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# Tactical ISR/C2 Integration with AI/ML Augmentation

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Monterey, California: Naval Postgraduate School

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## NPS NRP Executive Summary

Tactical ISR/C2 Integration with AI/ML Augmentation

Period of Performance: 01/02/2022 – 12/31/2022

Report Date: 12/31/2022 | Project Number: NPS-22-N215-A

Naval Postgraduate School, Graduate School of Operational and Information Sciences (GSOIS)



NAVAL RESEARCH PROGRAM  
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

# TACTICAL ISR/C2 INTEGRATION WITH AI/ML AUGMENTATION EXECUTIVE SUMMARY

**Principal Investigator (PI):** Dr. Randy William Maule, Information Sciences (IS)

**Additional Researcher(s):** No additional researchers participated in this research project.

**Student Participation:** Capt Jordan Figlioli, USMC, IS

**Prepared for:**

Topic Sponsor Lead Organization: U.S. Fleet Forces Command (USFLTFORCOM)

Topic Sponsor Name(s): CDR John Gaines

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### Project Summary

NAVPLAN 2021 specifies distributed maritime operations (DMO) with a tactical grid to connect distributed nodes, and artificial intelligence/machine learning (AI/ML) at the tactical edge to support expeditionary advanced base operations (EABO) and littoral operations in a contested environment (LOCE) (Chief of Naval Operations, 2021). Joint All-Domain Command and Control (JADC2) is the vision for integrated command and control (C2). However, the architecture has yet to be fully designed and the intelligence, surveillance, and reconnaissance (ISR) and C2 hardware and software fully integrated. This project evaluates options for ISR and C2 integration at the tactical edge to support a universal common operational picture (COP), on tactical clouds, with AI/ML for decision support. We evaluate new innovations in tactical cloud hardware infrastructure, tactical cloud software operations on that infrastructure, and industry and government solutions for a universal COP able to operate at the far edge and synchronize with tactical commands and headquarters when communications are available, providing AI/ML for automation and decision support.

**Keywords:** *command and control; C2; intelligence, surveillance, and reconnaissance; ISR; common operational picture; COP; distributed maritime operations; DMO; littoral operations in a contested environment; LOC; expeditionary advanced base operations; EABO; Joint All-Domain Command and Control; JADC2; artificial intelligence/machine learning; AI/ML*

### Background

My tests in the fleet, in the network operations centers, and in forward deployed shore commands throughout the 2000s and 2010s as part of the FORCENet sea trials for the Deputy Chief of Naval Operations (DCNO), Naval Network Warfare Command (NETWARCOM), and Joint Forces Command (JFCOM) provide the technical and operational foundation for this report. In our experiments we evaluated best-in-class tactical cloud infrastructure from industry and best-in-class C2 and ISR software from industry and government. The project herein integrates the DCNO, NETWARCOM, and JFCOM lessons learned and extends this research to address recent innovations that significantly reduce the space, weight, and power (SWaP) required for tactical edge infrastructure. This will enable us to further extend the tactical cloud to address the mobile devices of warfighters at the far edge. On this mobile cloud infrastructure, we evaluate sponsor requirements for an integrated C2/ISR universal COP, and CNO requirements for the DMO tactical grid, EABO, LOCE, and JADC2.

### Findings and Conclusions

In this project we evaluated hardware and software options for tactical cloud edge nodes with integrated C2 and ISR services to support sponsor requirements for a universal COP. Our solutions additionally supported DMO, EABO, LOCE, and JADC2 objectives. We tested the new generation of low-cost, low SWaP hardware and emerging options for tactical cloud software to select the best-in-class solutions for far-edge tactical operations and mobile hybrid clouds. We evaluated recent software innovations that enable a transition from dedicated hardware servers and virtual

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machines to containers and micro-services that integrate C2 with ISR to provide a universal COP that synchronizes from headquarters, to forward deployed tactical commands, to far edge mobile devices. The tested configurations were assessed for both online and offline operations, to function in communication, spectrum and cyber challenged environments. We summarized options for a low-cost, low SWaP universal COP with AI/ML decision support for the topic sponsor.

### **Recommendations for Further Research**

Future research may continue to refine the hardware and software configurations for lightweight tactical clouds suitable for extreme-edge deployments in challenged environments, integrating command and control (C2) with intelligence, surveillance, and reconnaissance (ISR) software and services into a universal common operational picture for warfighters that synchronizes with tactical commands and headquarters when communications are available—and when not, maintains persistent C2/ISR capabilities with a full suite of machine learning services for warfighters at the tactical edge.

### **References**

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### **Acronyms**

AI/ML	artificial intelligence/machine learning
C2	command and control
CNO	Chief of Naval Operations
COP	common operational picture
D-DIL	denied-disconnected, intermittent, and limited
DCNO	Deputy Chief of Naval Operations
DMO	distributed maritime operations
EABO	expeditionary advanced base operations
EMS	electromagnetic spectrum
ISR	intelligence, surveillance, and reconnaissance
JADC2	Joint All-Domain Command and Control
LOCE	littoral operations in a contested environment
SWaP	space, weight and power

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