Remote Passive Acoustic Barrier with Maritime Unmanned Systems: preliminary test during REPMUS-21

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Research Context

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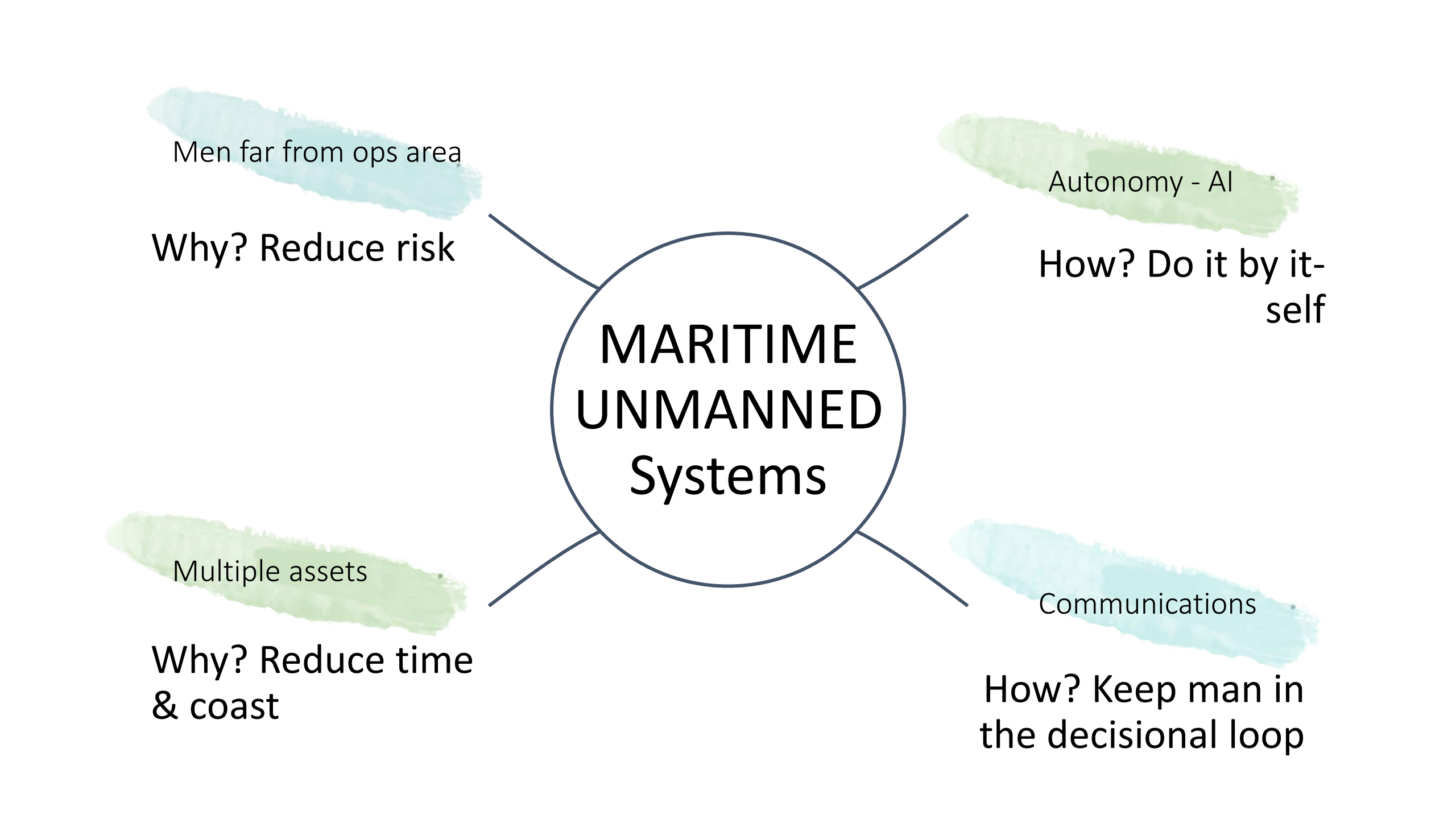
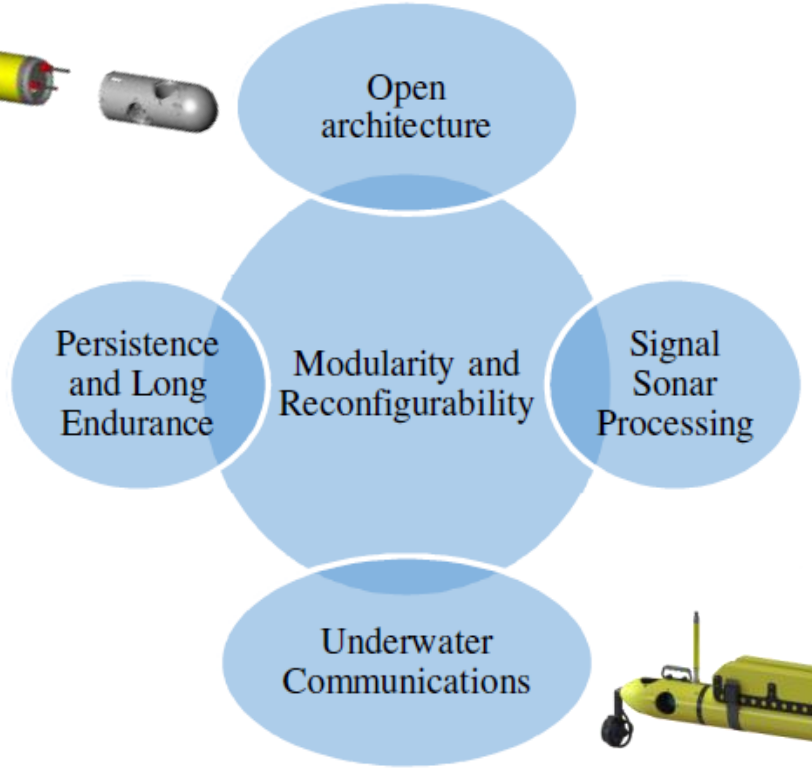
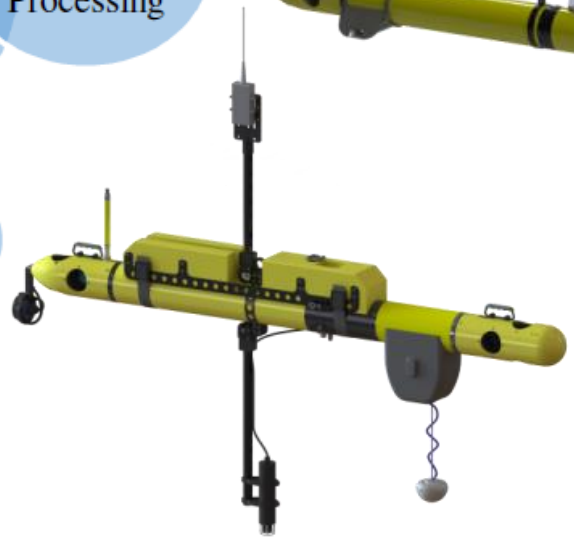
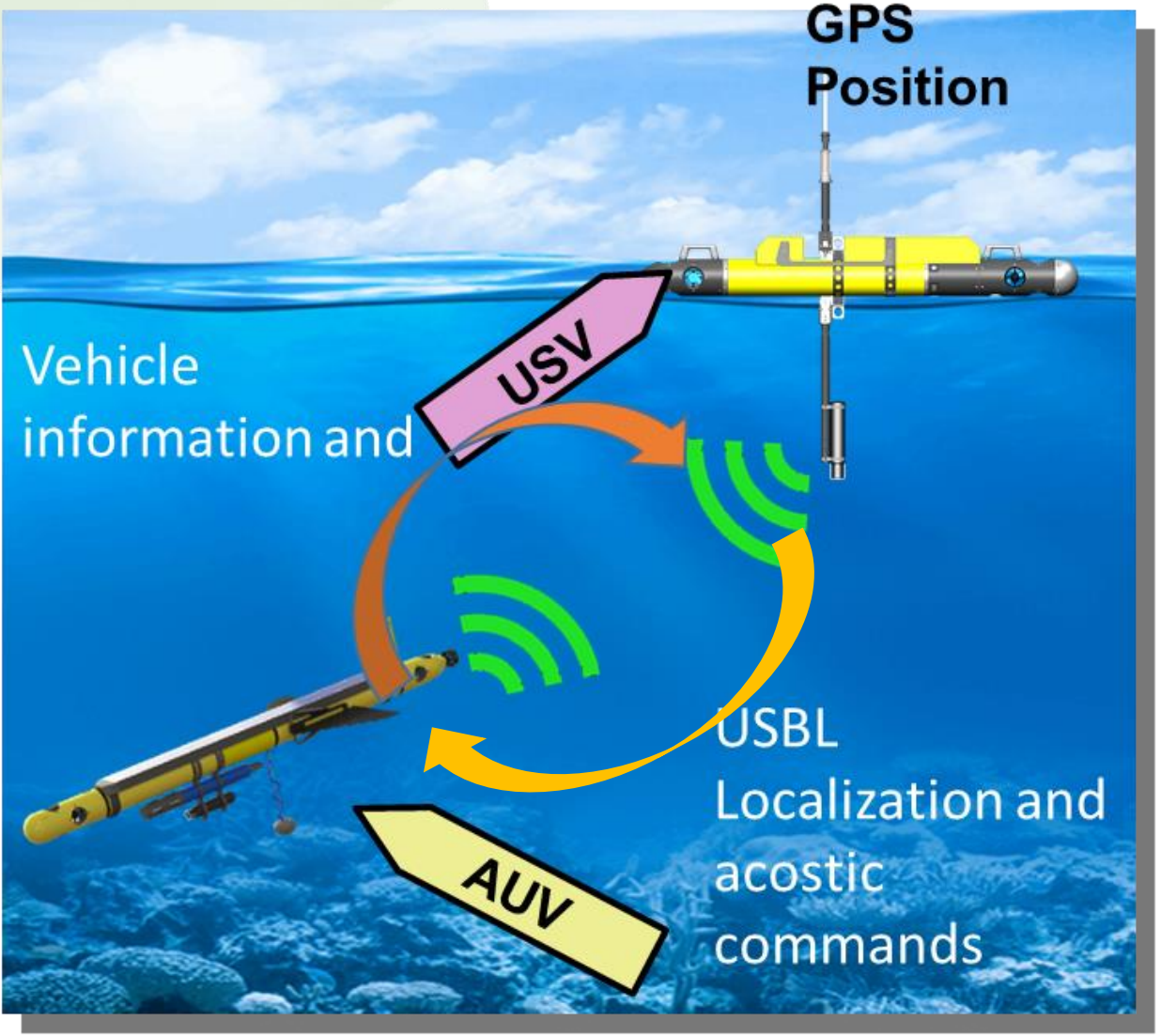

Men far from ops area
Why? Reduce risk
Autonomy - AI
How? Do it by it-self
MARITIME UNMANNED Systems
Multiple assets
Why? Reduce time & coast
Communications
How? Keep man in the decisional loop

Maritime Unmanned Systems





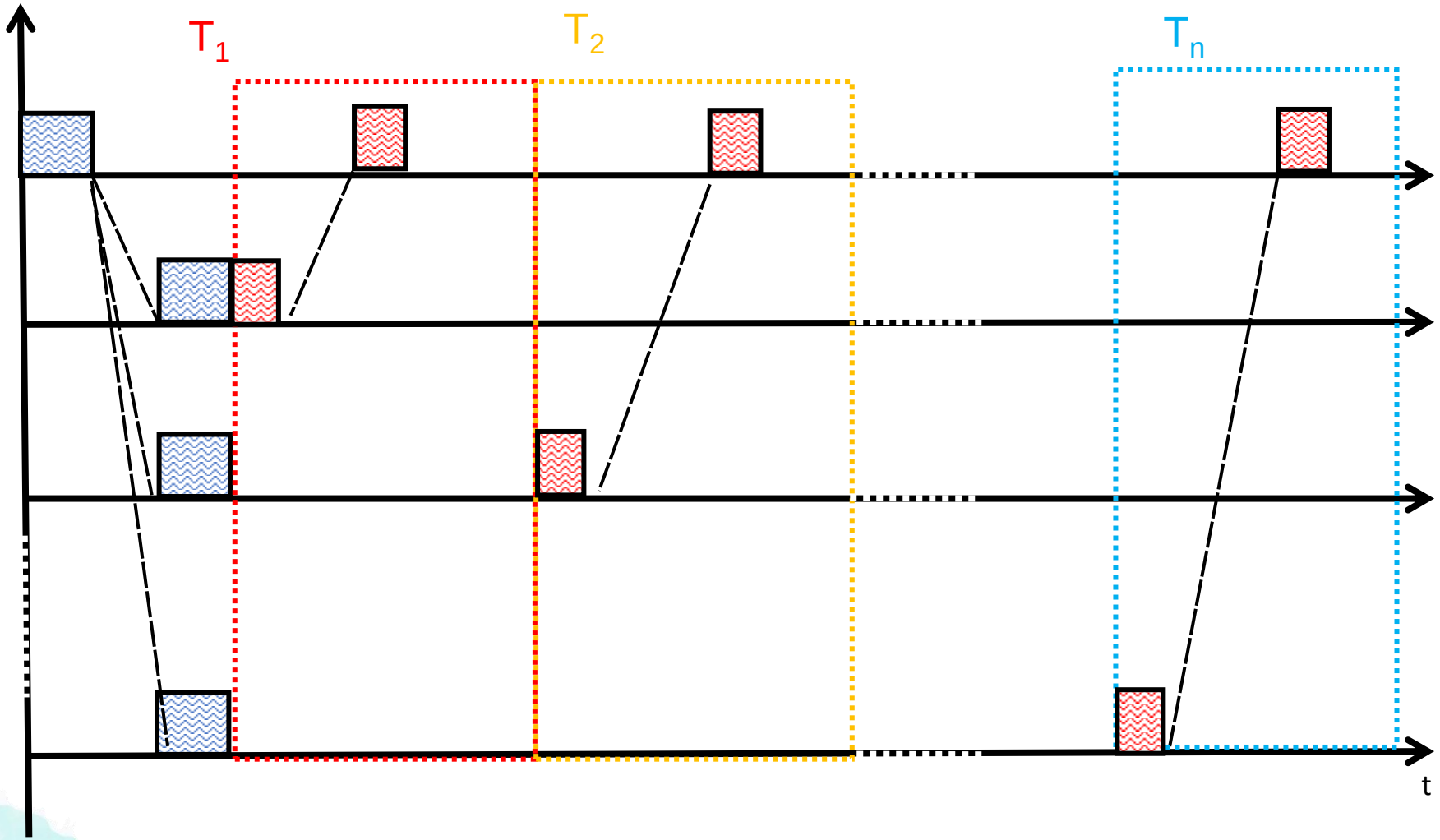
System Architecture



- USBL localization and GPS position used to give latitude and longitude to the AUV.
- AUV give feedback to USV, regarding its state and other important information
- Knowing its ‘’near’’ past position and navigating trough waypoints, the vehicle can correct its cruise using a compass.
- Master & Slave communication approach was chosen to use more than one AUV

System Architecture

$T_{SLOT} = T_1 + \ldots + T_n \; ; T_i = TravelT_{MAX} + t_{TX} + t_{RX}$



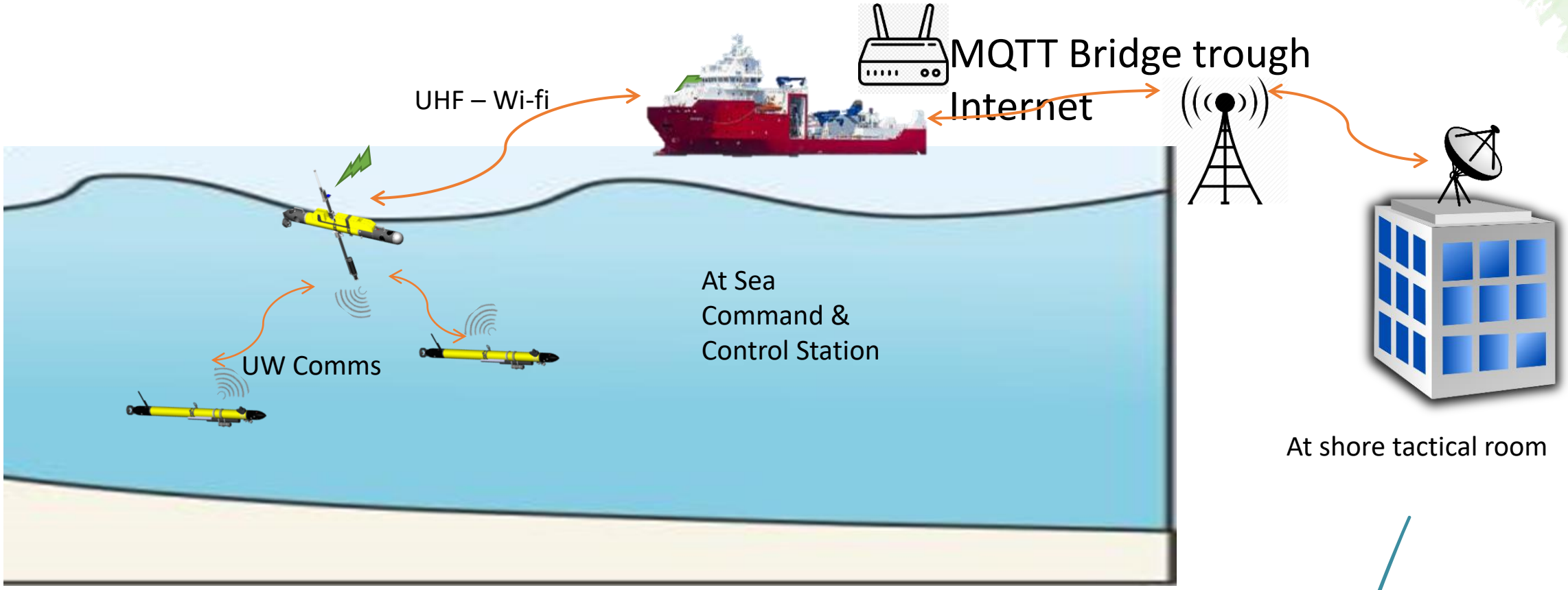
BOA

AUV 1

AUV 2

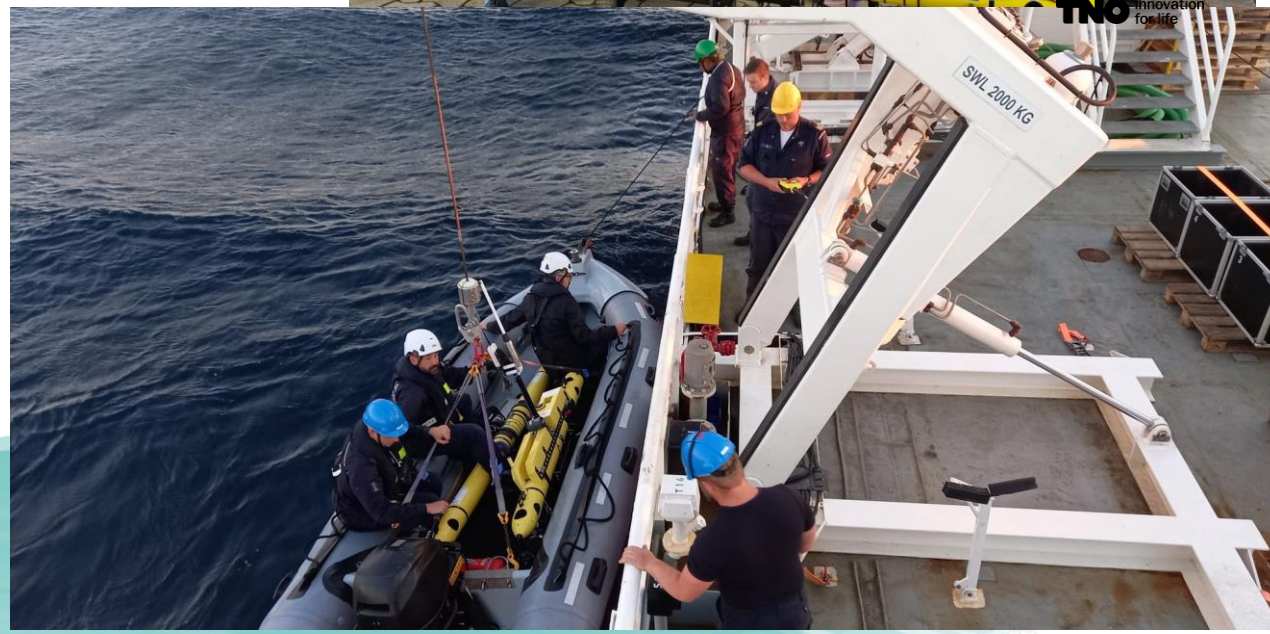
AUV n

System Architecture

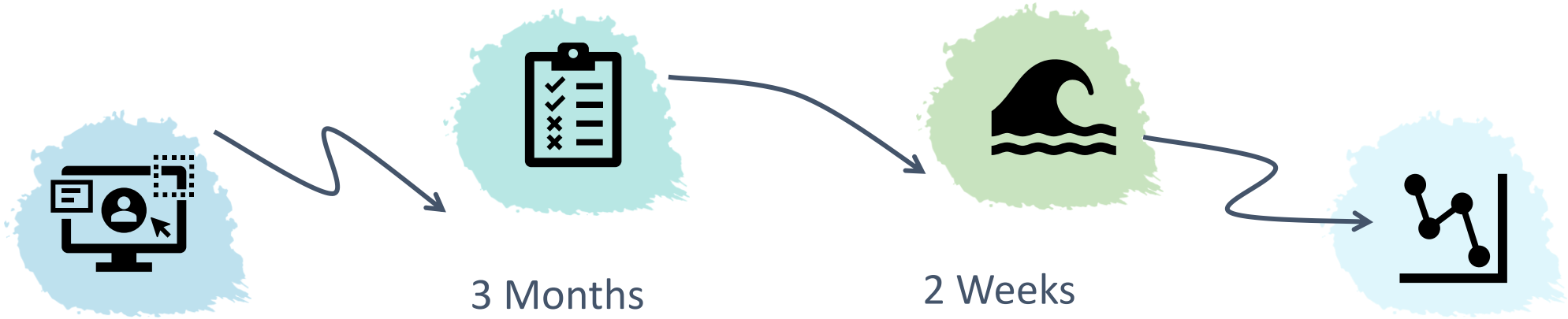


Direct link between undwerater vehicle and at shore tactical room through acoustic, radio and internet connection

At sea Trial



At sea Trial



3 Months

Architecture design & develop

3 Months

Trial with simulator and at sea

2 Weeks

Exercise, high valuable scenario data collection

...

Data analisys

At sea Trial

Goals

Perform an acoustic passive Barrier with MUS

Real-time DOA estimation

Send this info to control room

DiFar Payload

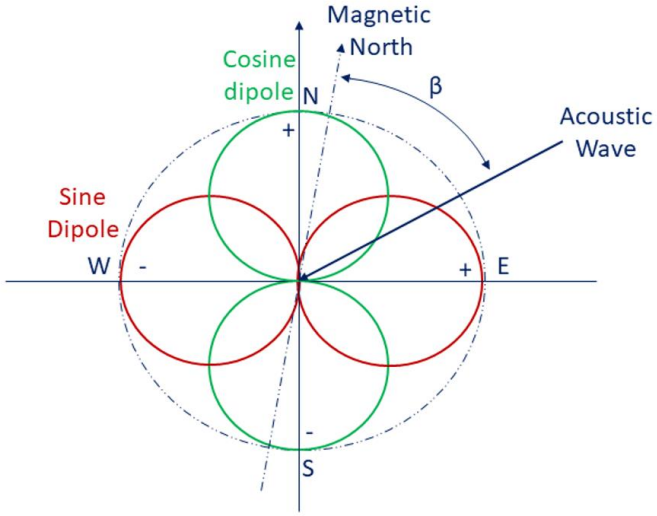
$$\begin{cases} \hat{\beta}_{\text{track}} = \hat{\beta}(f_{\text{M}}) \\ f_{\text{M}} = \underset{f}{\operatorname{argmax}}\, SNR(f) \end{cases}$$

BOA

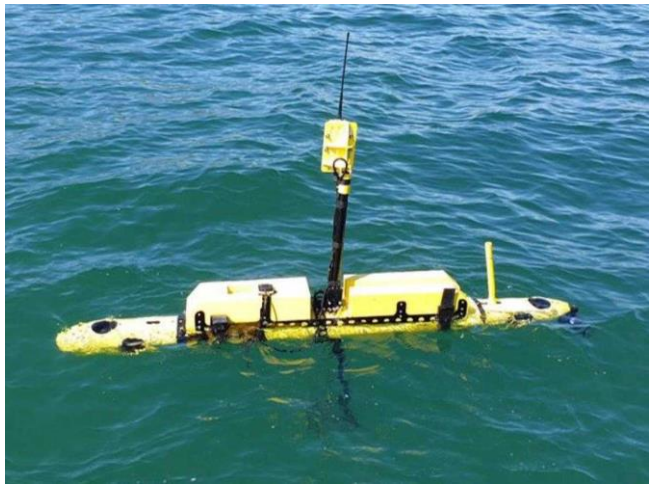
Surface boa acting as a bridge between UW & RF

At sea Trial – ASW Barrier

- AUV mounting Vector Sensor from AN/SSQ-53F DIFAR sonobuoy, and acoustic modem.



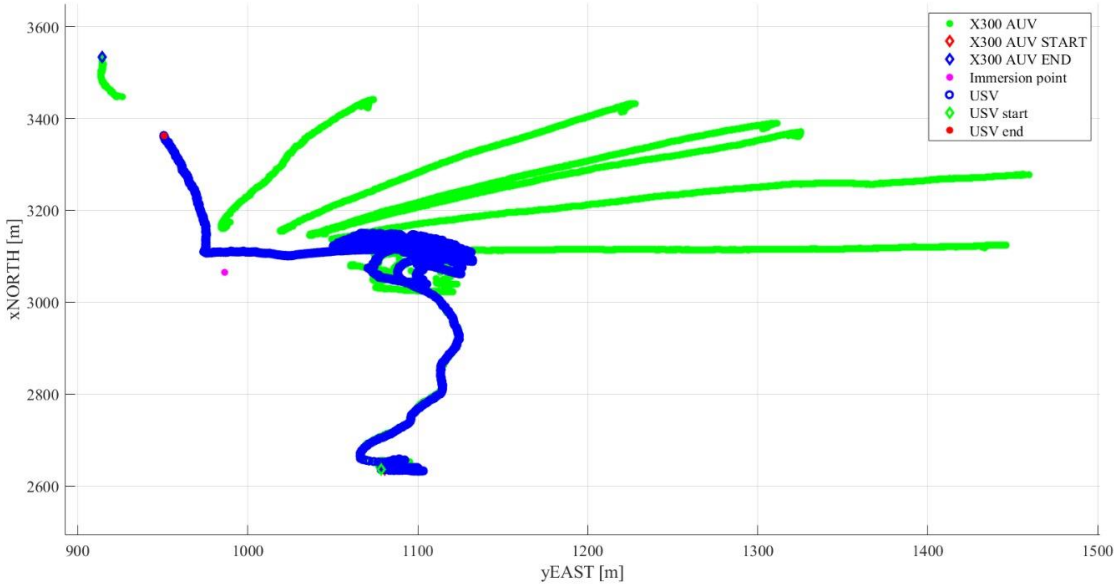
- MGB equipped with USBL, GPS, Wifi and UHF modem.



At sea Trial – Real-time Direction of Arrival estimation

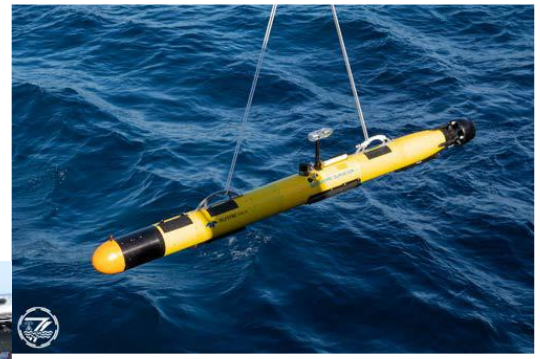
Autonomus behavior:

1. Start mission in quiet mode;
2. The AUV starts collecting acoustic data;
3. Real-time processing on board;
4. The selection of detections and bearing tracks used for the autonomous behavior is performed;
5. AUV, when interrogated, send the information of the detection at the Control Station trough MGB;
6. Periodically SNR is measured to establish the detection treshold.

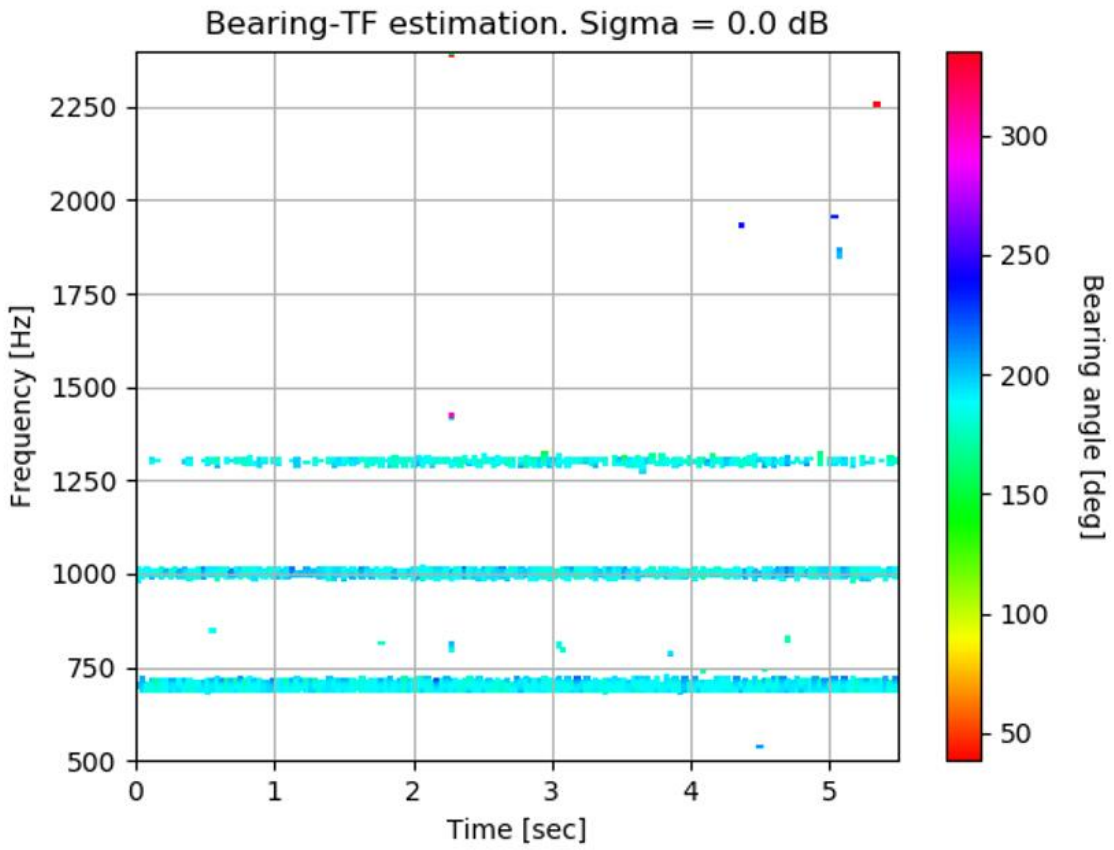


At sea Trial - Target

- CMRE Ocean Explorer (Passive Sonar)
- Royal Danish Navy GAVIA AUV (Active/Passive sonar)
- Royal Netherlands Navy RTSYS SEMA (Active/Passive sonar)
- Royal Netherlands Navy RHIB



Some Result



Spectrogram

Received signal within a single time window, 3 clear and persistent lines in light blue are likely associated to an artificial target.

Day	Overall Duration	Target	Number of Detections
20 Sept	7h	RHIB / SEMA TNO	23 / 1723
21 Sept	6h	GAVIA WTD71	1189
22 Sept	4h	RHIB	4
23 Sept	8h	OEX / SEMA TNO	892 / 421

Conclusions

01 SoS acting as ASW passive acoustic barrier was presented

02 Trough the usage of an ASV we performed a direct link between underwater assets and C2S/ at shore Control Room

03 Real Time data processing was performed on board AUV for DOA estimation

04 High valuable database can be now used for future development.

Future Works

01 Usage of more assets to exchange information, increasing the capability to make interoperable heterogenous assets.

02 Optimize the communication system especially for the UW domain exploring new strategies.

03 Test the tracking algorithm starting from database collected

04 Exploring the reconfigurability of these vehicle using the same strategies for different scenario (MCM – REA – DISSUB)

THANKS

Do you have any questions?
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