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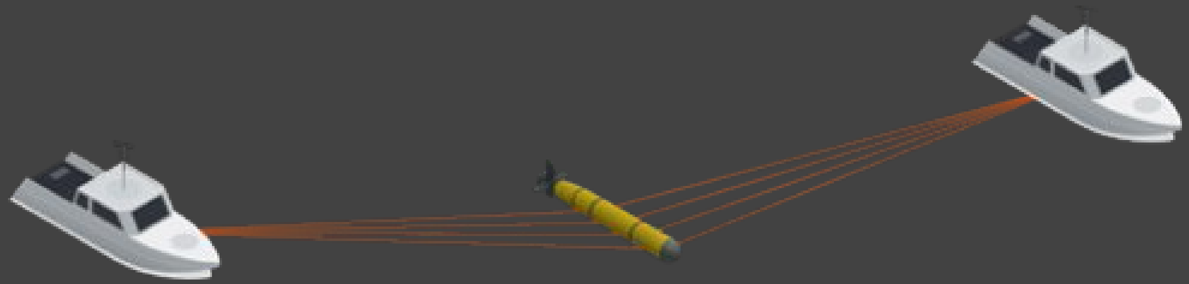


Modern Naval Minecountermeasures MCM Toolbox

Whitepaper

Contents

Courtesy of L3 Oceanserver

Introduction

Navies are turning to MCM Toolboxes of intelligent robotic systems as the doctrine and technology that underpins this mission undergoes a rapid transformation. Navies are faced with new choices to acquire, upgrade, or replace their MCM capabilities from an increasing range of vendors.

Choosing the right components of hardware and software is vitally important to achieve the optimal balance of performance and affordability. However, the choice navies face is more complex than choosing between buying a few highly capable, expensive systems or a larger quantity of less capable, cheaper ones. Other factors should be taken into consideration:

Mission Autonomy

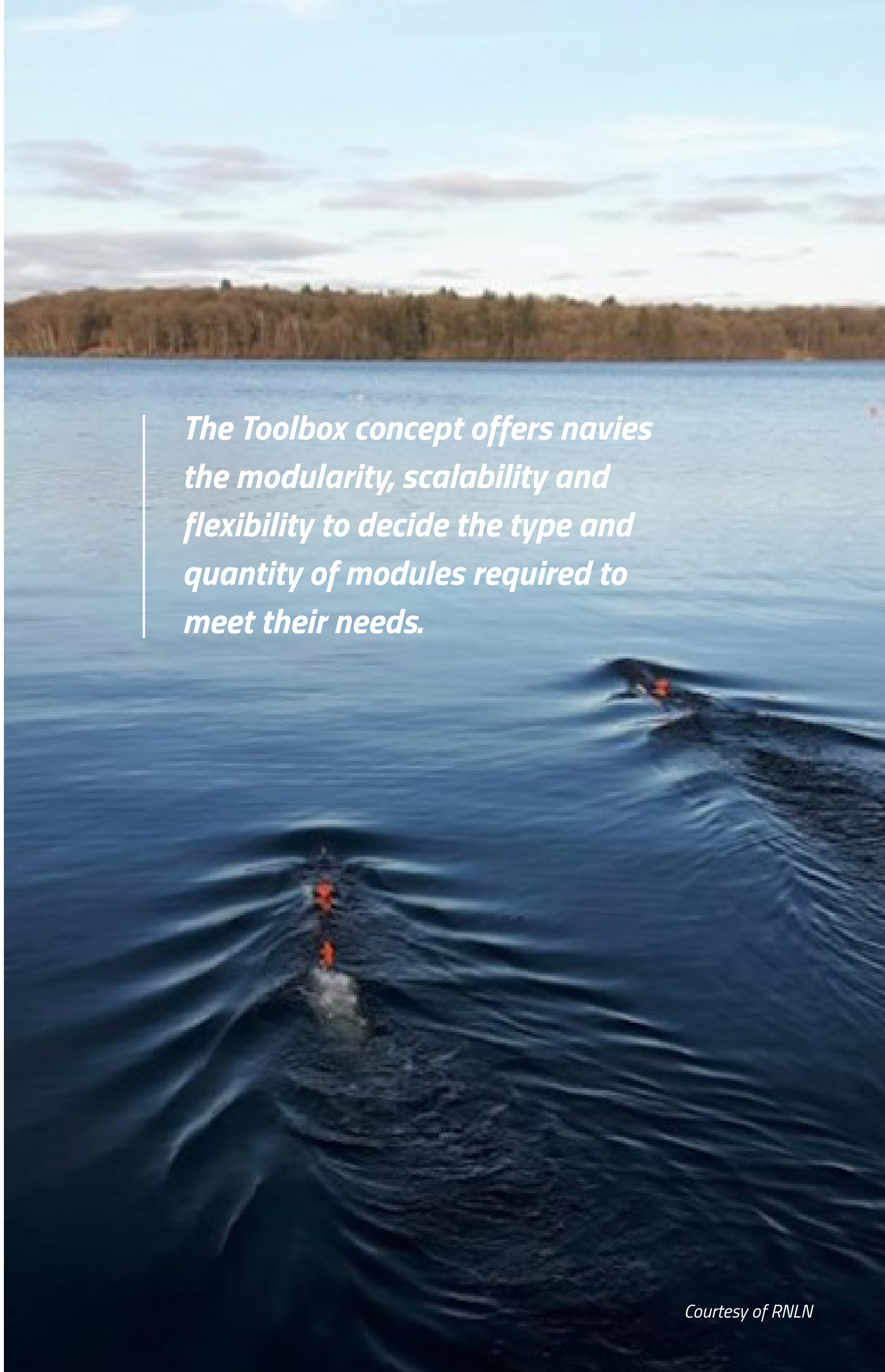
MCM Toolboxes rely on smart software for Mission Autonomy, Automatic Target Recognition (ATR), and MCM Command and Control (C2). Choosing the right software has a major effect on the system performance as a whole.

Openness

Selecting the best of breed MCM Modules from multiple vendors vehicles and sensors requires a commercially and technically open solution to avoid single vendor lock-in.

Interoperability

Selecting software that supports a broad range of vehicles and sensors from multiple vendors increases interoperability, and the confidence that the value of data is not lost when switching or upgrading.



Courtesy of RNLN

MCM Past & Present

Problem 1: It's dangerous business.

MCM operations are hardly new to world navies, with most having well developed capabilities for Mine Surveillance & Treatment.

Naval doctrine has been to use dedicated mine hunting ships to enter the mine threat area with a crew compliment of 35 to 40. This includes the command team and specialists operating the sonar equipment to search for each mines, and the disposal operators and naval divers who identify and neutralise the mine threat. They undertake missions spanning a few days to many weeks.

At the same time, mines have become more difficult to detect because of stealth shaping and casing materials that better blend in with seafloor characteristics. They have increasing lethality with sensitive fuses that trigger when prey is nearby. Add to this the growing threat of underwater improvised explosive devices (UIEDs), that can confound conventional MCM systems with unfamiliar sizes and shapes to that of 'conventional' mines.

> *MCM is arguably one of the most dangerous of all missions, where Navies employ manned ships and naval divers to enter the minefield and counter the mine threat.*

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> ***Whilst advances in computing software and ROVs have helped to locate and neutralise mines more quickly, and with fewer errors, it still remains painstakingly slow and tiring work.***

Problem 2: It's dull, difficult, and draining.

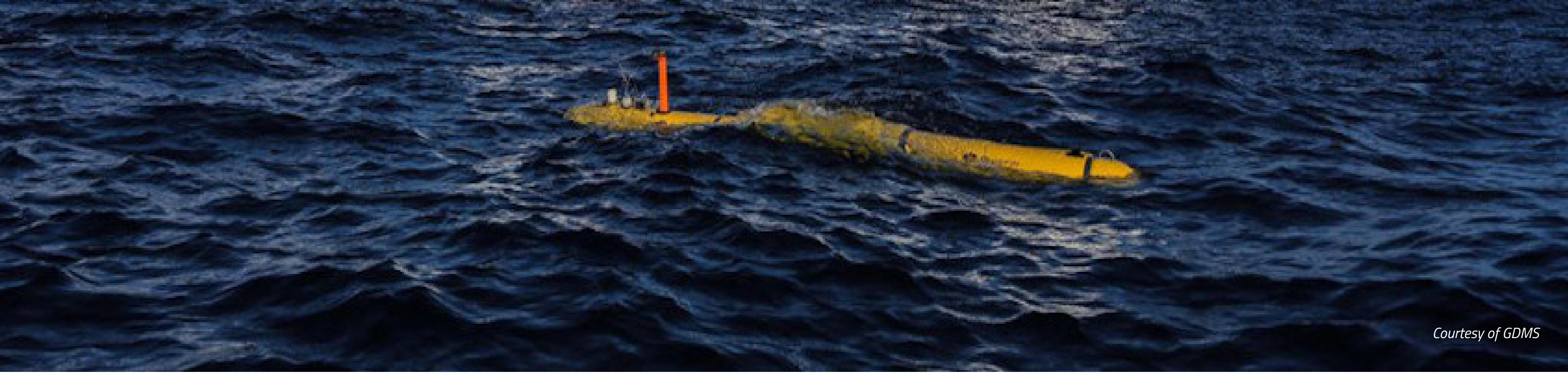
As well as dangerous, searching for irregular shaped mines against a background of seabed clutter and features is time consuming and error prone.

It requires human operators to remain “in the loop” for intensive periods of time; using their skills and experience to interpret the sonar displays, locating each mine in sequence, before advancing to the next. Disposal operators and divers must then inspect each mine at great personal risk to identify and neutralise the threat.

To address the problem, Computer Aided Detection (CAD) and Computer Aided Classification (CAC) programmes, that once aided the operator to perform the detection and classification, are being replaced by more advanced ATR's, that detect, classify and localise mines within the sonar image.

The neutralisation operation has also evolved to use Remotely Operated Vehicles (ROVs) to inspect and neutralise mines. The disposal operator pilots the ROV from inside the MCMV, reducing the need to place divers in the minefield.

But, whilst each development helps to locate mine-like objects at greater range, with higher resolution, ultimately increasing the speed of advance, the initial problem remains. The human workload continues to be dull and intense, fatigue quickly sets in during extended missions, and mistakes are made.


Courtesy of GDMS

MCM Toolbox

Technology has long played a key role in transforming MCM operations, reducing the workload burden on human operators, and reducing the risk of having people in an active minefield.

MCM Toolboxes of Advanced Robotics and Artificial Intelligence (AI) are merely the latest incarnation of this trend.

MCM is entering a new era as the doctrine and technology that underpins this mission undergoes a transformation. Many navies now widely employ a toolbox of intelligent robotic systems to perform the search and neutralisation operations, whilst the MCM ship and personnel operate at a safe standoff range or outside the minefield itself.

MCM toolbox is simply the name given to a suite of MCM modules that offer the modularity, scalability, and flexibility for the end-user to choose the type and quantity of modules required to meet both their needs, and the MCM mission requirements.

Solutions range from small-scale systems for harbour protection, to full-scale systems for major MCM Navies that are deployable from land or sea, using dedicated MCM ships, or ships-of-opportunity.

Some navies may choose to acquire their toolboxes from a single vendors product line, others from multiple vendors. Whichever path is taken, all navies would want to select components that are open, interoperable, and upgradeable to avoid vendor lock-in when replacing or upgrading toolboxes.

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Solution 1: Take the human out of the minefield.

The use of unmanned robotic systems (MCM Toolbox) has given rise to the “Stand-off MCM concept”. One of the main benefits of this concept is that the unmanned vehicles enter the mine threat area, instead of the ships and crew.

Many unmanned MCM Modules are provided with basic autonomous capabilities that achieve an MCM performance broadly equivalent to a classical MCMV, in terms of percentage clearance, clearance time, and command team workload. These capabilities include:

Mission Planning (MCM C2)

The operator(s) prepare integrated mission plans for each individual Unmanned Maritime System (UMS) employed, assigning assets, and manually dividing the mission area to match the capabilities and resources of each UMS, aided by C2 tools to automatically plot the search pattern (e.g. lawnmower).

Unmanned Vehicles

With autopilot that follows the mission waypoints and have collision avoidance to avoid hazards or contact with mines. They either stop or return to a predesignated recovery point should a malfunction occur.

Post Mission Analysis

Aided by Automatic Target Recognition (ATR) tools, the operator(s) analyses the sonar data to locate mines and assess the achieved percentage clearance. If the percentage clearance level is too low, additional searches of the mission area are planned and executed. Difficult to hunt areas may require multiple revisits from different axis.

> *Given that minefields are not signposted, sending unmanned MCM Modules into the mine threat area reduces the danger to human life.*

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Courtesy of AEUK

Solution 2: Focus on high value-added tasks.

Though using unmanned systems is intrinsically safer, it does not necessarily make mine hunting less difficult, require less human workload, or create fewer errors. MCM Toolboxes rely on smart software for Mission Autonomy, Automatic Target Recognition (ATR), and MCM Command and Control (C2).

MCM Modules equipped with increased mission autonomy, and artificial intelligence (AI) are capable of surpassing the performance levels of classical MCMVs in terms of percentage clearance, clearance time, and command team workload. These capabilities include:

Goal-Based Mission Planning

Designed to reduce operator workload and human errors, the operator defines the mission goal and the AI mission planner then assigns assets and breakdown areas to match the capabilities and resources of each UMS/Squad.

Seabed Classification ATR

Seabed Classification ATR recognises and classifies the seabed type and clutter density that degrades coverage and the ATR performance, to inform the mission autonomy of the areas that are difficult to hunt, improving mission efficiency.

Adaptive Mission Autonomy

Compensates for underwater currents, sonar degradation and seabed coverage, and will revisit difficult to hunt areas and suspect mines from additional axis, reducing PMA time and improving percentage clearance.

UMS Squads

Commanding a squad of UMS as a single unit; squads work together to achieve the mission goal, dynamically assigning tasks, adapting in-stride, and performing handovers should units malfunction.

> *With mission autonomy taking care of many routine and repetitive tasks efficiently and with fewer errors, command teams are able to focus on their high value-added tasks.*

Solution 3: Select the best-of-breed components.

The MCM Toolbox characteristics of modularity, flexibility, and scalability enables customers and end-users to pick and choose the components that best fits their needs and budgets. There are a wide variety of components available, in different sizes, and capabilities from an increasing number of vendors.

Choosing these components means customers and end-users are not tied to a single vendor, giving them the freedom to select the right tools for the job. Their data is also owned by them and not tied to a vehicle or sensor. Historic data will not be lost during an upgrade or replacement.

The ability for a navy to select components from multiple vendors requires a commercially and technically open solution, that offers multi-vendor interoperability, and the upgradability to support and sustain the capability throughout its life.

> *Making informed choices is key for navies to choose from the wide variety of Toolbox components on offer. First of these choices should be to acquire open systems.*

Open Systems

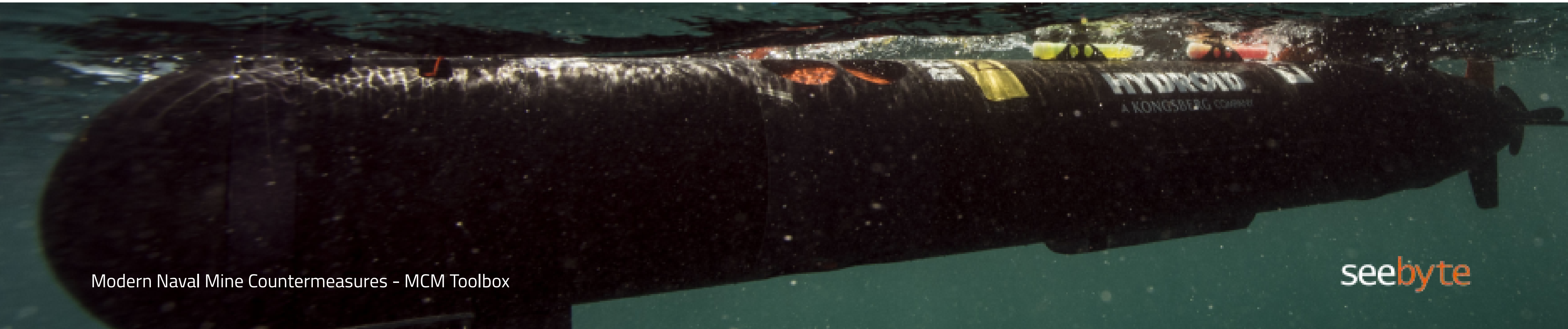
Commercially and technically open solutions, with a proven history of allowing third-party integrations. They are designed to avoid single vendor lock-in and to give the customer confidence that they can go it alone if they choose.

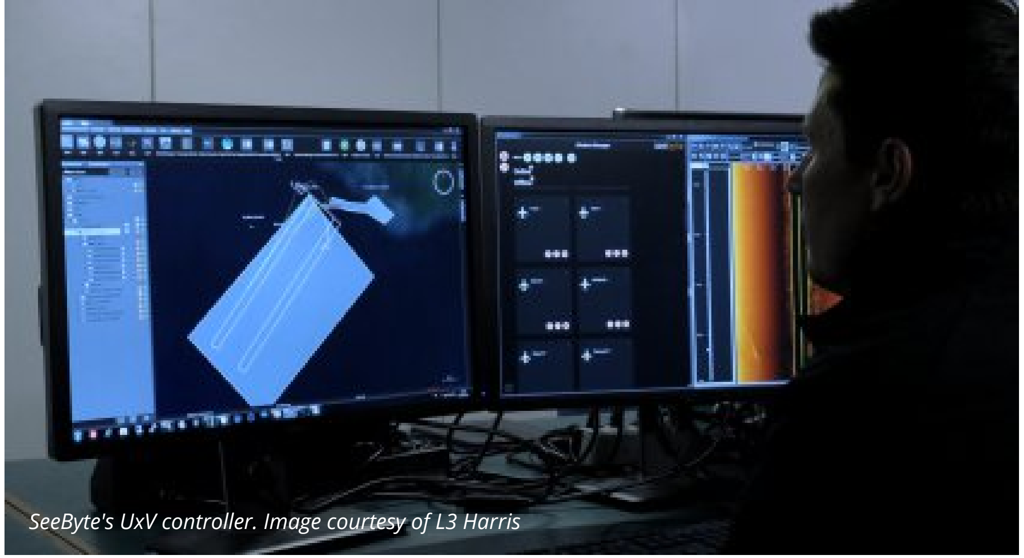
Multi-Vendor Interoperability

Systems that are vendor agnostic, and support a broad and expanding range of vendors, vehicles and sensors.

Upgradability

Changes to a system can easily be produced and applied enabling existing components to be upgraded, replaced, or new components added over time.





SeeByte's UxV controller. Image courtesy of L3 Harris

Conclusion

Employing MCM Toolboxes of intelligent robotic systems keeps the MCM ship and personnel at a safe standoff range outside the minefield.

They offer modularity, scalability, and flexibility for the end-user to choose the type, quantity, and vendor to meet their needs.

Choosing the right components of hardware and software is vitally important to achieve the optimal balance of performance and affordability.

MCM Toolboxes rely on smart software for Mission Autonomy, ATR, and MCM C2. Choosing the right vendors has a major impact on the MCM Toolbox performance.

The choice should include Mission-Level Autonomy, ATR, and MCM C2 software components that can have an equal, if not greater effect on the system performance.

Selecting these components from trusted vendors who support a broad range of vehicles and sensors from multiple manufacturers will increase interoperability.

Selecting the best-of-breed from multiple manufacturers of vehicles and sensors, requires a commercially and technically open solution to avoid single vendor lock-in.

This provides the customer and end-users with the confidence that their data is safe and owned by them. If the data is not tied to the vehicle or sensor vendor, they will never lose the value of their data when they upgrade their MCM systems, or change vehicle or sensor vendors.

The benefits of these choices can be made by comparing their relative performances. The actual operating area, type, and number of UMSs employed and Naval doctrine will affect the actual results achieved.

An operating area that is difficult to hunt will be equally difficult for each scenario. It is still expected that the adaptive capabilities of the Mission-Level Autonomy will achieve an improved performance than the others.