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Joining Humans and Robots at the hip, transitioning from command and control to teaming and trust

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The 5 Year Vision

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1. Can you survey the 1 sq. km area immediately outside the harbour?

2. Deck checks complete, on my way. ETA 2 hours.

3. I see the ATR has picked up a contact. Send me a snippet for verification

4. ATR Snippet sent. Reminder: can you get maintenance to check to my rudder?

Human-Machine Teaming

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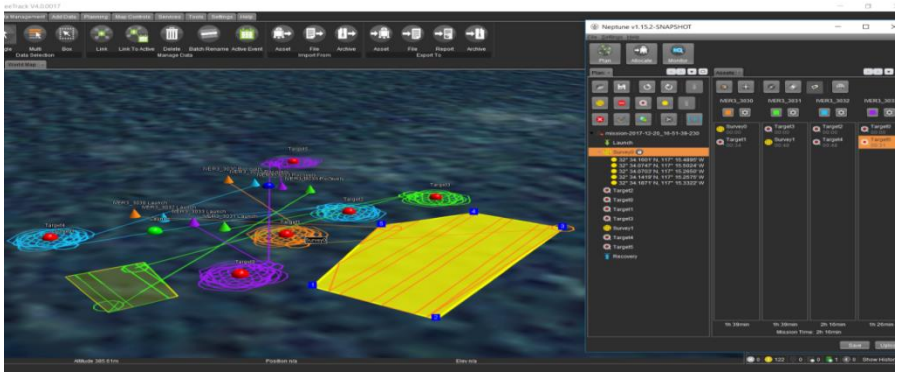
Problems to Overcome



Mental Model : The user's belief on what a system can do will strongly impact whether they use it, trust it and determine how they use it

Trustworthy Robotics:

- **Communications:** What is the system doing?
- **Transparency:** How does it work and why is it doing it?
- **Involvement:** The user must feel in control

Dependability and Predictability are key for trust

Transitioning to effective HMI

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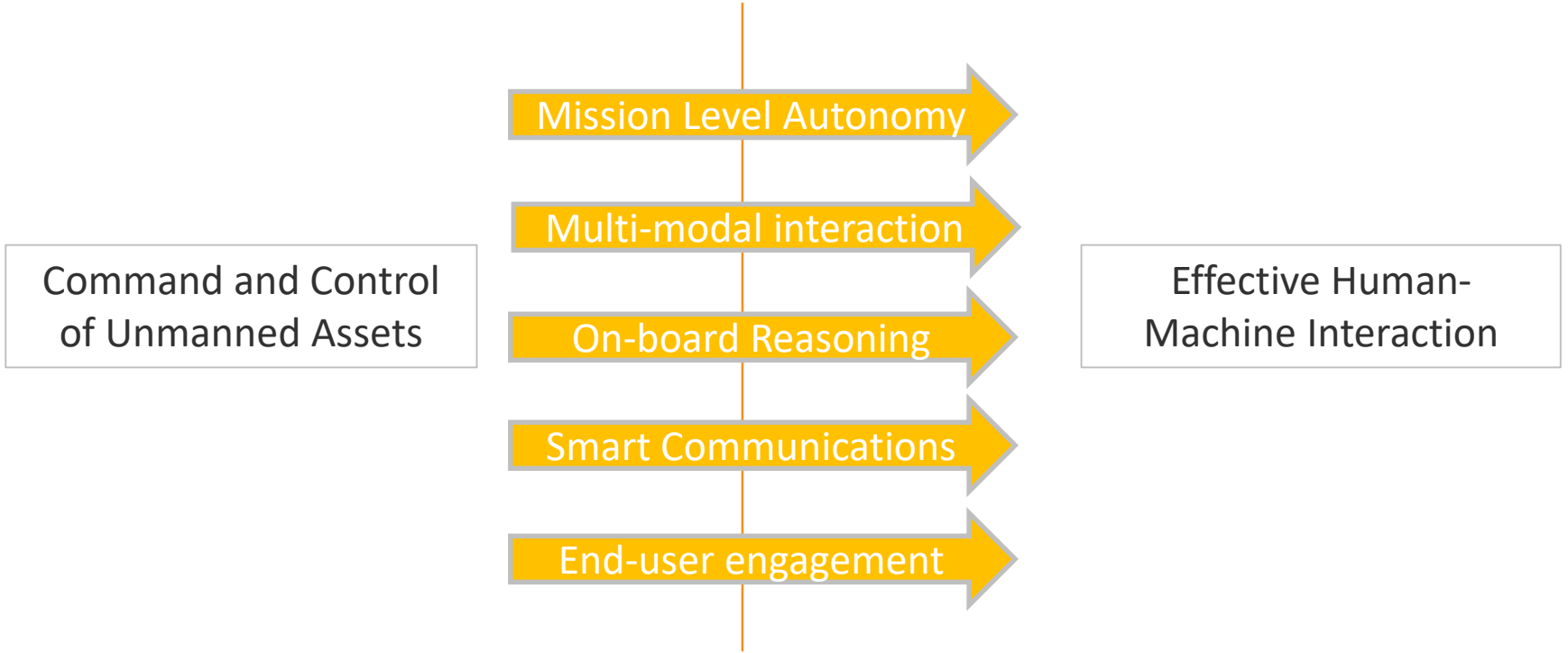

SeeByte Mission Level Autonomy

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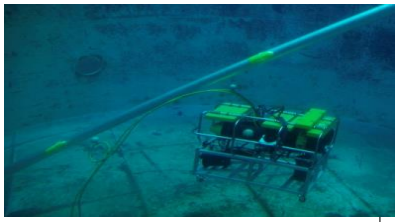

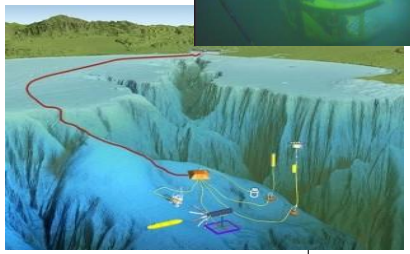

2003

2009

2014

2016

now

Level 1: Navigate

Level 2: Adaptive

Level 3: Distributed

Level 4: Multidomain

Level 5: Variable

Why use different modalities?

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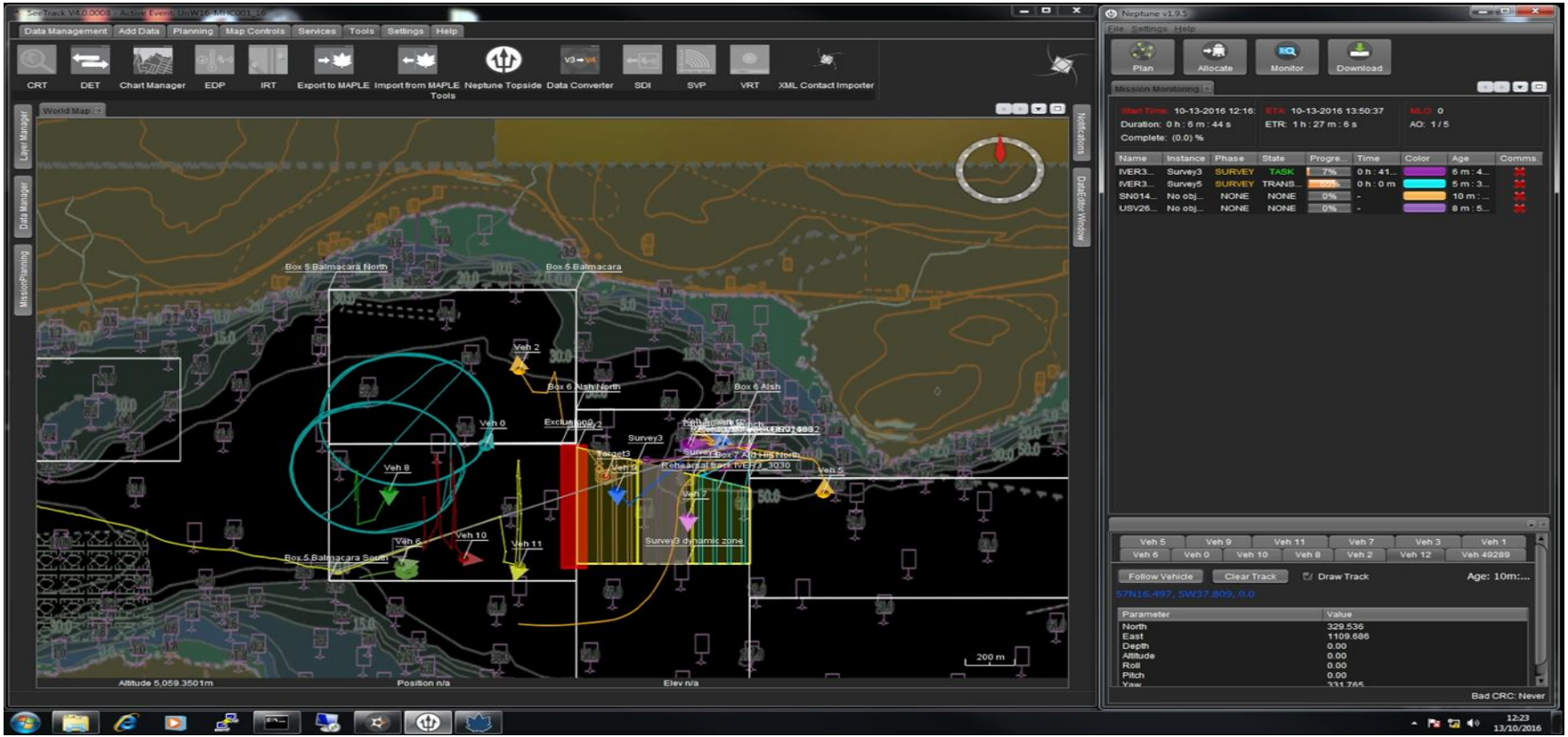

Multi-modal Interaction

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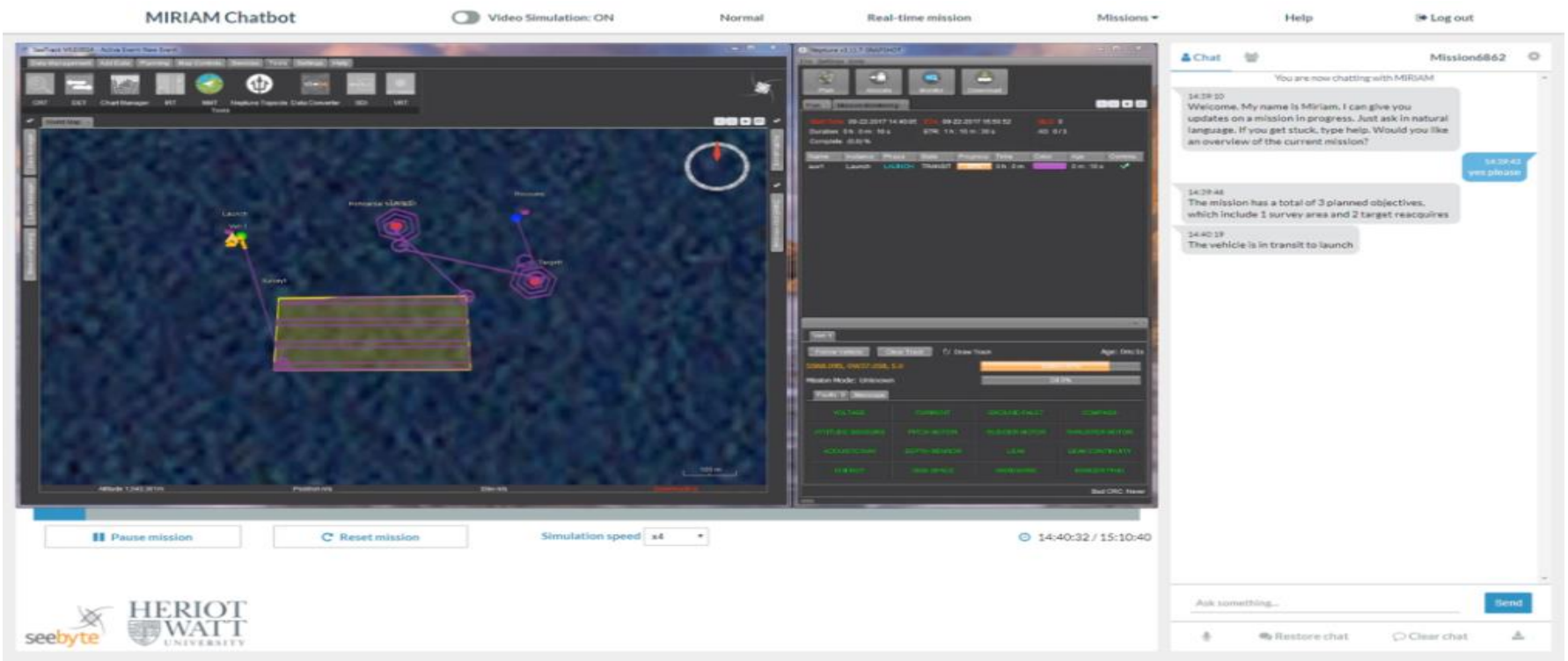

Defence and Security Accelerator

[dstl]

HERIOT WATT UNIVERSITY

Prof. H. Hastie, Dr D. Robb, J. Chiyah

(click image for video)

Example Interactions

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Integrating AR into Interactions

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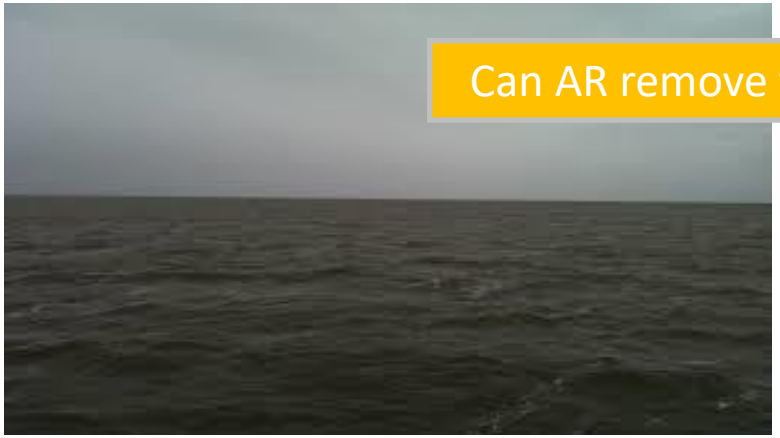

Can AR remove the water problem?

Participating with AR

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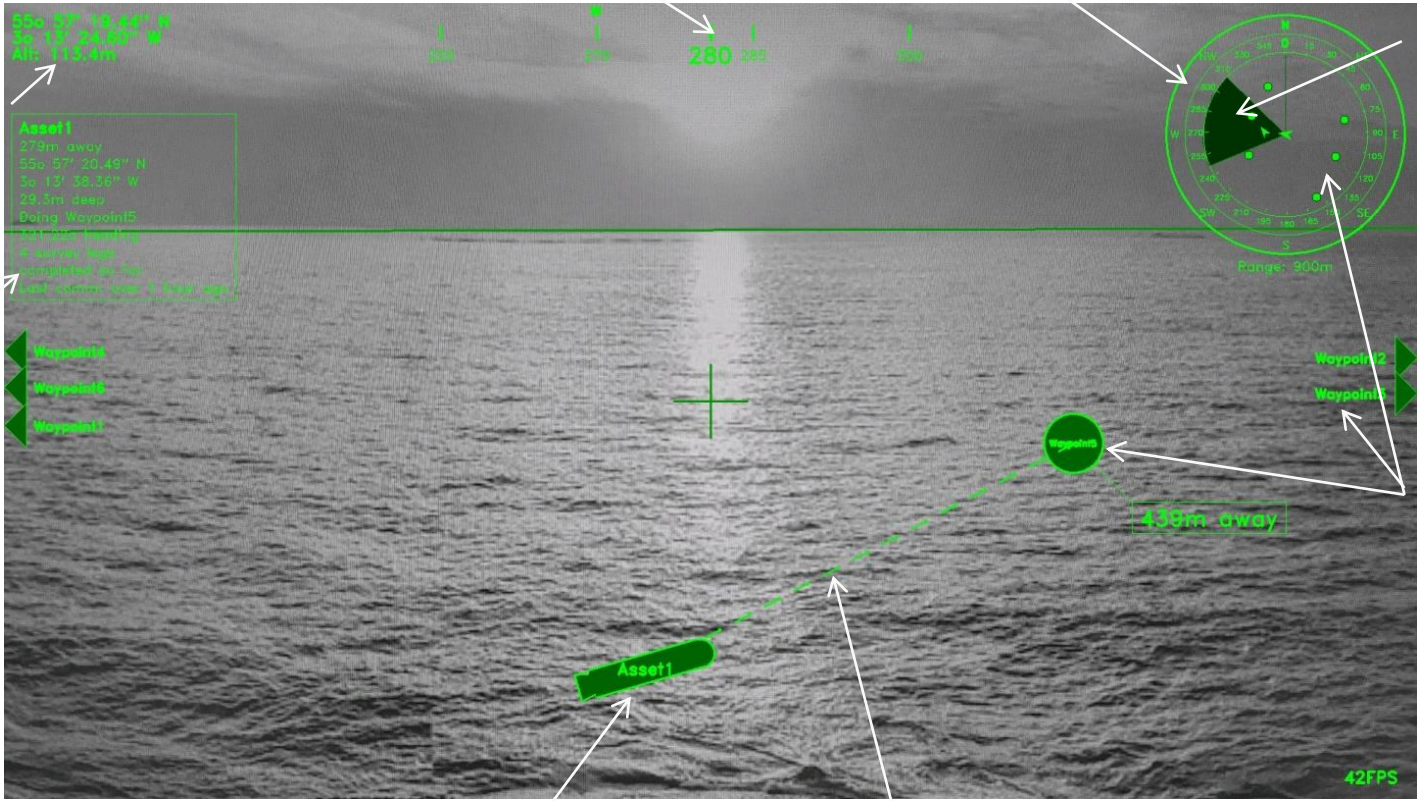

(click image for video)

On-board Reasoning

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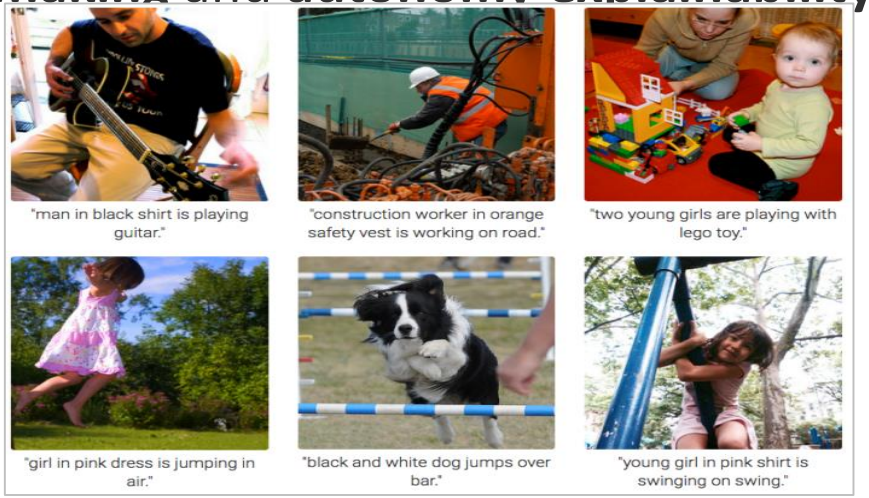
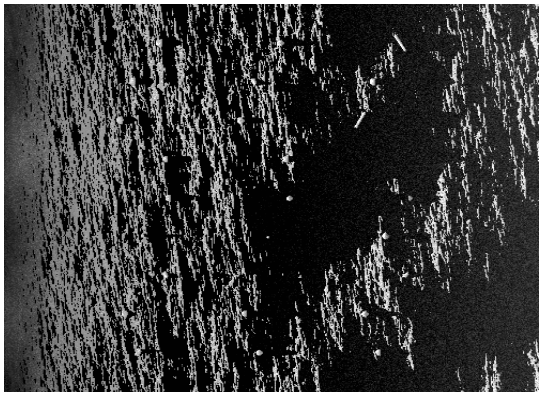
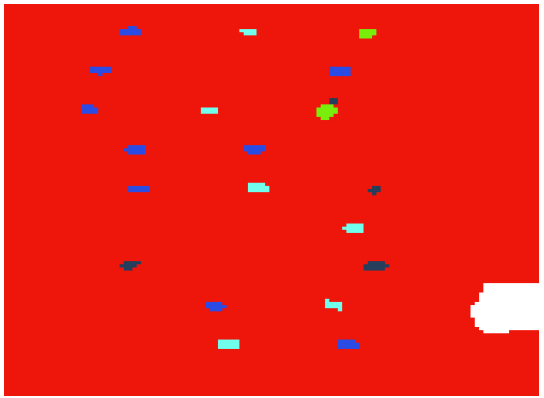
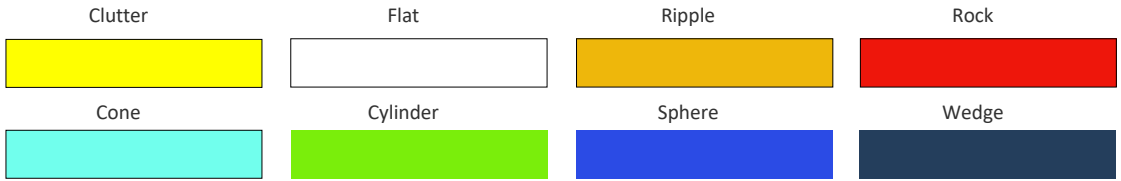
- Richer levels of on-board classification allow **autonomous decision making** and **autonomy explainability**









Smart Communications

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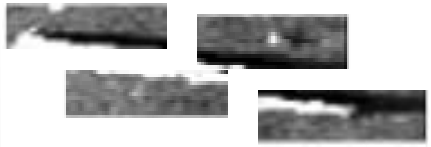
20 bytes / packet

Transmission

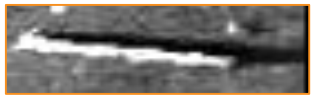


4096 bytes

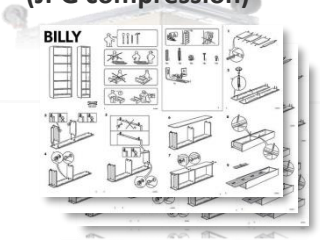
200 packets

Original

8192 bytes



(JPG compression)



(semantic compression)

Reconstruction

5 bytes

10 bytes

20 bytes

1 packet

25 bytes

50 bytes

70 bytes

3 packets

100 bytes

200 bytes

10 packets

ORIGINAL

DATA

MODEL

End User Engagement

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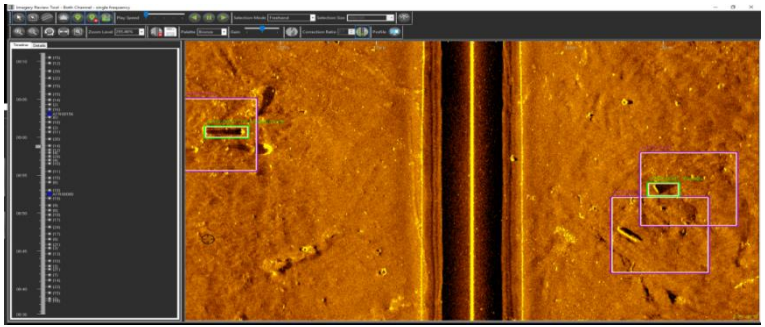
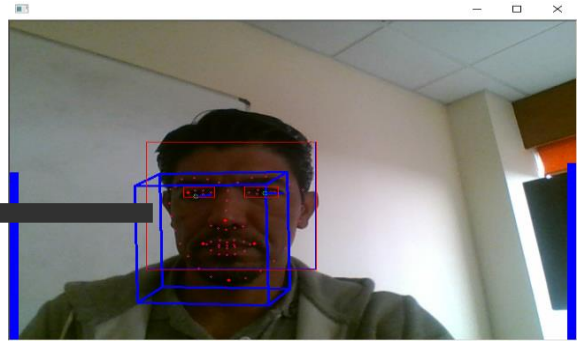
- On-going, iterative engagement with the end-user is vital to ensure the **autonomy technology adds capability**
- The **User Experience** is key – the technology must be simple, intuitive and add value
- Technology must be delivered that can operate within SOP's



Tracking of eyes can stop / start PMA



Summary

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Current autonomy operations focus principally on planning after which operators are “autonomy observers”

Transitioning to effective Human-Machine Autonomy requires:

- **Mission Level Autonomy** allowing dynamic re-tasking and re-planning
- **Multi-modal interactions**
- **Improved on-board perception** to allow **explainability**
- **Smart communications** to leverage available bandwidth and prioritise data sharing
- **Continual end-user interaction**