2022

USV and UAV Teaming for ISR-T Capability

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Monterey, California: Naval Postgraduate School

https://hdl.handle.net/10945/71953

NAVAL RESEARCH PROGRAM
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

USV AND UAV TEAMING FOR ISR-T CAPABILITY

EXECUTIVE SUMMARY

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This research is supported by funding from the
Naval Postgraduate School, Naval Research Program (PE 0605853N/2098).

Project Summary
This report investigates the application of current and near-term operational architectures to enable unmanned aerial vehicle (UAV) and unmanned surface vehicle (USV) teaming for intelligence, surveillance, reconnaissance, and target acquisition (ISR-T) missions for distributed maritime operations (DMO). The purpose of this research is to conduct an analysis, using the Joint Capabilities Integration and Development System (JCIDS) DOTMLPF-P (doctrine, organization, training, materiel, leadership & education, personnel, facilities, and policy) methodology, of UAV-USV teaming potential for integration into DMO. Deficiencies of current operational architecture design that inhibit or deny this capability are noted for correction for near-term operational architecture advancements. Doctrine, training, and leadership & education were determined to be the three DOTMLPF-P categories needing the most attention before UAV-USV teaming in the ISR-T environment can move forward. We recommend that the first priority is to have UAV-USV teaming doctrine be established before the US Navy moves forward with executing UAV-USV teaming in the fleet. Second, we recommend initiating integration of teamed UAVs and USVs into carrier or expeditionary strike groups to supplement or replace current assets for ISR-T missions and enable the transition of the fleet to support DMO.

Keywords: *unmanned surface vehicle; USV; unmanned aerial vehicle; UAV; intelligence, surveillance, reconnaissance, and target; ISR-T; teaming; distributed maritime operations; DMO*

Background
DMO requires ISR-T information on enemy warships. The ranges of current anti-surface missiles far exceed organic sensing capabilities. Space-based assets may not be operative, or otherwise tasked pre-empting their use in locating threats. One solution is to use USV launched UAVs to provide the ISR-T capability.

We first established baseline information for UAVs, USVs, DMO, operational architectures, and UAV-USV teaming related experimentation. The classification systems used for both UAVs and USVs were discussed as was a deeper dive into commercial and defense related concepts. The implementation challenges of UAV-USV ISR-T into DMO were scrutinized. Seven separate architectures were reviewed to determine their viability in the UAV-USV teaming arena. We also looked at implementation challenges/vulnerabilities and two UAV-USV ISR-T experimentation events.

The Navy's JCIDS DOTMLPF-P methodology was used to analyze the status of UAV-USV teaming and what shortfalls must be addressed before proceeding with its execution.

We consulted subject matter experts on background material and obtained feedback on appropriateness of proposed approaches and methodologies.

Eight DOTMLPF-P categories were examined for changes needed to allow UAV-USV teaming to be operated at its fullest potential. The amount of work needed, and priority placed on that work determined the effort required to execute this capability recommendation.

D-Doctrine	How the military fights its conflicts.
O-Organization	How the military is organized to fight.

T-Training	How forces are prepared to fight from basic training through unit/joint exercises.
M-Materiel	Equipment/systems needed to fight and operate effectively.
L-Leadership & Education(L)	How leaders (at all levels) are prepared to lead the fight.
P-Personnel	Does current manning allow for this capability to be used to its fullest potential?
F-Facilities	Are military properties and installations being used to fill in a capability gap?
P-Policy	Department of Defense/other policy issues that could prevent implementation of changes in DOTMLPF-P categories.

Current UAV-USV teaming for each category was given a grade (1-5) indicating what needs to be done to reach its highest level of realization: 1-poor current implementation/significant changes needed, to 5-fully realized/minimal changes needed (Schuck, 2022).

Grade 5	Fully realized; minimal work needed to reinforce current plans/documentation.
Grade 4	Mostly implemented; limited additions needed for full realization.
Grade 3	Partially implemented; major additions needed for full realization.
Grade 2	Information/procedures exist, but not very extensive, or out of date.
Grade 1	Little to no documentation/discussion; large amounts of work needed.

Each DOTMLPF-P category has a priority value indicating the importance of the criterion towards the success of UAV-USV teaming. Priority values are independent of grades. Even though a category may have a high grade (e.g., 5), it may be a low priority for the success of the system (Schuck 2022).

High	Essential for fully executed teaming to be at its highest form of completeness
Moderate-High	Required for fully executed teaming; can be under development, but progress towards completeness needed soon
Moderate	Necessary for fully executed teaming; can be under development
Low-Moderate	Not necessary, but complete development would help towards execution of teaming
Low	Not necessary for execution of teaming.

Findings and Conclusions

DOTMLPF-P analysis was conducted to determine the feasibility of, and changes required within each category for the successful implementation of UAV-USV teaming in the ISR-T environment.

The below data provide decision analysis showing compilations of the different categories and their status relative to one another. Only doctrine is completely lacking in support or development (grade of 1), and most (five with scores of 4 or 5) have some progress to be made for the UAV-USV teaming capability to be successfully implemented meaning that little to no additional work or effort needs to be accomplished within that category to support full implementation of UAV-USV teaming.

Category-Grade-Priority:
Doctrine-1-High
Organization-5 -Moderate-High
Training-3-High
Materiel-5-High
Leadership & Education-3-Moderate-High
Personnel-5-High
Facilities-4-Mod
Policy-5-Low-Moderate

Six of the eight categories were deemed to have a moderate-high or high level of priority with three of those (materiel, personnel, and organization) having a grade of 4 or 5. The goal is to have the categories with higher priorities to have a higher grade. The three categories with lower grades (doctrine 1, training 3, leadership & education 3) all have priorities of high to moderate-high, thus they must be given the most attention to successfully move forward with UAV-USV teaming in the ISR-T arena.

Doctrine, training, and leadership & education were determined to be the three DOTMLPF-P categories needing the most attention before UAV-USV teaming in the ISR-T environment can move forward. First and foremost, relevant doctrine needs to be developed to include a concept of operations (CONOPS) and tactics, techniques, and procedures (TTPs). We recommend a joint UAV-USV teaming working group (WG) be established by Commander, Naval Forces and Commander, Naval Surface Forces to create related CONOPS and TTPs—as it was done with a CONOPS WG for large and medium USVs.

We recommend to continue to work UAV-USV teaming into naval exercises and events to include conducting this work with a carrier strike group in 2023 and beyond.

We recommend the Department of Defense pursue partnerships with civilian UAV developers to ensure US military UAVs remain competitively advantageous against adversaries. There is a wide array of UAV applications envisioned for the future that would benefit both the defense and civilian sectors.

We recommend leveraging advances in processing power so USVs can act as both a repository and dispenser of unmanned ISR-T data and to dynamically lower the communications grid to remain suitable in communications denied environments. Cloud processing capabilities could be incorporated as redundant or supplementary means of processing ISR-T in permissive environments. Onboard processing of unmanned systems could not only mitigate atmospheric and adversary-related vulnerabilities by deprecating dependency on satellite communications but also enhance the warfighting effectiveness of deployed strike groups by shifting the data processing capabilities from shore assets to the tactical edge.

In addition, LT Peter Winstead's 2018 thesis has several pertinent recommendations that are also included in our recommendations section.

Recommendations for Further Research

Additional research is recommended to study how to reduce the drag of fixed-wing hybrid vertical takeoff and landing unmanned aerial vehicles (UAVs) while improving mobility and flight endurance. Coupling the maneuverability of rotary aircraft with the range and endurance of fixed-winged aircraft could allow for the performance of complex intelligence, surveillance, reconnaissance, and target acquisition missions that other UAV configurations would not be able to conduct.

References

Schuck, A. (2022). *Enhancing communications at sea: Video over ultra high frequency line-of-sight radios.* [Master's thesis, Naval Postgraduate School]. NPS Archive: Calhoun.

Acronyms

DMO	distributed maritime operations
DOTMLPF-P	doctrine, organization, training, materiel, leadership & education, personnel, facilities, and policy
ISR-T	intelligence, surveillance, reconnaissance, and target acquisition
JCIDS	Joint Capabilities Integration and Development System
UAV	unmanned aerial vehicle
USV	unmanned surface vessel
WG	working group