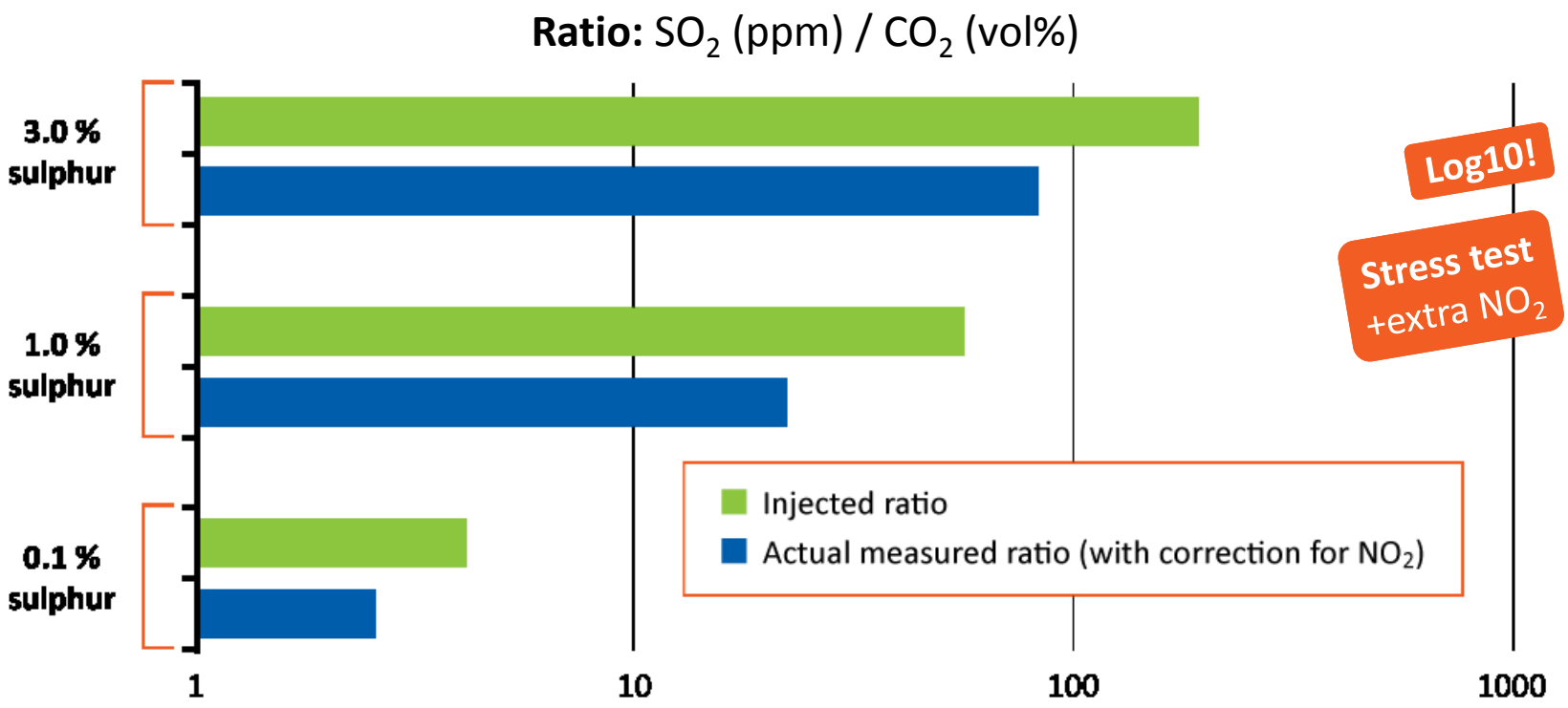
Test flight: CO_2 reading

Test flight: SO_2 and NO_2

- **Sampling:**
  - Ratio between SO_2 and CO_2, (correction for NO_2)
  - Tracking the centre line of the plume
  - Continuous sampling (+100 samples per ship)
  - ‘Steady state’ technology in sampling

© 2014 Explicit I/S

Sensor performance (or why accuracy is overrated)



Source: Testing performed and verified together with FORCE Technology A/S. All measured SO_2 concentrations were corrected for cross interference from NO_2

© 2014 Explicit I/S

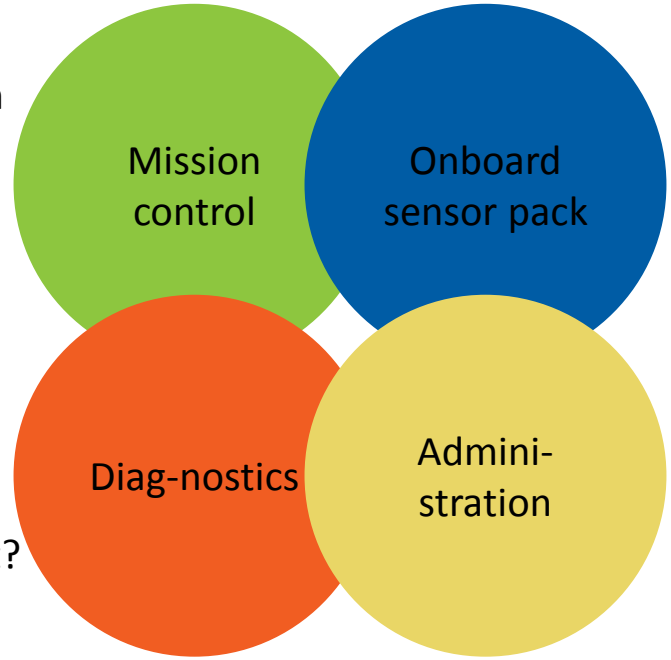
Software: Four modules working together

Smart Flight

- Way-point mission system
- Calculates and controls flight path
- Monitors battery to secure safe return

Diagnostics

- Sample analysis
- Result: Above/below limit?



Sampling

- Collects data during flight
- Relays and logs data onboard.

Administration & reporting

- Cloud-based administration and reporting module
- Keeps track of all missions and sample logs
- Manages flight planning

© 2014 Explicit I/S

Where can drones make a real difference?

Example: Denmark – Gateway to the Baltic Sea

- Small country, but a hotspot for maritime traffic:
  - The Sound
  - The Great Belt
  - The Kiel Canal / Femer Belt

  = 24,000 transits p.a.

- Annual health costs related to shipping:
  - **$750 million = 15 % of total air pollution costs**

Result: 1:50 ships in transit are inspected!

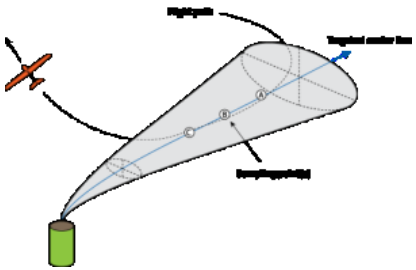
Operational 'base case': One pilot team, 500 inspections annually

50 flight days — 10 inspections per day — one pilot team (2 persons) — all three routes

© 2014 Explicit I/S

Sources: Centre for Energy, Environment and Health (Denmark), Danish Ports, Danish Maritime Authority, Danish EPA.

Business plan



The offer

- Full service contract
- Simple fee structure
  - Fixed fee per inspection day
  - Software maintenance fee
- Min. 4-500 inspections per client

The operational setup

- Partnership model
- Explicit:
  - Drone fleet + maintenance
  - Software platform
  - Key account handling
- Operating partners:
  - All piloting
  - Regulatory licensing (if any)

The roll-out

- Target clients:
  - Primary: EU authorities
  - Secondary: US/Canada
- Marketing:
  - Network participation and support
  - Demos: 15 free flights on site
  - PR: Promoting the "good story of drones", sharing insight

5,000 ships constantly in North European ECA
= 1.8m targets p.a

0.2 - 0.5 % = 3,500 - 9,000 inspections p.a. !

© 2014 Explicit I/S

License to operate: The main issue at hand

- **Complying with aviation code:**
  - Regulations do not consider autonomous flight!
  - **Limits range, but does not block operation**
  - VLOS restrictions many jurisdictions, but manageable
  - BLOS possible with extended licensing/dispensation
  - Reforms underway everywhere... but they may take time.
- **Mitigating factors:**
  - Flight over water (perceived low risk)
  - Light-weight, foam materials with propeller at the back
  - Built-in safety mechanisms (fail-safe, geo fence, horn, auto landing, etc.)
  - Defined inspection zones (air space)
  - **Authority collaboration to define operational parameters:**
    - Maritime Authority, Navy Admiralty, EPA, Transport Authority

"Drone speak"

- **RPAS:** Remotely Piloted Aircraft Systems.
- **VLOS:** Visual line of sight
- **EVLOS:** Extended visual line of sight
- **BLOS:** Beyond line of sight

© 2014 Explicit I/S

Status as of October 2014

- Pending European Patent → PCT in early 2015
- Presentations in various EU Member State forums:
  - CompMon – EU Sulphur Compliance Network
- Invitations to fly demos in:
  - Denmark, Belgium, Netherlands, Sweden, Finland
- Preliminary talks with possible operators
- Awards:
  - Finalist Ocean Exchange (Savannah, Georgia)
- Grants:
  - MUDP I (Danish Government) - $180,000
  - MUDP II (Danish Government) – $100,000
  - Horizon2020 (EU) - $68,000 – pending

Talk of the town!

Drones as new weapon against emission violators

Drone Tech for ECA Compliance Under Development

Denmark invests in ship pollution drones

Drones could be the way to catch 'dirty' ship operators in low-emission zones

Ship Operators Propose Drones to Hunt Sulfur Scofflaws

Drones will supervise pollution from ships

DANISH SNIFFER DRONES TO DETECT SULPHUR VIOLATIONS

© 2014 Explicit I/S

Sources: Bloomberg, Shipping Watch, Sustainable Shipping, Ship & Bunker, InterFerry, Baird Maritime, Maritime Denmark, DR

Thank you!

Jon Knudsen, CEO

- Phone: +45 28 14 80 50
- Email: jon@explicit.dk

www.explicit.dk

© 2014 Explicit I/S