NAVAL POSTGRADUATE SCHOOL

WIC Warfare Innovation Continuum

An Interdisciplinary Exploration Into Future Conflict Solutions

Warfare Innovation Continuum (WIC) Workshop:

Hybrid Force 2045

September 2021

After Action Report

NAVAL WARFARE STUDIES INSTITUTE

CRUSER
Consortium for Robotics and Unmanned Systems Education and Research

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ACKNOWLEDGMENTS

Thank you to all those who made this workshop a success:

- To our design facilitators, both on the NPS campus in Monterey and on the NPS "Virtual Campus" via MS Teams, Mr. Travis Aion, Ms. George Campbell, Ms. Ann Gallenson, Mr. Garth Jensen, Mr. W. Kulzy, Col Todd Lyons USMC (ret), CAPT Tony Nelipovich USNR, Mr. Dave Nobles, CDR Chris O'Connor USN, Col Randy Pugh USMC, and Ms. Kristen Tsolis. All your work and expertise were absolutely reflected in the outstanding outcomes.

- To our panelists, mentors, and observers for sharing their time and expertise with the participants to better prepare them for their work.

- To all the participants for your willingness to join us for our first workshop in a hybrid format with participants in two concurrent realms – physical and virtual – and navigating all the pandemic protocols to keeps us all safe as we work to help shape the future.

EXECUTIVE SUMMARY

This Naval Warfare Studies Institute (NWSI) and the Consortium for Robotics and Unmanned Systems Education and Research (CRUSER), sponsored Warfare Innovation Continuum (WIC) workshop was held 20-23 September 2021 concurrently on both the Monterey campus and the 'Virtual Campus' of the Naval Postgraduate School (NPS). The three-and-a-half-day experience facilitated focused interaction for NPS students with faculty from across the NPS campus, fleet officers, and guest engineers from Navy labs, warfare centers, system commands and industry.

The September 2021 workshop "Hybrid Force 2045" tasked participants to apply emerging technologies to shape the way we fight in a 2045 global conflict depicted in the fictional scenario "Hybrid War 2045." Concept generation teams were given the design challenge: *How might emerging technologies, new operational concepts, and alternative fleet designs contribute to a more effective naval force across the spectrum from competition to conflict? How do the alternative fleet designs enhance the effectiveness and resilience of joint, combined and coalition forces across all domains?* Following panel discussions and presentations from leading technical and policy experts, the teams and their embedded facilitators had fourteen hours of scheduled concept generation time to meet that challenge and presented their best concepts on the final morning of the workshop. Teams worked at two levels of classification.

The "Hybrid War 2045" WIC Workshop included 128 registered participants in the roles of concept generation team members, facilitators, panelists, mentors, and observers – the full participant pool included representatives from 47 different organizations. Half of the workshop participants were NPS students and faculty drawn from over a dozen curricula across the NPS campus. For this workshop, the participant roster also included representatives from The Johns Hopkins University (JHU) Applied Physics Lab (APL), the Naval Information Warfare Command (NIWC) both Atlantic and Pacific, U.S. Army Pacific (USARPAC), the Office of Naval Research (ONR) Global, the Defense Acquisition University (DAU), Raytheon, and Lockheed Martin. An officer of the Romanian Navy, an Indonesian Defence University student, the innovation lead for the Royal Australian Navy, and the University of New South Wales in Australia ensured we kept a truly global perspective.

Participants were asked to propose both physical designs and concepts of operation for notional future systems' employment in a plausible real-world scenario with the intent of informing future fleet design work. From all the concepts generated during the ideation phase, each team selected concepts to present in their final briefs on Thursday 23 September.[1] NWSI leadership reviewed all the proposed concepts and selected ideas with potential operational merit that aligned with available resources for further research and development. The six concepts of interest (*listed alphabetically*) are:

1) **Enders GAM^{2}E:** generative architecture for military and machine execution; through reevaluate processes and incorporate AI-enabled technology to optimize human machine teaming

[1] all concepts presented are described either in the appendix of this report or in a classified annex available through appropriate channels

2) **JUJITSU "Belts":** joint undersea and seabed systems composed of just-in-time surfacing units designed for specific uses such as humanitarian (Blue Belt), intermediate conflict (Green Belt), and full-scale A2AD conflict (Red Belt)
3) **The Kelp Road Initiative:** network of distributed hardware and undersea infrastructure; intermediate force capability leveraging the undersea environment in the competition phase.
4) ***Morpheus*:** virtual training environment; virtualized capabilities
5) **RoAM Boat:** robotic autonomous manufacturing vessel for production, maintenance, and repair shop; additive manufacturing "mother ship"
6) **Shallow Submarine:** small diesel-powered littoral vessel, increased carrying capacity and shallow dive capability

These four additional concepts were selected to enhance work already underway:

7) Carrier strike group (CSG) resilience
8) Fast wing-in-ground (WiG) effect sea plane
9) Lightly manned autonomous combat capability (LMACC)
10) ***System-of-systems (SoS) network***

Selected concepts will inform research and exploration across the NPS campus over the next 18 months and will enable NPS students and faculty to work with stakeholders across the Department of Defense (DoD), academia, and industry to develop solutions for the future. This sort of applied approach ensures that NPS provides defense-focused graduate education, including classified studies and interdisciplinary research, to advance the operational effectiveness, technological leadership, and warfighting advantage of the Naval service.

I. BACKGROUND

The Naval Postgraduate School (NPS) Warfare Innovation Workshop acts as an innovation engine, leveraging operationally-focused students and defense-oriented faculty to address complex fleet issues – from technical to ethical and from concept-generation to experimentation. Small teams of early career professionals from the fleet, Navy labs, industry, and academia with diverse experience levels and perspectives spend three and a half days rapidly generating concepts of employment and evaluate risk within a future conflict scenario. Government, military, industry, and academic leaders vet these ideas before disseminating results back to Naval leadership. Sponsored by and the Naval Warfare Studies Institute (NWSI) and the Consortium for Robotics and Unmanned Systems (CRUSER), this Warfare Innovation Continuum (WIC) workshop was held on the NPS 'Virtual Campus' during Thesis & Research Week, 20-23 September 2021. Tasked with developing concepts of operations (CONOPS) in a near future global scenario with simultaneous conflicts on several distinct fronts, participants generated and proposed technologies to support their CONOPS in a future hybrid force comprised of human and autonomous assets.

A. ORIGINS

Innovation and concept generation are key drivers for NWSI, CRUSER and other NPS research efforts, and these workshops are a central element of the overall strategic plan for these initiatives. The first NPS Innovation Seminar supported the Chief of Naval Operations (CNO)-sponsored Leveraging the Undersea Environment war game in February 2009. Since that time, workshops have been requested by various sponsors to address self-propelled semi-submersibles, maritime irregular challenges, undersea weapons concepts and unmanned systems concept generation. Primary participants in these workshops are junior officers from NPS and the fleet; early career engineers from industry, U.S. Department of Defense (DoD) laboratories, and other Federal agencies; and officers from allied nations.

Beyond producing concepts of interest, these workshops are designed to maximize relationship building to strengthen the extended NPS community in the future. During Enrichment Week in September of 2012, the Navy Warfare Development Command (NWDC) and CRUSER sponsored a concept generation workshop that was focused on advancing the Design for Undersea Warfare.[2] The March 2013 workshop, Undersea Superiority 2050, took a more focused look at the undersea domain aspects of the September 2012 workshop outcomes. The September 2013 workshop looked at distributed surface and air forces and was the first workshop as part of the Warfare Innovation Continuum (WIC). The September 2014 workshop explored operations in contested littoral environments. The September 2015 workshop was designed to explore the concept of electromagnetic maneuver warfare, and tasked participants with employing unmanned systems in cross domain operations. Based on Fleet interest, the September 2016 workshop focused on developing autonomy to strengthen Naval power in response to CNO Richardson's release of the Design for Maintaining Maritime Superiority focusing document in January 2016. The September 2017 workshop "Distributed Maritime Operations" tasked participants to

[2] *Design for Undersea Warfare Update One*, November 2012: http://www.public.navy.mil/subfor/hq/PDF/Undersea%20Warfare.pdf

apply emerging technologies within a near future conflict in an urban littoral environment, and the 2018 workshop "Cross Domain Operations" looked at integration of assets. The September 2019 workshop "Logistics in Contested Environments" asked teams to focus on how to maintain forces in a sustained conflict. In addition to supplying topics for further NPS research, past WIC Workshops provided information and concept ideas to NWDC and the Marine Corps Warfighting Lab. The September 2020 Workshop "Resurrecting War Plan Blue" was held entirely on the NPS "Virtual Campus" via MS Teams during the COVID-19 pandemic. Leveraging lessons learned in the virtual environment, the 2021 workshop was the first hybrid format workshop, held concurrently on the NPS campus in Monterey with remote participation available via MS Teams.

B. PLANNING AND EXECUTION

Six concept generation teams presented over a dozen concepts generated over two days of focused work on the design challenge for "Hybrid Force 2045." In this first ever hybrid workshop held concurrently on both the NPS campus in Monterey and the NPS "Virtual Campus" via MS Teams, we had nearly 130 active participants from NPS, industry, OPNAV, civilian academia, the Fleet, systems commands, and international participants from Ecuador, Romania, the United Kingdom, and Australia. Concept generation teams composed of NPS students, civilian engineers, and researchers with diverse perspectives addressed issues related to future force design to maximize mission capabilities. We also had two U.S. only teams working on the NPS campus in Monterey in classified spaces on related challenges. Equal in significance to the concept outcomes was the opportunity to build and grow networks between NPS students and faculty, warfare center personnel, and industry engineers.

Four Discovery Panels included speakers from across NPS, the warfare centers, industry, and allied partner nations. We hope these presentations and the conversations they inspired will carry on well after the workshop experience. The objective of this report is to synthesize all the concepts provided by the teams for distribution to NPS researchers and NWSI stakeholders. This report will inform the NWSI Research Task Force Hybrid Force, and will influence NPS classes, research topics, experimentation, the NPS Systems Engineering and Analysis (SEA) capstone project, wargaming, prototyping and theses over the remaining nine months of the Warfare Innovation Continuum "Hybrid Force 2045". All work within the WIC "Hybrid Force 2045" – to include this workshop – will be summarized in a report to be available in July 2022.

Planning for this workshop began in earnest several months in advance of the event, purposefully scheduled the week between the end of classes and graduation in September each academic year to maximize the utility of NPS student time. NPS Thesis & Research Week – a week without regularly scheduled classes – is intended to allow all NPS students to participate in an activity to further their intellectual growth in specialized areas of study. These rapid concept generation workshops are an ideal fit for this mission.

Like the 2020 virtual workshop, the 2021 workshop used the NPS instance of Microsoft (MS) Teams for remote participation in the plenary sessions and for concept generation team breakout rooms. The NPS distance learning platform Sakai supported all materials for the workshop which allowed for participants to review materials in advance, and reference materials throughout the workshop as well as retrieve

results once posted. Concept generation teams also used free education accounts for the digital collaboration tool MURAL[3] to better incorporate remote participants. Two teams worked in classified spaces in Monterey, and the other four teams worked unclassified to include remote participants. All those who gathered on the NPS campus in Monterey complied with strict pandemic room capacity and masking protocols regardless of vaccination status.

1. Workshop Participants

Workshop participants were recruited from across the full NWSI and CRUSER communities to include NPS, DoD commands, academia and industry. A concerted effort was made to solicit representatives from all naval warfare domains, as well as from the full range of armed services on campus.

Figure 1. Warfare Innovation Continuum (WIC) Workshop "Hybrid Force 2045" participants, September 2021.

This September 2021 WIC workshop included 128 registered participants in the roles of concept generation team members, facilitators, panelists, mentors, and observers – the full participant pool included representatives from 47 different organizations. Half of the workshop participants were NPS students drawn from over a dozen curricula across the NPS campus. In addition, half of those on the roster participated in the workshop on the NPS campus in Monterey, California and the other half of the registered participants attended workshop activities on the NPS "Virtual Campus" via MS Teams (*see Figure 1*). To comply with pandemic room capacity restrictions some NPS personnel participated from their offices on the NPS campus. The six concept generation teams were organized to maximize diversity of participant experience.

[3] MURAL is a digital workspace for visual collaboration (https://www.mural.co/)

2. Workshop Design

The September 2021 workshop, "Hybrid Force 2045," leveraged the innovation lessons learned in previous workshops and was designed specifically to inspire innovative and rapid concept generation using tools of user-centered design. It was also the first rapid concept generation workshop to be held in a hybrid format – concurrently on both the NPS campus in Monterey and the NPS 'Virtual Campus' via MS Teams.

Scenario

All participants were given an overview of the future scenario titled "Hybrid War 2045"[4]. Written by workshop lead NPS Professor of the Practice Jeff Kline, this fictional scenario provided a launching point for the work but was not meant to be constrictive or prescriptive.

Process

The U.S. Navy (USN), and DoD writ large, have encouraged innovation at all levels and have pointed to Silicon Valley as an innovation exemplar. Product and software development based on user needs led Silicon Valley to become an innovation leader. These user-focused processes have evolved into what is now practiced as user-centered design – sometimes termed "Design Thinking" – in industry, academia, and now the military. The WIC Workshop employs tools of user-centered design for rapid and effective concept generation.

With the help of embedded facilitators, the teams use this "toolkit" to explore a complex military problem space and address the given design challenge. User input is gleaned from a variety of subject matter experts, and senior military, academic, and industry leaders serving as mentors. Some of this input is given formally as a plenary brief or panel discussion for assembled participants, as part of organized interviews, or informally throughout the workshop. This user input, as well as the assembled team's experience in the given problem space, is the data that begins the concept generation process. The second day of the workshop is focused on divergent ideation because teams need to create choices before they are able to make choices, and the third day begins by converging on a couple of concepts to develop and fully describe in their final presentations on the fourth morning of the workshop. Summaries of the six team presentations are included at the end of this report[5], as well as the full workshop schedule.[6]

[4] see Appendix B, pp 56-67
[5] see Appendix A, pp 18-50
[6] see Appendix C, p. 68

II. CONCEPT SUMMARY

Three knowledge-leveling Discovery Panels started the exploration of the problem space providing concept overviews and technology injects related to the design challenge. This workshop also included a fourth Discovery Panel on innovation in military spaces. Based on the plenary session guidance, read-ahead materials, and panelist input, each team generated numerous concepts and then selected their best ideas to present in their final briefs. Following the final briefs on Thursday 23 September 2021, NWSI leadership identified ideas with potential operational merit that aligned with available resources for broader dissemination.

A. Concepts and Technologies

Several emerging concepts and technologies were introduced during the three plenary Discovery Panels scheduled throughout the first two days of the workshop.[7] Teams were encouraged to consider how global geopolitics, future force design concepts and technology injects might impact allied forces in the scenario presented, but they were not required to include any inputs in their final selected concepts. Each panelist gave a short statement introducing their topic, and then participated in a moderated discussion and answered questions from participants. The 2021 Discovery Panels were:

1) Global Geopolitics
2) Force Structure
3) Emerging Technology
4) Innovation

In the first panel, a discussion of Global Geopolitics, three faculty members from the NPS National Security Affairs Department were joined by a guest from the King's College London Department of War Studies. The panel was moderated by an NPS faculty member from the Operations Research Department, and covered topics ranging from *Great Power Competition* to maritime strategy and doctrine. The panelists discussed the evolving definition of *hybrid war* as compared to *cold war* and posited what a future war might look like.

Moderated by NPS Operations Research Professor of the Practice and workshop lead Jeff Kline, the Force Structure panel included two NPS faculty members and three guests from think tanks. The assembled panelists brought perspectives from all traditional warfighting domains – air, surface, undersea, and land – and explored the impact of energy and life cycle costs on the design of the future hybrid force.

The Emerging Technology panel started the second day of the workshop with thoughts on human-machine teaming, preparing the future force to leverage artificial intelligence, and a catalog of recent essays on a variety of emerging technology in the maritime security space. This panel was moderated by an NPS Information Science faculty member, and included guests from ONR, a warfare center, and

[7] Please see Appendix C on page 68 for the full workshop schedule listing panelists, affiliations and topics presented.

industry. One panelist also shared a short example of recent prototyping and testing, and what they learned "by doing" – and how their concept has shifted through development as they incorporate lessons learned.

Finally, a group representing different perspectives working within the military "Innovation Ecosystem" shared their lessons learned to launch the third day of the workshop – inspiring teams to keep up the press through to the finish line. Moderated by a guest from industry, this panel included two NPS faculty members, a warfare center senior leader, and a member of the Royal Australian Navy's Innovation Centre. They discussed the theory and practice of rapid concept generation work across many different military environments and complex problem spaces and made a series of recommendations for future relationships to enhance future work.

B. Concepts of Interest

Key criteria used to select concepts of interest from all those proposed for further development were:

- Is the concept feasible (physically, fiscally)?
- Is the concept unique?
- Does the concept solve a key problem or fill a key gap?
- Is the concept testable?

The 2021 concepts of interest are:

1) **Enders GAM^{2}E:** generative architecture for military and machine execution; through reevaluate processes and incorporate AI-enabled technology to optimize human machine teaming
2) **JUJITSU "Belts":** joint undersea and seabed systems composed of just-in-time surfacing units designed for specific uses such as humanitarian (Blue Belt), intermediate conflict (Green Belt), and full-scale A2AD conflict (Red Belt)
3) **The Kelp Road Initiative:** network of distributed hardware and undersea infrastructure; intermediate force capability leveraging the undersea environment in the competition phase.
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These four additional concepts were selected to enhance work already underway:

1) Carrier strike group (CSG) resilience
2) Fast wing-in-ground (WiG) effect sea plane
3) Lightly manned autonomous combat capability (LMACC)
4) System-of-systems (SoS) network

These concepts will guide NPS student and faculty exploration through FY22. Unclassified details of these concepts as presented are included in Appendix A (*pp. 18-50*) of this workshop report.

C. Key Takeaways

After the final concept presentations on Thursday 23 September, workshop leads identified four overarching insights:

1) **Human-in-the-Loop Machine Learning** – using human decision making in wargaming multiple tactical situations to farm a data base for supervised machine learning
2) **Leveraging the Undersea Environment** – across the spectrum of competition and warfare by creating sea floor infrastructure and capability now
3) **Autonomy in Sustainment** – sustainment, repair, and replacement through unmanned system platforms with additive manufacturing capability
4) **Future Fleet Design** – a future fleet of "forward" high risk offensive and primarily unmanned systems with a more traditional sea control and defense force currently found in our carrier strike group capabilities

These four key themes will likely be heavily featured in the work of the NWSI Hybrid Force Research Task Force throughout FY22.

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III. WAY AHEAD

Of all the ideas generated through the facilitated design process, each team selected concepts to further explore and present in their final briefs. Of all the concepts presented on 23 September 2021 a handful of ideas were selected as concept of interests to plant *idea seeds* for research across the NPS campus. The NPS System Engineering Analysis (SEA) cohort will also use the foundation of the workshop concepts to begin their capstone project required for their degree with anticipated completion in eighteen months. Additionally, the concepts from each annual workshop are taken with participants back to home organizations and commands to inform future work.

A key outcome of the annual WIC Workshop is all participants leave the workshop experience with a set of tools to approach the next complex problem space they face in their careers. Innovation is more than a buzz word – the work of innovation takes tools but does not require a significant investment of time. With a task defined by exploration of the problem space a solution might come from anywhere and is more likely to emerge rapidly through focused work by a small team looking at the same problem space through the many lenses of different perspectives.

A. Naval Warfare Studies Institute (NWSI)

The mission of the Naval Warfare Studies Institute (NWSI) is to coordinate NPS inter-disciplinary research and education to accelerate and enhance warfare concept and capability development.

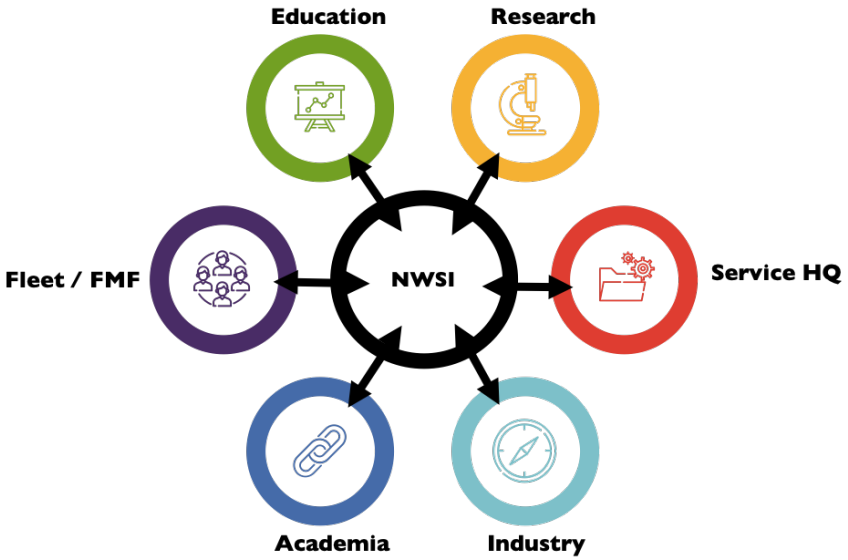

Figure 2. Naval Warfare Studies Institute (NWSI) at NPS is a hub for warfighter expertise.

NWSI is a hub of experts that enable teamwork and collaboration with the NPS innovation ecosystem to optimize NPS' inter-disciplinary educational and research response to Naval warfighting needs (*see Figure 2*) and accelerate and enhance tactically and technically informed solutions to the Naval forces. NWSI provides a portal to access NPS talent, resources, and facilities. NWSI informs, coordinates, integrates, and advocates in support of the USN N7 and U.S. Marine Corps (USMC) Combat

Development and Integration (CD&I) requirements. NWSI is currently organized with four primary branches:

- Critical Thinking & Judgement
- Emerging Technologies
- Concepts
- Wargaming

Joining the Warfare Innovation Continuum (WIC) "Hybrid Force 2045", in FY22 these four NWSI branches along with warfare domains and disciplines across the NPS campus will contribute to six planned research task forces to align with Naval leadership priorities:

1) Task Force Overmatch – *launched FY21*
2) Task Force War Plan Blue – *launched FY21*
3) Task Force Hybrid Force – *launched SEP 2021*
4) Task Force Maritime Gray Zone– *launched NOV 2021*
5) Task Force Arctic – *anticipated launch in early 2022*
6) Task Force Blue-Green Integration – *anticipated launch in mid 2022*

As new priorities emerge for Naval leadership NWSI will follow with a dedicated task force. Please visit the NWSI website (https://nps.edu/web/nwsi) for more information about the institute, partner efforts, and to apply for membership to stay informed on new efforts to support current and future warfighters.

B. Warfare Innovation Continuum (WIC)

Under the program umbrella of NWSI, the Warfare Innovation Continuum (WIC) encompasses the successful research, education, and experimentation efforts, ongoing at NPS and across the greater Naval Enterprise. The goal of the continuum is to align regularly scheduled class projects, integrated research, and special campus events into a broad set of coordinated activities that will help provide insight into the opportunities for future naval operations, fleet architectures, and fleet design. Exploring a new topic area each fiscal year, the WIC is a coordinated effort to execute a series of cross-campus educational and research activities that share a central theme. Classes, workshops, and research projects are synchronized to leverage and benefit from prior research that results in a robust body of work focused on each annual topic area.

By incorporating topics of fleet interest into established academic courses and by supporting student thesis project research, through the WIC structure students and faculty promote research that aligns with fleet priorities while simultaneously achieving the educational requirements for the graduate students. The 2021-2022 WIC "Hybrid Force 2045" (*see Figure 3*) address the question *"How might emerging technologies, new operational concepts, and alternative fleet designs contribute to a more effective naval force across the spectrum from competition to conflict? How do the alternative fleet designs enhance the effectiveness and resilience of joint, combined and coalition forces across all domains?* Final reports are available for all prior continuums dating back to 2013.

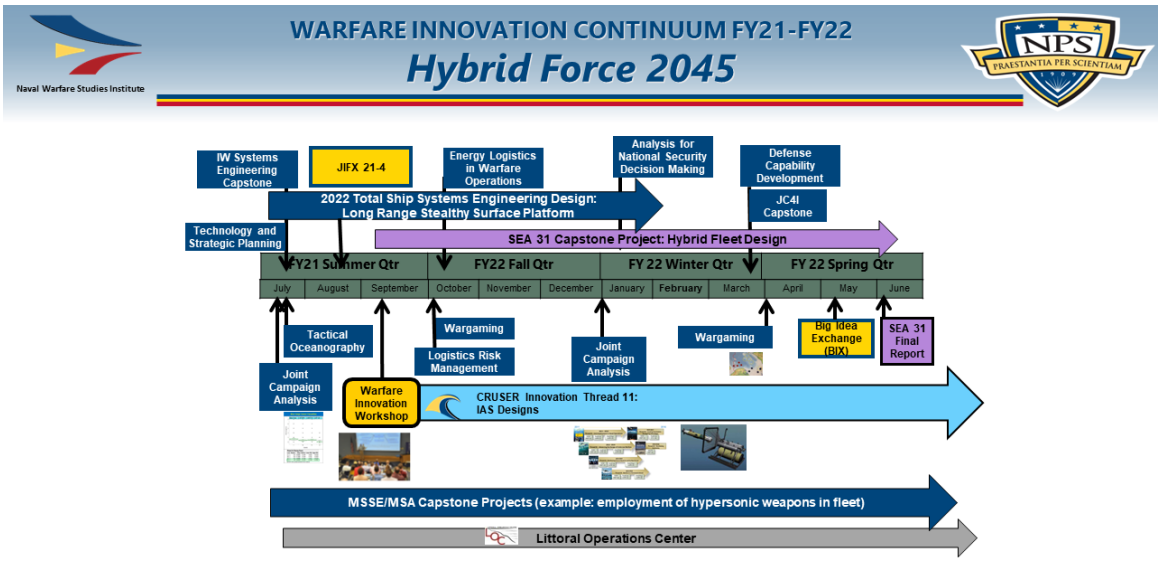

Figure 3. NPS Warfare Innovation Continuum (WIC) 2021-2022, Hybrid Force 2045.

This September 2021 workshop will likely be the last workshop to be incorporated into a full WIC framework. Future rapid concept generation workshops at NPS will launch each NWSI research task force as they are stood up in response to Naval leadership priorities.

C. CRUSER Support

The Consortium for Robotics and Unmanned Systems Education and Research (CRUSER) has leveraged the September rapid concept generation workshop to support their program needs for many years. In addition to the concepts and technology proposals, the September 2021 workshop also supports key elements of CRUSER's charter: 1) the advancement of general unmanned systems knowledge among the participants; and 2) a greater appreciation for the technical viewpoints for officers, or the operational viewpoint for engineers. The information interchange and relationship building that occurred during this event were characteristic of the workshop venue, and support CRUSER's overall intent.

CRUSER also provided labor support for workshop personnel. Planning takes six months, with the last three months pulling full time effort. The start of September each year involves labor hours to plan and prepare from several individuals throughout not only NPS, but the full Naval research enterprise as facilitators and subject matter experts. CRUSER also supports labor to produce this final report each year.

Ideally, final concepts of interest from this WIC Workshop will filter through CRUSER affiliated researchers throughout FY22, inspiring new research threads and contributing to research already underway.

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APPENDIX A: Final Concepts

Six teams presented their final briefs on Thursday 23 September 2021 and were each given 15 minutes to present their most developed and promising concepts. The following concept summaries were created from these final presentations. The two teams working the challenge at the classified level presented on Thursday afternoon and full summaries are available through vetted request through appropriate channels.

A. Team Hybrid 129

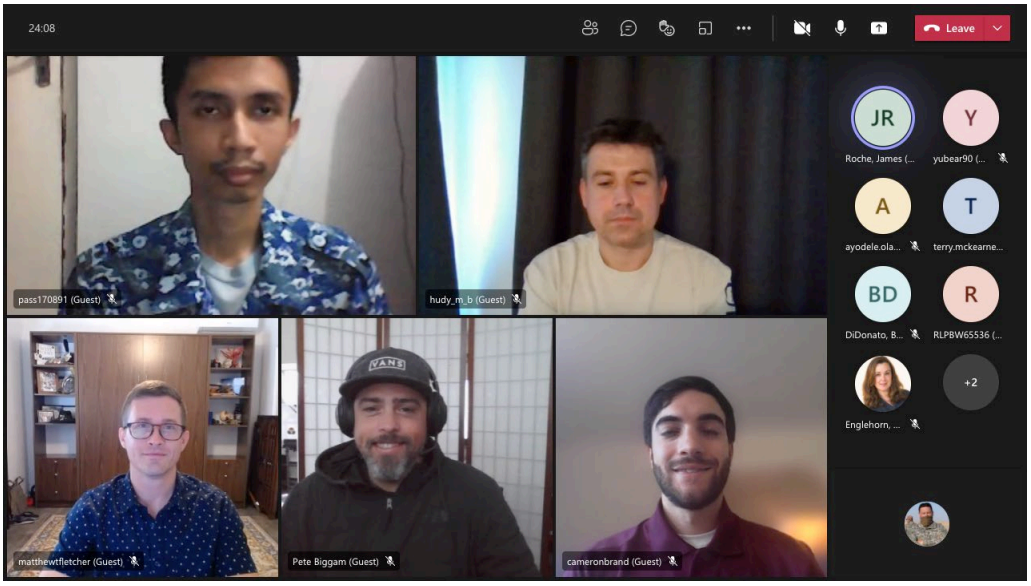

Figure 4. Members of Team Hybrid 129 *(pictured clockwise from top left)* A. Seno INDONESIA, LT A. Hudisteanu ROMANIA, C. Brand, P. Biggam, M. Fletcher, September 2021.

The members of this team (*see Figure 4 and Table 1*) included three officers and six engineers. The participants represented academia, industry, and three nations. The team was facilitated by a senior level warfare center representative and a US Navy ONR reservist, and included an NPS faculty member.

Table 1. Members of Team Hybrid 129 (*alphabetical by last name*)

NAME	**PERSPECTIVE**	**AFFILIATION**
Mr. Pete Biggam	*Entrepreneur (Mentor)*	Blacksite Solutions, Inc.
Cameron Brand	*Structural engineer*	JHU Applied Physics Lab
Ben DiDonato	*Systems Engineer*	NPS Information Sciences
Dr. Matthew Fletcher	*Operations Analyst*	Raytheon
LTN Alexandru Cristian Hudisteanu	*International*	Romanian Navy
Garth Jensen	*Facilitator*	NSWC Carderock
Quinn Matthew	*Electrical Engineer*	JHU/APL
CAPT Tony Nelipovich USNR	*Facilitator*	ONR
Ariel Prabawa	*Operations Engineer*	Raytheon
Ario Seno	*International*	Republic of Indonesia Defense Univ.

Although this team started as a hybrid team with half of their members working on the NPS campus in Monterey and the other half on the NPS "virtual campus" via MS Teams, due to a targeted regional internet outage on Tuesday 21 September the team was reconfigured and worked with only remote participants and facilitators. The resident participants originally on their team were reassigned to Hybrid 122.

Forward Deployed Hybrid Force

From the given scenario the reach of the adversary is growing, and the team anticipates that to continue through to the year 2045. This will prevent future forces from getting close enough to be effective with large, manned assets such as carriers and destroyers without putting many people and a lot of money under the threat of adversary missiles and submarine. The team focused their work with this problem statement:

> *How might we operate in this highly lethal environment and how might we dismantle it to provide freedom of operation to our existing assets?*

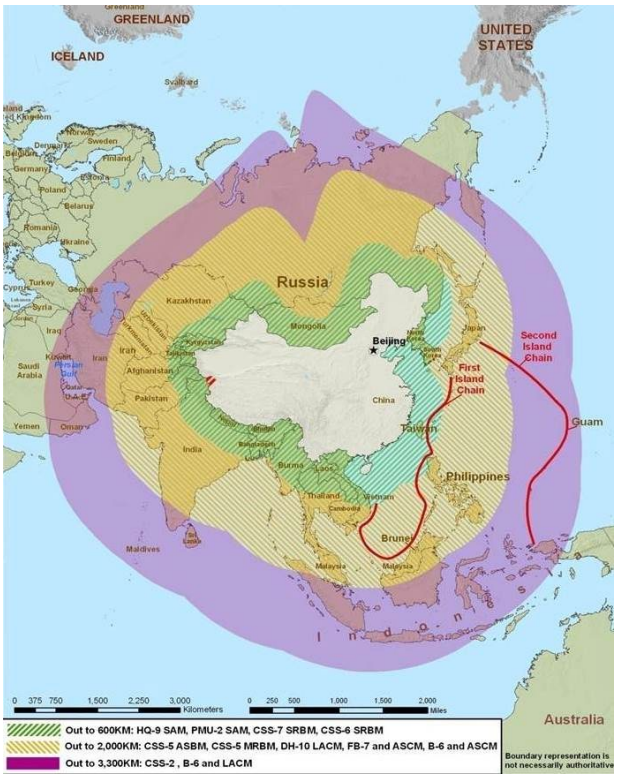

Figure 5. A map of the notional future area of responsibility (AOR) with ranges noted.[8]

They proposed a forward deployed hybrid force – a mixed force deployed in three layers. The first buffer layer of small, unmanned vehicles that would act as the sensors for other shooters, backed up by medium unmanned and lightly manned vehicles in the intermediary buffer area. The existing large fleet would support from the very back with a set of smaller more risk tolerant and survivable "go between"

[8] Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2010, p. 32

systems connecting all three layers of the deployed force. The small unmanned aerial vehicles (UAVs) would conduct targeting, and all assets would be supporting regional allied forces deployed on the islands in the area of responsibility (AOR) (*see Figure 5*). Using these deployed forces to peel back the layers of the enemy's defensive onion, we will then push our existing fleet closer giving us a credible non-nuclear deterrence to allow forward deployment in the competition phase before conflict putting larger assets such as aircraft carriers at risk within the target range of the primary adversary (*see Figure 6*).

Coverage Expansion from S-400 SAM and J-10 Deployment to South China Sea Airfields

Figure 6. Coverage expansion from S-400 SAM and J-10 deployment to South China Sea airfields.[9]

Core Combatant – the Lightly Manned Autonomous Combat Capability (LMACC)

The core combatant in this forward deployed force is the lightly manned autonomous combat capability (LMACC) which is a small lightly manned warship (*see Figure 7*) that is built like an unmanned surface vessel (USV) with heavily automated systems, but it has a permanent crew of 15 sailors. The LMACC is about 200 feet long, has a 6 1/2-foot draft, displaces 600 tons, and has a range of over 7500 nautical miles. The vessel is armed with eight long-range anti-surface cruise missile (LRASMs) – its primary weapon – and backs that up with 36 spike NLOS medium-range anti-surface missiles, seven pintle mounts which each carry a Javelin and either an M2 Browning or Mark 19 automatic grenade launcher, and a 105-millimeter Howitzer (a 155mm howitzer is not possible because its bagged charged would get wet and a turreted weapon would cost too much). For defense it has a SeaRAM[10] and the full-size AN/SLQ-32 electronic warfare suite[11] which is designed to protect the Arleigh Burke class destroyer – *"so it's massively oversized for excellent survivability on in this application."*

[9] "Effects of South China Sea Air Strips on the Range of Chinese Surface-to-Air Missiles and the J-10 Fighter" *Journal of Political Risk* Vol 3 No. 5, May 2015 (https://www.jpolrisk.com/effect-of-south-china-sea-air-strips-on-the-range-of-chinese-surface-to-air-missiles-and-the-j-10-fighter-asean-countries-threatened-by-expanding-chinese-air-power/)

[10] Raytheon's SeaRAM ship defense system (https://www.raytheonmissilesanddefense.com/capabilities/products/searam-ship-defense-system)

[11] Raytheon's electronic warfare suite (https://www.raytheon.com/capabilities/products/slq32)

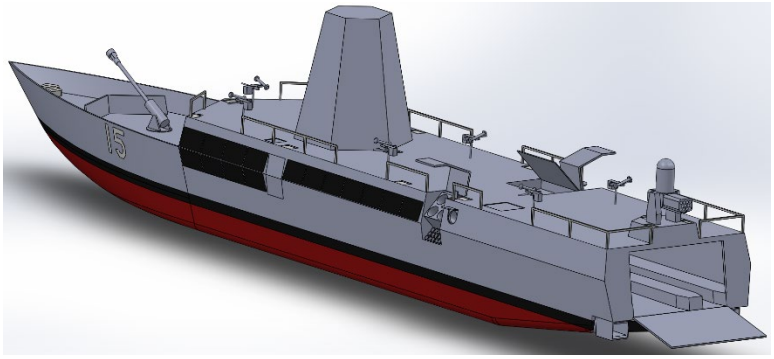

Figure 7. Lightly manned autonomous combat capability (LMACC).

The deployed LMACC will serve as a command-and-control node for unmanned assets in the AOR. To avoid giving its location away, the LMACC relies heavily on passive optical sensors with only a commercial off-the-shelf (COTS) navigation RADAR – to better blend in with the signatures of expected civilian traffic. Offensively, LMACC will team with unmanned spotters like medium displacement USVs (MUSVs), using them to detect the enemy and allow the LMACC to act as a primary shooter and use LRASM's routing and networking to have the missile fly deceptive routes and mask the launch point. This combination of assets, capabilities, and tactics will allow the LMACC-centered team to defeat the enemy and secure the first island chain.

USVs are too vulnerable to boarding to fill this role, and we do not have a clear understanding of what might be allowed within future legal regimes for self-defense of unmanned assets. This limitation is exacerbated by the fact that the Chinese will jam communications as part of a boarding attempt to force these USVs to act on their own limited initiative. For this reason, the team placed the missiles only on the manned platform. LMACC also takes advantage of its crew for its launch bay which also has dedicated facilities to launch and recover UUVs and seabed systems for forward, deployed, and persistent collection in contested areas. There are also a variety of long-hull variants which insert a hull segment to add new capabilities like air defense and a seabed system storage and support bay which would let it handle very large numbers of seabed systems to rapidly deploy large undersea sensor nets or minefields if desired. Since every LMACC will have some ability to deploy these undersea and seabed systems, we could cause serious problems for the Chinese in peacetime with deceptive routing. For instance, if the ship loiters over a bunch of points where we know they have things on the bottom, we would force our adversary to check out every one of them. *"Even if we don't do anything while we're there – they just go point to point and make them come out and spend a bunch of time and money."*

Since past efforts to reduce manning have shown the consequences of not accounting for the risk of overly optimistic reductions, there are 31 beds for 15 crew to allow for unexpected crew growth and detachments, especially from other coast guards in the region. In combination with its launch bay which can support an 11-meter RIB or a small USV, this makes LMACC ideally suited to supporting maritime law enforcement and other gray zone operations. In wartime, this large RHIB and the free beds also allows LMACC to transport Marines and light supplies, making it an integral EABO support asset in addition to its primary combat and command and control (C2) roles to maximize flexibility. Finally, it is also able to launch UAVs thanks to a dedicated storage box on top of the vessel for overhead surveillance and to spot malicious activity from over the horizon. *"We bring on their detachment,*

connect them with issues, and help them enforce the law" which makes it very difficult for the Chinese to push back against our partners since they're on a U.S. warship. If the Chinese get too aggressive against our joint maritime law enforcement operations, it becomes a threat to the U.S. military and we can respond accordingly.

Figure 8. An example of a fast wing-in-ground effect seaplane.[12]

Survivable Support Assets – F-WiG and Shallow Sub

The team then presented two examples of survivable support assets. Of the possible platforms that might be needed to support this forward deployed force in the buffer zone they first presented the fast wing-in-ground effect (F-WiG) seaplane (*see Figure 8*). The F-WiG can loiter by floating on the water when not in transit, so much like an amphibious ship could deploy or retrieve forces without an airfield. However, as an aircraft it can also cover distance more quickly than a ship without the threat of submarine interdiction while also being harder for long range missiles to target because it leaves their search area. The size and speed of the basic concept could be designed for various missions, with smaller ones used for patrol and attack or larger ones used for transport of troops, supplies, and unmanned vehicles (UxVs).

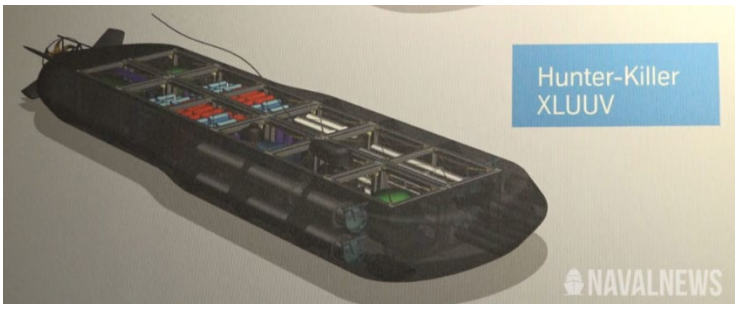

Figure 9. An example of the type of vessel envisioned for the *Shallow Sub* concept.[13]

The team also presented a shallow diving submarine concept (*see Figure 9)* to avoid satellite observation and ship or aircraft radar detection. The *Shallow Sub* has more carrying capacity (*see Figure 10*) than the

[12] This example is a concept in development by Regent, a Boston-based company, and the concept art is from the article *"Regent to build high-speed electric ground-effect 'seagliders'"* by Loz Blain in the 11 May 2021 issue of New Atlas (https://newatlas.com/aircraft/regent-seaglider-ground-effect/)

[13] Conceptual art of Thyssenkrupp Marine Systems' Modifiable Underwater Mothership (MUM) project. (source https://www.navalnews.com/naval-news/2020/06/tkms-presents-the-results-of-its-mum-modular-xluuv-study/)

seaplane and is able to operate in shallow littoral environments without needing to dive deep on missions. This diesel-powered asset is relatively small compared to the existing SSN fleet and will be much less expensive to operate than most U.S. Navy submarines, by using conventional propulsion and without their deep diving pressure hulls to increase carrying capacity for any given mission. It can perform many of the same troop transport, resupply, and UXV deployment missions as the F-Wig.

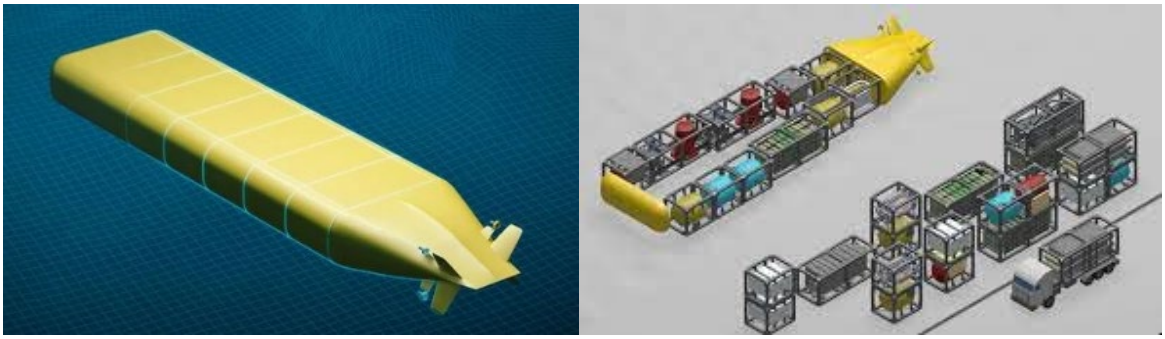

Figure 10. Example of the potential carrying capacity of the envisioned *Shallow Sub*

Both the F-WiG and *Shallow Sub* are envisioned to be lightly crewed to start but could be transitioned to fully autonomous to meet future mission requirements and keep humans out of harm's way. With more survivability and flexibility than traditional ships or planes, the F-WiG and *Shallow Sub* will support and connect the dispersed sea or island forces deployed in the area of operations within the opposition's weapon engagement zone and between deployed forces and bases operating safely outside of the reach of enemy missiles. Forward deployed in the competition phases, these survivable support assets will likely avoid conflict with maritime militias, while remaining available at the outset of conflict. The F-WiG is difficult to catch up with, and the *Shallow Sub* would be difficult to spot and board.

These relatively small survivable assets could support a variety of missions. Examples include troops deployed to forward operating bases (FOBs) on islands or in the Arctic or along coastlines that could conceal under camo, in a cave, or under tree cover might use these small survivable assets to relocate between islands regularly, or after firing, to avoid targeting. These troops could also deploy all domain fires with missiles such as the SM6 or guided projectiles such as HVP via the ERCA cannon. Finally, these austere bases would also provide a refueling and reloading "jump off point" enabling F-35Bs to serve as sensing, coordination, or shooting nodes in the area of operations without returning regularly to vulnerable carriers or amphibs, resulting in a much higher sortie rate and less risk to those large ships. Specific missions for these survivable support assets would include:

- ***amphibious troop and weapon transport*** for forward operating bases allowing F-35Bs to operate in the area without risking aircraft carriers
- ***all domain fires*** forces resupplied by these relatively small and survivable assets which could insert and remove forces as well as relocating them among a number of islands or locations along an island to make targeting for the enemy more difficult in counterbattery operations enabling them to target aircraft and ships such as guided projectiles from cannons or missiles, which would allow islands to deny areas to the enemy at sea

- ***at sea resupply, recovery, deployment and relocation*** of UXVs enabling small and attritable uncrewed subsurface, surface, and air vehicles to operate far from bases by carrying and refitting them closer to the front, also acting as an intermittent command node between autonomous missions
- **patrolling** open ocean areas
- **strike platform support** for any targets found by the smaller frontline layer of autonomous vehicles

These frontline vehicles, while small, attritable, and affordable, will likely be lacking in range and endurance and will not be able to operate indefinitely forward deployed on their own. For this CONOP to be effective it needs *"essentially a school bus"* to bring that first layer of smaller assets to and from the fight. In addition, the additional carrying capacity of the *Shallow Sub* acts as a refueler or tanker to support aircraft, unmanned surface vehicles, ground forces, and other assets in these forward deployed environments without risking a large conventional tanker.

To mitigate the challenge of operating in this highly lethal environment with large quantities of affordable and risk tolerant, lightly manned or unmanned vessels. In 2045, this forward deployed force – a hybrid force – will provide reassurance and defense for our allies. Deterrence is achieved through the assurance that we are willing to employ this forward deployed hybrid force without risking our larger, more expensive, and heavily manned assets.

Questions & Discussion

Workshop lead Jeff Kline commented that this proposal sounds a lot like a bimodal force that has been proposed and thought about at NPS, but this put some real meat on it. With this concept as a foundation, follow-on work might include command and control of this force, resilient capabilities, and in graduated Gray Zone operations.

The first question to the team was about how they envisioned integrating land force capabilities into the forward force because "*we have a lot of allies in that region and our own land forces are looking at advanced basing in that area as well*." The use of the LMACC provides several ways to integrate land force capabilities. Being the logistics connection and providing support and carrying things forward integrates this forward deployed hybrid force with land capabilities, as well as joint command and control. LMACC's primary over the horizon datalink is a high frequency system that is at least somewhat compatible with what the Marines have today, "*so that will allow us to bounce signals down to them, and then we'll be able to plug into their command and control*." Depending on the situation, the LMACC might also serve as command and control for land forces. There is very much an exchange of information planned. With respect to the ground forces specifically, with covert deployment from the submarine or fast deployment from the seaplane, forces could be deployed to likely uninhabited islands and archipelagos in the area or austere operating bases and retrieved or resupplied as needed. In addition, this forward deployed hybrid force could ferry around Allied forces and stiffen them by deploying our own defensive or offensive missile or cannon batteries alongside their existing ground forces. This concept is ripe for further development as far as command, control, and communications

go, locally at NPS or at a major operation or military center. The integration across those capabilities would be a great subject for further research.

The next question was when the team considered what LMACC might carry in 2045, if there was any consideration for directed energy weapons or other electronic countermeasures, and if so is there enough power to actually incorporate those or other electronic warfare systems other than just the AN/SLQ-32 that you had envisioned in their concept as presented. The short answer is yes – LMACC uses an integrated electric propulsion system. All the engines are producing electrical power, which then goes into propulsion. That means we can reroute that to directed energy weapons and any future upgrades of things like the AN/SLQ-32 as they keep improving and changing. Since the LMACC is a relatively small vessel, the plan is to build them with the latest and greatest systems, use them for 20 years, and then donate them to someone else – just keep cycling them through so we always have the latest and greatest. Our allies then get the second-hand but still usable vessels – just not brand new. That said, the LMACC will be built as affordably as possible so our allies could afford to purchase the newer ones as well if desired. In fact, there was an integrated crew concept proposed a couple years ago where the operations would be integrated to enhance Allied cooperation. *"Of course, we'd be happy to sell new builds to Allies that are interested in buying them."* However, many nations with very limited budgets cannot procure as many ships as they need. Maybe a nation buys one, and then we send another one to some other nation who needs one that cannot afford it – like the Tom's shoe model.

The next question about the LMACC was about whether the capability for glide munitions in development for the Army's 155 millimeter howitzers was considered. The key point to remember is that the larger gun uses bagged charges, and we cannot bring those into an open deck mount on a ship. "*They'll get wet, and it'll be a disaster*." We will need to use the smaller 105 because it has a cased round that can be prepacked and sealed. That said, the LMACC will have a standard 105-millimeter Howitzer which will probably be a very minimally modified version of what the Army is currently using. Any standard Army 105-millimeter round will go in and fire just fine, and most 155mm rounds also come in a 105mm version or have one developed eventually. That means the new glide munition will be available once it makes its way down to the smaller gun. That said, it would be possible to build a simple turret enclosure around a 155mm gun to allow the use of bagged charges and long-range guided rounds if the Navy wants to pay for it, most likely in a future version after the initial design has proven its capability and cost effectiveness.

B. Team SEA Hybrid 115

Figure 11. Resident members of Team SEA Hybrid 115 *(pictured from left to right)* CDR N. Walker USN, LT R. Sunda USN, Dr. W. Elmer, September 2021

This team was originally to include both remote and resident team members, but due to an internet connectivity issue most of the remote members of the team had trouble participating. The active members of this team (*see Figure 11 and Table 2*) included three Navy officers, and three guest engineers, from academia, industry, and a government lab respectively. Only three participated in residence in Monterey, and the others joined the team remotely via MS Teams. The team was facilitated by a retired Naval officer from JHU/APL and a current member of the TANG team, and included three NPS students.

Table 2. Members of Team SEA Hybrid 115 (*alphabetical by last name*)

NAME	PERSPECTIVE	AFFILIATION
CAPT Frank Cowan USN	*Cyber Warfare*	OPNAV N2N6W
Dr. William Elmer	*Engineer (Mentor)*	LLNL, DOE
W. Kulzy	*Facilitator*	JHU/APL
Dr. Nicholas Stowe	*Naval Architect*	JHU/APL
LT Russell Sunda USN	*Surface warfare officer*	NPS Systems Engineering Analysis
CDR Nathan Walker USN	*Naval Aviator*	NPS Systems Engineering Analysis
Dr. Andy Wilde	*Undersea Warfare*	Raytheon

The team named themselves “The Sword of Damocles” and presented a carrier strike group resilience theory. Through their concept generation process they worked to carry the resiliency and the prestige of the carrier strike group (CSG) through to a future where a carrier might not exist. Their problem statement was:

> *How might we match the deterrent effect and combat capability of a carrier strike group (CSG) while increasing adaptability and resiliency?*

The carrier strike group is really too often the go to solution for any contingency that you have throughout the world. As the number of presence deployments increases it decreases airwing readiness and mission capability, as well as decreasing the mission capability rates for all aircraft. The carrier life cycle is also shortened, and this will impact future conflicts as the team maintained that the CSG will still be an important force in the battle in 2045. What resonated with workshop leadership from the concepts generated by this team was a need for many more intermediate force capabilities because as we integrate these smaller vessels with allied forces across the areas of concern, we are increasing our own influence in those areas as well as potentially providing intermediate force capabilities for some things like maritime governance.

To lay the foundation for their concept, the team discussed resilience and prestige. *Resilience* derived from Latin means *to spring back*, therefore the readiness component is very important. Current missions and operational tempo are degrading readiness through using up carrier life faster than anticipated and decreasing personnel retention. "We want to make sure that we retain folks who are going to be a part of this battle in 2045" while maintaining the deterrent effect of the deployed carrier. Part of the deterrent effect comes from this other word: *prestige*. The original meaning of prestige has essentially been lost. In Latin, the word prestige meant *deceit*, and then in French it evolved to mean *an illusion*. In this concept generation process the team used the word prestige to refer to a way to make the enemy think that they have a problem that needs to be solved – when they may not. "If you think about it as a magic trick, something where you have the ability to project what you want the audience to see."

"Much of this problem that we define came from the whining and complaining of one of the aviators in our group." Having experienced firsthand burning holes in the South China Sea to then suddenly be re-tasked to South Korea to stomp out the problem with ICBM launches demonstrated that the use of the carrier as the end all solution to all problems in the world is infeasible. Using carriers this way is degrading the readiness of not only the strike group, but the pilots and the aircraft as well. Aviators were just asking too much, and the usefulness of the carrier for what it is supposed to do with strike aviation is increasingly degraded. Projecting power deep inland needs to be replaced with a new solution.

Future Distributed Fleet

The team developed a concept that would reduce costs and increase the readiness of the CSG by holding them in reserve. The team proposed replacing the deployed CSG on power projection missions with a large quantity of manned and unmanned teams of vessels capable of matching the combat capability of a CSG. These teams of vessels could project the same power with the same deterrent effect as a CSG. Bringing deployed CSGs back home would enable us to increase maintenance and training of the pilots and increase mission capable readiness on the aircraft so that all assets are ready when needed.

For example, in the South China Sea the presence of the carrier lets the Chinese know that there is this massive capability sitting offshore. The power projection capability of a carrier is something to behold, so the team wanted to mimic that capability. Coupled with networked sensor vessels, a large number of manned LMACCs in formation with equally capable unmanned LMACCs, LUSVs and MUSVs could replace

the CSG. The LMACCs would be equipped with LRASM or possibly Tomahawk or maritime strike Tomahawk capabilities. Massive numbers of this combination of vessels could present the required force projection capability to deter an adversary in the competition phase by absorbing that sea space and making our presence known. However, this increased number of vessels will increase the logistics requirement. The carrier is essentially self-sufficient. With just supply ships coming out to it to supply JP5 and food for the crew a carrier is fairly self-sustaining. Replacing the CSG require improved relations with allies in contested regions, maybe building naval bases in any future potential AORs to address the logistics requirements and maintenance needs for these teams of LMACCs that will be roaming the seas.

This new force structure provides physical presence and will be a distributed force with many targets instead of the single carrier that presents itself as a "nice juicy target" for a DF 21 or 26. The combined force projection capability will provide deterrence. The number of assets enables flexibility so if one of those LMACCs goes down there is another to replace it whereas if the one of the screws[14] goes down on the carrier it is a big a loss and sometimes hard to fix. Sending twelve cycles of sorties with many aircraft up burning JP5 or JP8 all day long is expensive. Replacing the carrier with these smaller groups of small ships would likely reduce costs. Finally, many small assets will decrease enemy targeting capability – the enemy can target a few, but they are not going to get all of them. The carrier represents "one single juicy target." If the adversary strikes one of the LMACCs, we will have many options to replace the combat capability. If the competition phase fails and the enemy decides to go kinetic, we now have the initial strike capability with that projected force being in place to launch our offensive weapons to match the enemies strike. As we are launching LRASM or maritime strike Tomahawk or Tomahawk on land-based targets, that gives decision makers time to determine what the next step might be: *Do we bring down the carrier strike fleet from Japan? Do we send another one from the Pacific Coast?*

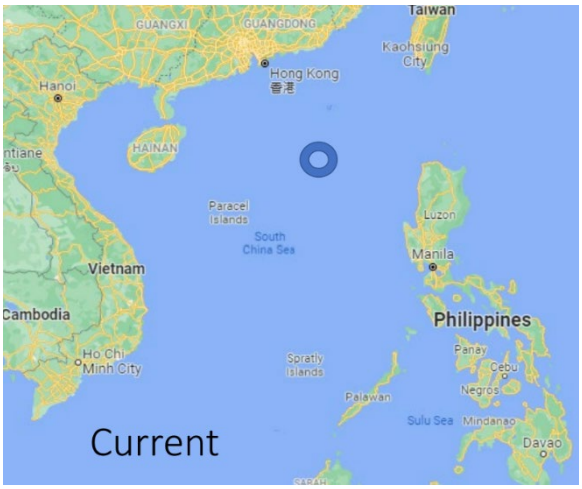

Figure 12. Current CONOPS solution is based solely on a single deployed carrier (*blue circle*).

The current CONOPS solution was one carrier with many aircraft projecting power and providing physical deterrence based off of the known CSG capabilities (*see Figure 12 blue circle*). Future presence

[14] the propeller

will demand many small assets distributed throughout the AOR in a combined sensor network, sharing information on contacts detected in the area (*see Figure 13, blue triangles*).

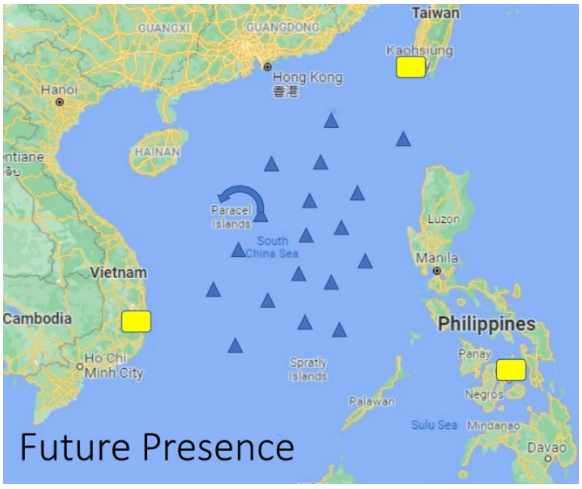

Figure 13. Future proposed CONOPS will lead with a distributed fleet of small autonomous and lightly manned vessels (*blue triangles*) supported by bases in allied nations (*yellow squares*).

This future state will require basing in allied nations (*see Figure 13, yellow squares*) to support the maintenance and logistics cycles of these mini ships. If we get into the sea denial phase, campaign forces can amass quickly and execute a show of presence or show force *en masse*. Ships that need repair or resupply (*see Figure 14, orange triangles*) will head back to port as they are replace by fresh vessels.

Figure 14. Future CONOPS in sea denial phase of conflict would rapidly replace damaged or destroyed assets (*orange triangles*) from bases in allied nations (*yellow squares*).

Finally, if we do have that standoff and we need an extra CSG we could augment the force already in place with a CSG (*see Figure 15, blue circle*) resulting in a much more capable force with essentially double the firepower.

Figure 15. The future CONOP in the sea control phase could add a carrier (*blue circle*) to add overwhelming power projection.

The team initially discussed challenges but decided in the end that they were really identifying culture shifts needed to be addressed before we are faced with a 2045 scenario that requires a complex system that is not feasible right now. What do we need to do to give capabilities time to develop and evolve to be ready for that 2045 scenario? What do we need to start now? What could happen next – in 10 years?

Trust in artificial intelligence (AI) capability is essential, so the incremental acceptance needs to start now and start small. *"I don't need a partner vessel cruising around with my destroyer that has a directed energy weapon. It doesn't even need radar – just have it cruise out beside me and let's test that out and start there. Start small."* Acceptance of risk such as the poor airborne early warning and anti-air warfare that our proposed force has now, we need to move to a future state where risk is distributed, and we are more accepting of the risk – it is lower cost, and we can accept that risk. Sealift capabilities require support of allies to get the missiles and the other equipment into the AOR. A lot of these vessels proposed are seafaring and can make the trip into the AOR but they would need additional support maintenance and incremental fielding once on station. *"Do I expect the USV to know everything and be able to conduct all that maintenance? No. We need to start small."* Send that small vessel out with a destroyer to successfully operate beside the destroyer and complete small maintenance tasks – "*and see how long you can survive at sea just trailing me.*"

The team next discussed the culture shifts required to address manning this future distributed fleet. *"This is the Top Gun for SWOs. It's UAVs! Every kid knows what a drone is, so it's getting that and looping it in and bringing those into our culture."* To the issue of command opportunity *"I can say right now if you took a survey of all the SWOs that are in mid-grade and their next major milestone would be CO of a destroyer and you said prior to that you could be the CO of an LMACC squadron and take ships out and train and learn and have that experience I would suspect that many, including myself, would jump at that opportunity."*

This concept requires an initial investment in large fleet so the team worked to determine how they might convince Congress of the need since Congress would need to pass the budget. To effectively augment the CVN the planned construction of the third carrier already on the books could be postponed and divert the funds already set aside to invest in this new distributed fleet. Preventing requirement

creep is essential to successful development. If asked how we propose to add energy weapons on this the answer is "*No, we're going to keep it small. Because if we push all these technologies and try to make it some great thing that does all the things that you want to do, and he has a vote and you have a vote. The answer is no. We want to keep it small."* Let's do it now so that we can proceed. *"If I gave this brief to a combat commander, I would probably get mugged."* The commander's answer would be *No, I want all my carriers. I need the carrier now. Why don't you have enough carriers?* It is about getting commanders to change the operational art – to think about the problem differently and think about how they might influence the enemy.

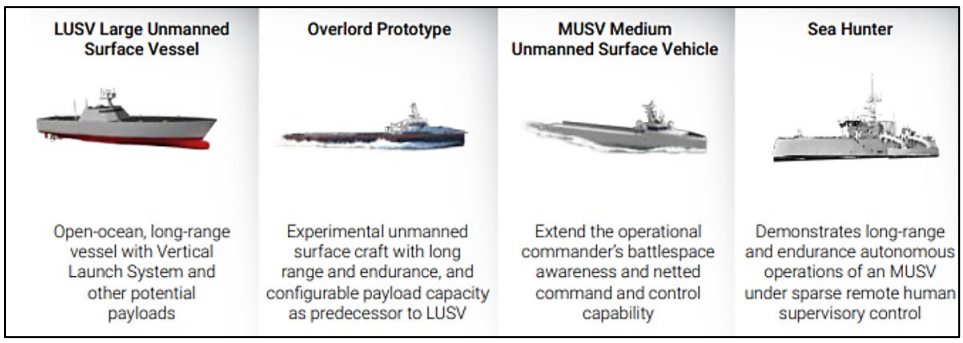

Figure 16. Examples of candidate vessels for the proposed *Future Distributed Fleet* from the Department of the Navy's Unmanned Systems Framework.

Finally, the team presented four vessels included in the Department of Navy's Unmanned Systems Framework (*see Figure 16*). Pictured from left to right are the actual proposed vessel and on the right the prototype that is currently in field experimentation. This future is the envisioned distributed fleet.

Questions & Discussion

When asked why to keep the carrier in the future fleet rather than completely doing away with it the team responded that they still saw value in the use of the carrier in the in the future fleet. A carrier can deploy rapidly and projects significant power which is essential in a contested region. Although not strictly expendable, some of the vessels in their proposed future distributed fleet will be targeted and after they fire their full salvo at the start of the conflict these vessels will be Winchester and will need to be rapidly replaced. In this scenario there is a role for the carrier. *"We would just like to reduce the burden on the carriers, increase their readiness and save that for a future force."*

When asked about their assumption that we must supply our allies with ships rather than jointly develop combat vessels or engage in a division of labor, the team responded that we do not necessarily have to supply them. Ideally, a partnership is the preferred route. A sustained force is not required. *"We're not going to do this forever. This isn't going to be a persistent force. We eventually want to build that trust and allegiance with the nations that surround the area to embolden them, to let them know that we have their back."* We will be in a joint venture with allied nations in the contested region and make clear that we will support their claims for whatever the situation may be. In the South China Sea scenario, we will support allied claims to their territorial waters.

When asked about using the carrier to counterattack enemy breakout attempts caught by the net of LMACCs the team responded that if the adversary started going after our fleet of LMACCs, that would be

probably crossing over to full conflict. *"We spitballed this – how about we just put a full autonomous force out there, all drone ships and we look back to the UAV's being shot down in Iran and there's less consequence for shooting down an unmanned vessel than a manned vessel, so that's why we put them as manned, unmanned teams by putting that human element on board."* Usually, you're decreasing risk by making an unmanned, but we wanted to put that element out there to provide that deterrence. *"You can't just go shoot down one of our drone ships for no reason. We have people on or near that ship and doing so would be a good deterrence to your escalating vertically."*

When asked how they might employ the LMACC if it is known that the adversary has directed energy weapons based off of these island chains that they could deploy against the LMACC, the team responded that the adversary has weapons now that they could engage – just a different flavor. If the adversary has demonstrated that they are willing to launch an attack on one of these LMACC and vertically escalate the tensions, then a weapon is a weapon. If the Mark 82 can have the same effect as a directed energy weapon it is the same action – the technology does not change that much. Again, this is in the contested phase. *"When things kick off, I probably expect most of the LMACC to go away. Sad to say, but that's part of the expendable force. We haven't lost the carrier yet."*

Dr. Shelly Gallup[15] commented that if we step back and look at what a carrier really is, it's a truck. It's a truck to get airplanes from one point to another. Oftentimes, you can sortie those aircraft off to airfields. The air wing is what is important, not from the carrier. If you can get the airplanes off and they can join the fight without having to actually push a carrier and its support structures forward one rethinks what a carrier actually is and the intention for it to be a deterrent. If you are mixing up five LMACCs and five MUSVs the enemy now has ten targets – and does not know which is which because of some things that we are adding to that like the enemy's intelligence common operating picture and other emulators. It really creates a challenge for adversary targeting which will give us the opportunity to bring in those air wing assets which are much closer. In response to Dr. Gallup's comments, another participant did not disagree that the carrier is a truck for the air wing but contend that the carrier also has other functions that we need to keep in mind as if we are not going to have that carrier forward. Command and control is obviously the key element. You no longer have the destroyer squadron (DESRON) commander – *"you don't have the carrier strike group for the new commander on board in theater. We do not necessarily need have to have a carrier there to provide that capability, but we need to take that into account."* The carrier is much more than just the floating airport comes with it. The command control associated with the CSG commander or Marine Expeditionary Warfare (MEW) commander or whatever flavor of kind of carrier you are thinking of.

Finally, a mentor suggested they look at how Fletcher and Halsey managed the air wings in the Guadalcanal campaign[16] – a similar island chain situation and they moved air wing assets from a carrier to shore at Henderson Field. *"That's right, the destroyers fought that battle."*

[15] The originator of the LMACC concept

[16] The Guadalcanal campaign, also known as the Battle of Guadalcanal and codenamed Operation Watchtower by American forces, was a military campaign fought between 7 August 1942 and 9 February 1943 on and around the

C. Team Residence 118

Figure 17. Members of Team Residence 118 *(pictured from left to right)* MAJ W. Brown USA, CDR M. Mendieta ECUADOR, K. Tsolis, B. McNelly, Dr. M. Worsley, D. Bailey, Capt A. Maldonado USMC, Col T. Lyons USMC (ret), September 2021

The members of this team (*see Figure 17 and Table 3*) included three junior officers representing the U.S. Army and U.S. Marine Corps and the Ecuadorean Navy, and three early career engineers from government labs and industry. This team was facilitated by two NPS faculty members, and the team included three NPS students.

Table 3. Members of Team Residence 118 (*alphabetical by last name*)

NAME	PERSPECTIVE	AFFILIATION
Dan Bailey	*Modeling & Simulation*	LMCO
MAJ William Brown USA	*PsyOps & Social Media*	NPS Operations Analysis
Col Todd Lyons USMC (ret)	*Facilitator*	NPS Innovation Facilitator
Brendan McNelly	*Mechanical Engineer*	JHU/APL
Capt Alejandro Maldonado USMC	*Infantry Officer*	NPS Space Systems
CDR Milton Mendieta Ecuadorian Navy	*International*	NPS International & Defense Studies
Kristen Tsolis	*Facilitator*	NPS RoboDojo
Dr. Marcus Worsley	*Chemical Engineer*	LLNL, DOE

The team started with an overview of the book Ender's Game by Orson Scott Card,[17] a military science fiction novel published in 1985 and adapted into a film released in October 2013. The title character,

island of Guadalcanal in the Pacific theater of World War II. It was the first major land offensive by Allied forces against the Empire of Japan.

[17] Ender's Game is a 1985 military science fiction novel by American author Orson Scott Card. Set at an unspecified date in Earth's future, the novel presents an imperiled humankind after two conflicts with the Formics, an insectoid alien species they dub the "buggers". In preparation for an anticipated third invasion, children, including the novel's protagonist, Andrew "Ender" Wiggin, are trained from a very young age by putting them through

Ender, was trained in a simulation to eventually defeat his enemy, but what made Ender powerful and enabled him to achieve his mission to save mankind was his ability to think – his ability to work through the problem and to plan appropriately with the machine in mind. The team named their concept *Enders GAM^{2}E – Generative Architecture for Military and Machine Execution*.

Generative Architecture for Military and Machine Execution

The team focused their concept generation work on what 2045 might look like from a human-machine teaming perspective. Technology is going to continue to develop and advance, and technology will likely outpace what we might imagine today, and they referenced a Discovery panel discussion about what has changed in the last 24 years. A lot of the technology that we have today no one would have imagined 24 years, demonstrating the importance on focusing on the people in the scenario – *"focus on that human-machine teaming aspect so that you can be ready for the future in 2045."*

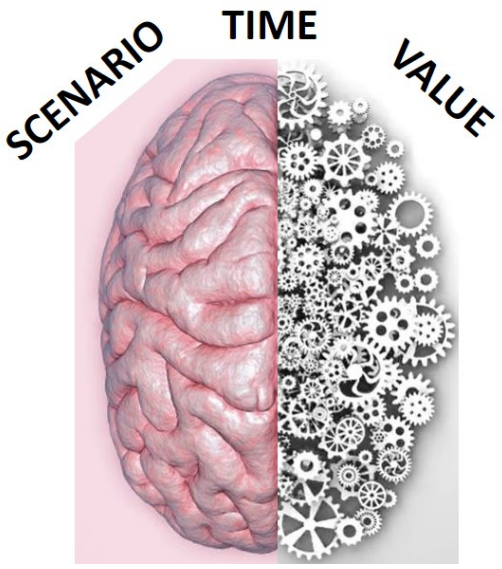

Figure 18. An artistic rendering of a human-machine brain, denoting three key drivers of teaming.

An artistic rendering of that human-machine brain (*see Figure 18*) where everything is tied together and cohesive visually demonstrates that one side will likely not function without the other in the future. In effective teaming there is a spectrum from the human doing most of the work to the machine doing most of the work – and all the combinations in between. The three key drivers that will determine where the team will function on that spectrum are:

1) *What **scenario** are they working in?*
2) *What's the **time** horizon or **time** sensitivity to act and respond?*
3) *And what is the **value** at play? What's the **value** of the target? What's the **value** of your capability? What's the **value** of the personnel and the machines that you're using?*

increasingly difficult games, including some in zero gravity, where Ender's tactical genius is revealed. (https://en.wikipedia.org/wiki/Ender%27s_Game)

Considering all three of those parameters and both the human and the machine elements the team envisioned a functional force in 2045. The team then presented their vision of how this future functional force might execute a traditional kill chain. Currently, we have these planning processes and forced development we use to execute a kill chain (*see Figure 19, top row*). Is that sustainable or executable in the future? Likely not.

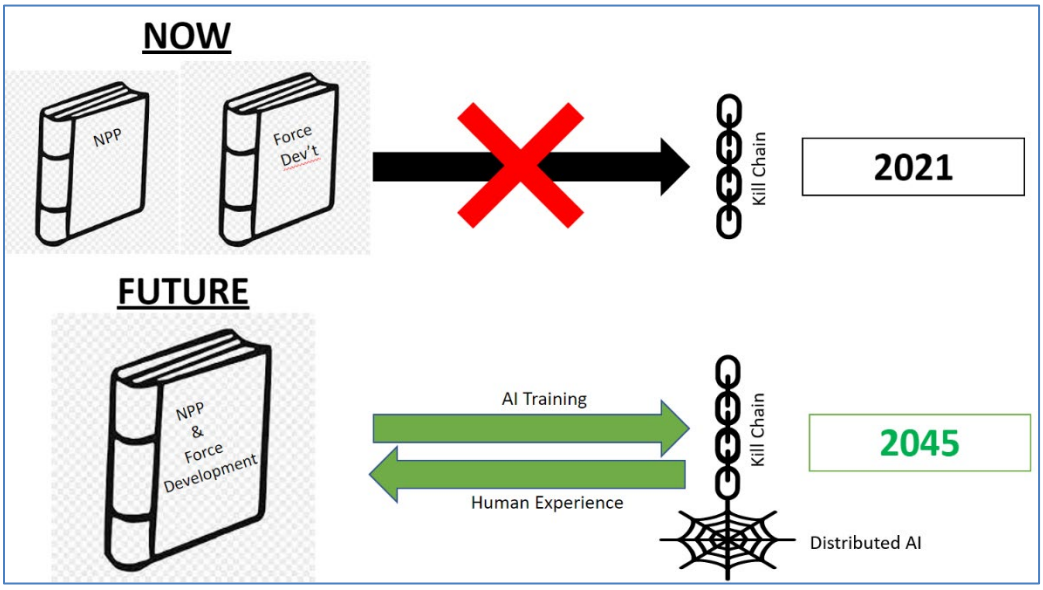

Figure 19. Current kill chain process (*top*) and envisioned future kill chain (*bottom*).

In the future envisioned by this team (*see Figure 19, bottom row*), we will likely need to recreate how we think about planning with the machine in mind. In this future the AI training and the human experience in this duality creates a kill chain with a distributed AI sensor web (*see Figure 19, bottom right*). In essence this is how these things might work together in 2045.

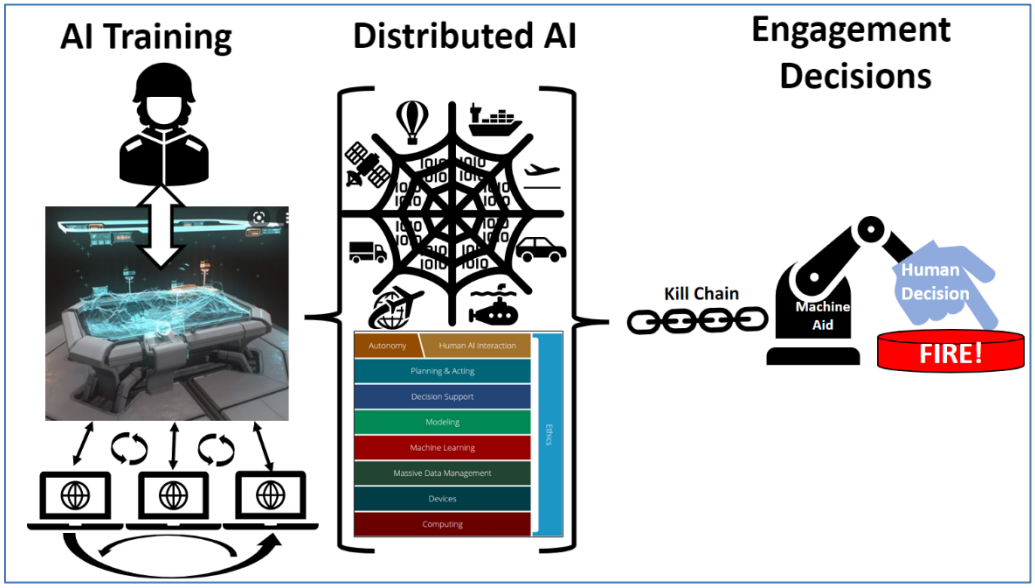

Figure 20. Envisioned AI training (*left*) and distributed AI web (*middle*) to inform future engagement decisions (*right*).

Looking more closely at that kill chain and web of sensors, or that web of distributed AI (*see Figure 20*), in the end it is really going to come down to an engagement decision and there is always going to be a human in the loop making that decision. After evaluating all the information available – the sensing and all the capabilities that come from machines or team analysis – when it comes time to make that final engagement decision there is a human at the end. However, there is a lot of machine work and teaming that drives that final engagement decision on the kill chain. The distributed AI web is feeding the sensor information, the tracking, and the assessment in that part of the kill chain. The team admitted that *"we are pushing the I believe button for this with the technology, because the technology is really going to far outpace what we think it is today."* Their envisioned distributed AI web (*see Figure 20, middle*) is made up of feeds from all the different maritime air, underwater surface land domains, and those feeds will likely be from distributed sensors to provide that capability at one location or at all locations, whether the area of operations is a denied environment or not. This represents a big technology challenge, but the team is confident that technology is going to continue to move forward to solve a lot of those problems that we have today.

Regarding the final engagement decision (*see Figure 20, right*), the military operates with a core decision and a decentralized execution model. The team intend that model to remain in their envisioned future – the human is going to make that that core decision, but the execution will be decentralized. Whether by autonomous sensors for forward or individuals, the engagement decision made by a human will be executed somewhere along the human-machine team spectrum by a distributed force. AI and zero shot learning and things like that at the edge will come into play where you can program algorithms in capabilities operating all the way far forward. Using something like the Navy's AI stack, the future envisioned distributed human-machine force will have the information behind it to really integrate and leverage capability on the technology side.

Central to developing and "training" the AI stack is the teaming between the human and the machine (*see Figure 20, left*). Ethical concerns need to be coded in these systems up front and develop a process to address future concerns. There is an iterative process back and forth with machines, developing the simulation and those capabilities at the ground level – learning from each other. That learning process back and forth will then feed back up through the distributed AI network and then finally feed all the way up that kill chain to the final engagement decision.

New planning procedures and force development are foundational to this envisioned future state. Currently, our planning procedures were made for the human and with the human in mind. How might we "*bake in"* machine considerations into the process? Primary decision-making responsibility rests along a human-machine continuum, and that responsibility reasonably shifts from peacetime to wartime (*see Figure 21*). For instance, during peacetime humans have primary decision-making responsibility in all ethical decisions (*see Figure 21, yellow decision continuum*), but in wartime maybe machines to take on a bigger role to inform the final human decision. Maybe the machine needs to be more involved in the ethical decision-making process in peacetime as well. The sensing and data processing decisions all rest on the machine end of the continuum, but maybe that shifts a bit in a wartime scenario. These are questions that we do not yet have answers for, but what we do know is that it is a dynamic process.

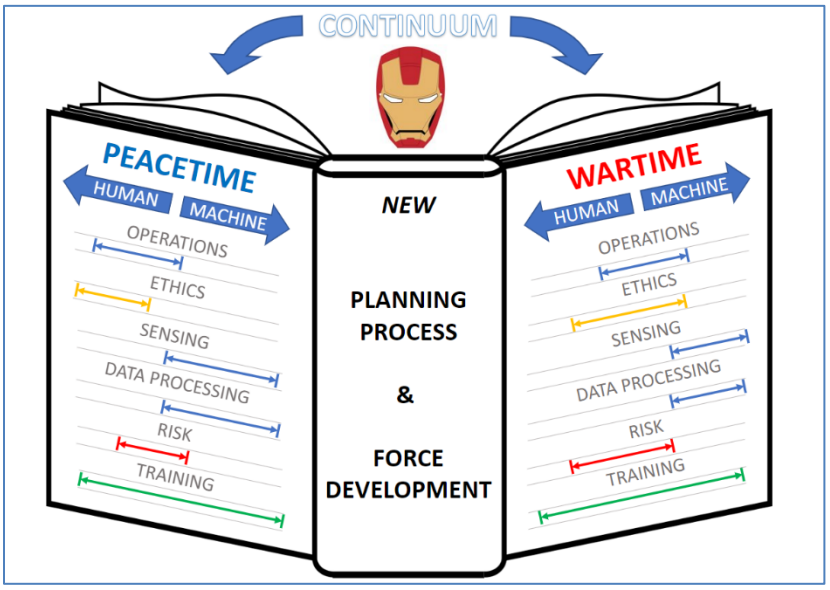

Figure 21. Planning processes and force development will inform proposed future human-machine decision-making continuum in peacetime (*left*) and wartime (*right*).

In peacetime the commander takes on a lot of the risk (*see Figure 21, red decision continuum*). In wartime, maybe the machine is going to take on more of the risk. When viewed as a continuum, we need to remake and redefine the planning processes with the machine in mind. For example, in the MCPP process referenced in Mr. Brett Vaughan's Discovery panel statement there are three courses of action (COAs) and multiple different planning process, and they are all meant to be distinguishable and executable. An autonomous system could quickly run thousands of COAs and present a human decision-maker with three distinct and distinguishable executable COAs. That is a small example of how we could implement an AI-enabled decision-aid, effectively *"baking"* machines into our planning processes acknowledging that an effective human-machine team continuum is how future decisions will be made. Today we rely heavily on procedures. *"You have X and we execute Y. You need to press A and then we press B."* Baking that machine into our planning processes is necessary for us to even understand the capabilities we have available and how to employ the machines that we have – how to employ the seeds at the bottom of the ocean. This must be baked into our planning processes and into the way we think before we might maximize the capabilities at our fingertips.

Currently, the military really focus on satisfaction with the human in mind. A human can make a good decision based on the information they have. But if we then put that mask of a machine teammate in front of the human (*see Figure 21, top center*), the human is still behind the mask and still driving that information, but we are really focusing more on the optimization and no longer simply on satisfaction. We must reach that optimal place so that when we are reacting and evaluate decisions based on the criteria of scenario, time, and value, we are really doing what is best for all three.

Questions & Discussion

Workshop lead Professor Jeff Kline started the discussion session with an observation that the concept presented by this team is highly complementary to the first two teams. The concept of distributed

decision-making and the proposal to redesign our planning process is to integrate the machine would fit well with the other concepts presented. One of the most unique things he heard from his operations research perspective is human-in-the-loop machine learning through human-in-the-loop simulation – *"which is kind of cool, so we're training the machine."* This AI training would not be accomplished using databases like statisticians like to do, *"but we're training them with the humans actually training the machine as the human is presented with different scenarios and I think that's kind of a cool concept."*

The Center for Naval Analysis generated a report a couple of years ago on robotics and humans - the human-machine dynamic. This report includes a list of tasks and a graphic quad chart that shows essentially what humans are really good at, what machines are really good at, and what a human-machine team could be optimized for. A different way of viewing the human-machine interaction is as a partnership rather than a team. Viewing the system more like an economy or the human autonomous nervous system, both of which work within a window of tolerance, is useful for analysis. We do not need to create more and more streams of code and algorithms; all we really need to do is to understand the triggers. These triggers put us in a state of fight or flight or freeze. What triggers put a machine in that same state? A dialogue between machine and human would allow us to learn what that window of tolerance might be on the human-machine continuum. This window of tolerance is dynamic and changes with context. Another valuable lesson may be what might help move something back within the human-machine window of tolerance.

The team referred to their continuum of human-machine decision responsibility between peacetime and wartime where they identified windows for where they thought the decision responsibility would fit either to the human or the machine, and the flexibility within that continuum. The process of identifying the ideal combination of human-machine responsibility brought up a recent film reference. In the 2014 film Interstellar[18] there is a scene where the AI is telling their human counterpart that a proposed COA is not feasible, but the human decides to ignore the AI input and proceed. That back and forth between the machine and the human is how they come to the final decision, which is an example of this continuum. There are several other pieces here. There is work ongoing in a project[19] to estimate the number of states would be in a complex situation. That idea of requisite variety is much more important than people are thinking about – to match the requisite variety of the context given up by your enemy to defeat it. In military campaign analysis your professor will tell you, "No, we do things like the Lanchester equation" to understand what forces we need to attrite the adversary and then let us win. We are likely entering a phase of warfare which is not just about attrition, so these kinds of discussions are essential.

Finally, a participant noted that the team put ethics in the middle of their concept and recognized that ethics needs to overlap in the machine space. When robots are not in line with commonly accepted

[18] Interstellar is a 2014 epic science fiction film […]. Set in a dystopian future where humanity is struggling to survive, the film follows a group of astronauts who travel through a wormhole near Saturn in search of a new home for humanity. (https://en.wikipedia.org/wiki/Interstellar_(film))

[19] Monterey Phoenix, a project led by Dr. Kristin Giammarco, NPS Systems Engineering

ethical limits "they're off the reservation – they've gone rogue." Having the humans identify that ethical line is key. Being on the right side of that line results in better defense and better warfighting.

D. Team Hybrid 122

Figure 22. Members of Team Hybrid 122 *(pictured from left to right)* D. Nobles, T. Aion, LCDR R. Elred USN-RC, and C. Yungkurth, September 2021

The members of this team (*see Figure 22 and Table 4*) included two officers from the U.S. Navy reserves and the U.S. Marine Corps respectively, and one senior engineer from academia. The team was facilitated by two guests from academia and industry respectively, and included an NPS student and an NPS faculty member.

Table 4. Members of Team Hybrid 122 (*alphabetical by last name*)

NAME	PERSPECTIVE	AFFILIATION
Travis Aion	*Facilitator*	JHU/APL
LCDR Ross Eldred USN-RC	*Systems Engineer*	NPS Systems Engineering
Dave Nobles	*Facilitator*	Microsoft
Maj Matthew Simard USMC	*IW Systems Engineer*	NPS Information Sciences
Chuck Yungkurth (Mentor)	*Hypersonic Weapons*	JHU/APL

Although this team started as a hybrid team with half of their members working on the NPS campus in Monterey and the other half on the NPS "virtual campus" via MS Teams, due to a targeted regional internet outage on Tuesday 21 September the team was reconfigured and worked with only resident participants and facilitators in Monterey. The remote participants originally on their team were reassigned to Hybrid 129.

The Kelp Road Initiative

This team presented a concept they named *The Kelp Road Initiative*. The given scenario includes *"the good, the bad and the ugly."* The good news is that the U.S. is the most networked and advanced military force the world has ever known, but the bad news is that our vulnerability lies in our

dependence on that digital arena. The ugly news is that China has been working steadily over the course of many decades to change the environment in their benefit, eroding the U.S. dominance of the sea with the implied and real threats ranging from the use of an electromagnetic pulse (EMP) to take out our ability to compute in the digital space to eroding resistance to the Chinese Communist Party in their regional area of influence – namely in Taiwan and Hong Kong. The U.S. "war machine" is very capable but is vulnerable to attack in the digital space. Currently, the U.S. lacks survivable platforms, and we lack the training for the old school operations we used to be proficient in.

"The clever combatant looks to the effect of combined energy (shi) […] the energy (shi) developed by good fighting men is as the momentum of a round stone rolled down a mountain thousands of feet in height." – Sun-Tzu, The Art of War 5:21-23

Underlying Chinese decision-making is an ancient concept called *shi* (势). A lot has been done in the last couple of decades in the U.S. to try to understand how *shi* is applied in Chinese actions, and this ancient Chinese concept was foundational to the solution developed by this team. By understanding and leveraging the environment wisely results in irresistible change. Often visualized as a stone rolling down a hill, *shi* is sometimes understood as momentum – either in terms of energy or psychology. By changing the environment – by leveraging the natural order of things and making small and subtle changes over time, our adversaries hope to create a scenario that becomes irresistible. This momentum can be physical or psychological. To wield *shi* one proactively changes the environment to advantage your side of a conflict. The Chinese have been doing this through their Belt and Road Initiative, manufacturing islands in the South China Sea, and of course through statecraft.

The team then translated what are sometimes presented as *Great Power Competition* challenges into opportunities in this environment and across the spectrum of conflict. The overarching problem statement this team began their process with was *How might we leverage the environment to improve our shi?* They then added detail to the problem statement:

> *How might we dominate the spectrum of competition to maintain a competitive edge in times and regions of relative peace; deliver calculated, scalable effects in the gray zone; and deliver maximally disruptive effects in kinetic conflict? And I believe we can, but we got to get started quickly and we've got to start making those small changes now to leverage those effects later, particularly in the areas of the Gray zone and all the way up to more intense conflict?*

The team then moved into their solution space with urgency. "We need to make those small changes now in order to leverage the effects later." Their proposed solution, *The Kelp Road Initiative,* is our attempt to leverage *shi* – and the answer to *The Belt and Road Initiative*. This proposed solution is both a physical and a conceptual network with geographically dispersed hardware (delivery platforms) and undersea infrastructure. The *Kelp Road* is a long term, large scale development of the of the strategic seabed geographical space intended to change the nature of the future battle space in a in a semi-permanent way. To go a football vice rugby discussion from earlier in this week, *The Kelp Road Initiative*

is rugby – *"it's bringing the aircraft carrier to the seabed, just substitute the underwater delivery systems for aircraft."*

The Kelp Road Initiative is a pairing of *seeds* – delivery vehicles – with the *kelp forest* – infrastructure – for implementation across the spectrum of conflict. We first establish this vast network of resilient effects delivery mechanisms and lay the infrastructure on the seafloor. Next, we pair it with delivery vehicles to disrupt the adversary's digital space and plant "seeds" to assure future *friendly* asset digital space. This disruption of the digital space *"is a throttleable thing."* The payloads that these *seeds* deliver are subject to change as technology improves. These seeds are paired with delivery vehicles within an underwater infrastructure built over time. These delivery vehicles themselves may be spaced in such a way that they may swarm, they may be mobile and able to congregate in certain spaces, or there may also be a physical lane of cable stretching from a from a deep-sea area and extending into the littorals. This cable might be segmented so less vulnerable to attack.

Joint Undersea Just-in-Time Surfacing Unit (JUJITSU)

Such infrastructure allows for many missions and tactics – and the team proposed JUJITSU *"belts"* as assets to employ along *The Kelp Road* to accomplish any given mission. The *belts* relate to the spectrum of conflict and the JUJITSU is the seed with swappable payloads configurable to the *"belt"* of conflict at hand. After lying in wait, these intelligent, autonomous systems – or pods – deliver payloads from the seabed to the surface to the atmosphere via buoyancy. Envision these pods as lie-in-wait mines, but not necessarily in the traditional kinetic sense. The JUJITSU is a type of vehicle that can move between the physical domains of the seabed through to the surface, possibly even into the atmosphere (*see Figure 23*) if we leverage the effects of buoyancy and just increase that volume of displacement. These mobile units can hop, swim, or crawl on or off the *kelp "branch"* along the *Kelp Road* undersea infrastructure. They may re-anchor, move along a segment of inductive cable or signal carrier cable, or the unit may crawl directly on the seabed – or some combination thereof. The wide range of future potential payloads will drive the configuration of the seeds.

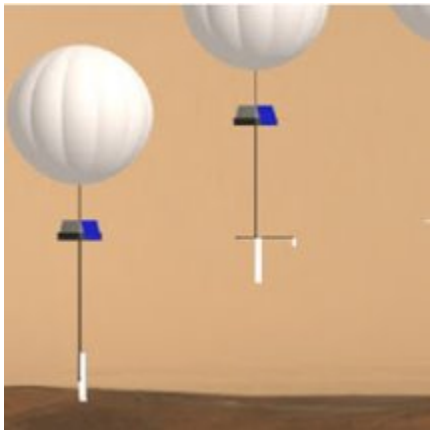

Figure 23. An envisioned atmospheric JUJITSU deployment.

"Belt" CONOPS

The team next gave examples of how JUJITSUs might be employed at the different levels of conflict – or *"belts."* The *Blue Belt* is humanitarian operations all the way on the left-hand side of the spectrum of

conflict. With demonstrated humanitarian applications, the *Kelp Road* infrastructure might be justifiably developed over time. In *Blue Belt* operations we might deliver capabilities such as internet restoration by delivering physical hardware to a region that has been devastated by a hurricane – or perhaps a region where internet access has been purposely repressed. If the freedom of the Internet is behind a kind of "Great Firewall." Humanitarian payloads and climate change effect mitigation systems might also be delivered using the JUJITSU pods. The myriad of different possibilities are all on the end of the spectrum where *"we're in the hearts and minds half of the campaign […]."* Through active marketing to regional allies and partners who need a rapid response during a crisis, the *Blue Belt* operations employing JUJITSU will demonstrate the need to get the *Kelp Road* infrastructure in place.

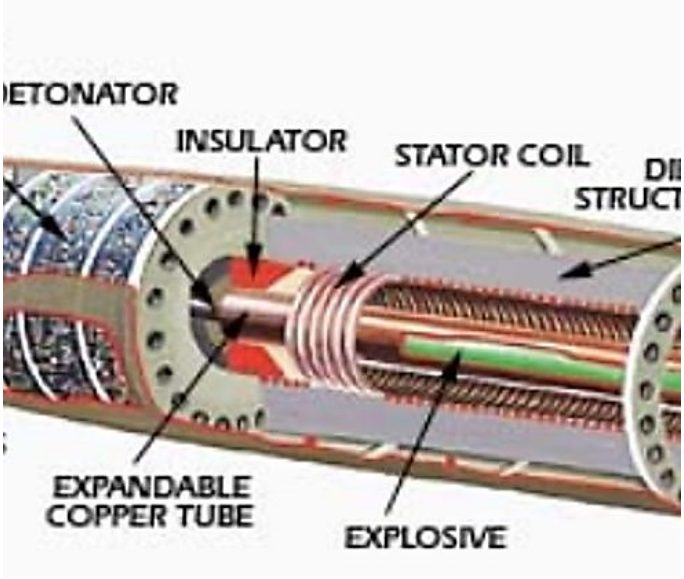

Figure 24. A simple tactical EMP.

As things start to heat up a little bit in the *Green Belt* of intermediate conflict, the JUJITSU will be employed for "remove and replace" missions. At this level of conflict, we want to take away an adversarial capability and replace it with our own. JUJITSUs could carry scalable disabling devices – precision disruptors of adversarial digital space, from cyber disruptors to small-scale tactical EMPs. For instance, a small tactical electromagnetic pulse (EMP) in the form of a simple electromagnetic induction coil behind a small charge (*see Figure 24*) has been around for a long time but has not been considered much recently. This scalable disabling device employed on a JUJITSU might provide precision disruptors that are lying in wait distributed over the seabed to be employed in localized areas during the *Green Belt* level of conflict. For "replace" operations, that physical hardware needs to be pre-deployed on the seabed *Kelp Road* in the region, ready to provide selective restoration of friendly capabilities.

Kinetic conflict takes us into the *Red Belt* range. Full-scale A2AD conflict – or *The Great Reset* – might force us to embrace a possible complete loss of the digital space. The team proposes that if we are first to take the disruptive step we will remain in control of the environment. *"We've been fearing [this] because we've been preparing for this. We've been training in the basics and in how to conduct operations without that use of the digital space."* This major disruptive step, be it a large scale tactical EMP – conventional or unconventional – to a cyberattack, will remove all digital capabilities for

everyone in the future battle space. This scalable disruptive effect may include multi-domain targets, and the resulting state will likely be universal within the target range. *"This is your ticket back to The Industrial Revolution. You hit the button, you cut the digital rope, and we reset."* Following this *"reset"* we will rapidly replace the missing digital capabilities with the pre-deployed hardware – the JUJITSU modules – along *The Kelp Road* waiting for employment. Regional partners and allies might be inside that disruptive range, but we will be able to restore capability selectively to bring only ourselves and our allies back online.

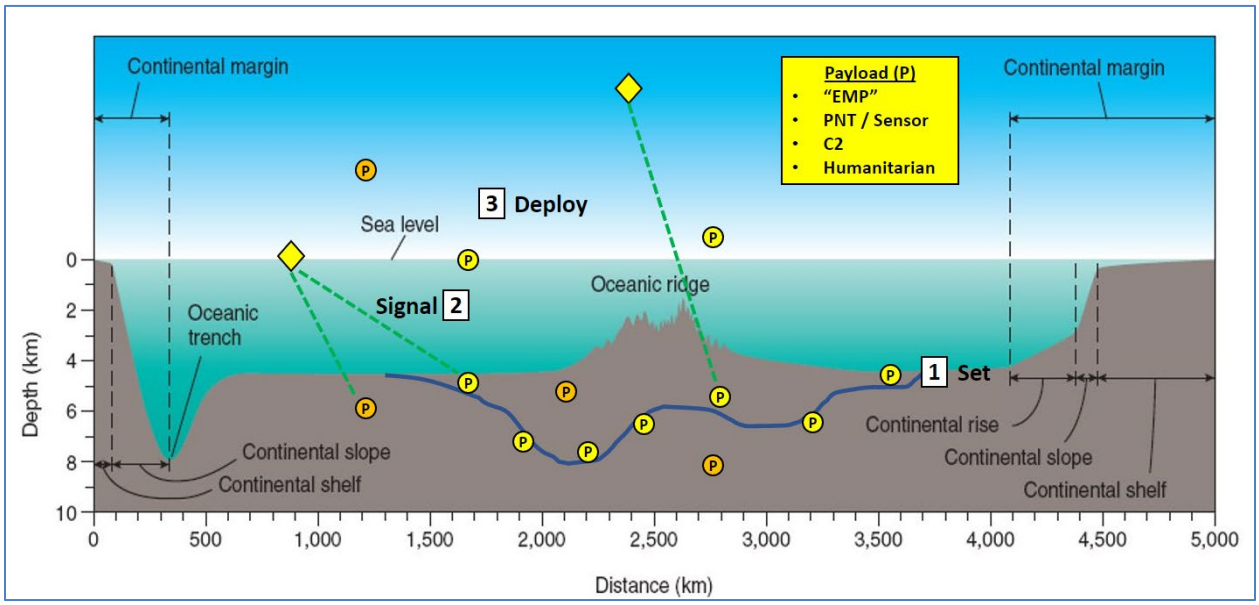

Figure 25. OV-1 of The Kelp Road undersea infrastructure in three steps: 1) Set, 2) Signal, and 3) Deploy. Dispersed pre-deployed JUJITSU pods are marked with yellow circled "P"s, the blue line is the undersea *Kelp Road* infrastructure, and the dashed green lines represent potential blue-green wavelength communications. The yellow diamonds are envisioned communication methods for signaling JUJITSU pods.

Finally, the team presented a full view (OV-1) of The Kelp Road (*see Figure 25*). The first step is to leverage the *shi* and lay that infrastructure, whether that be cable or the distribution of the pods (*see Figure 25, bottom left*) to get that network set up in the areas that have imminent humanitarian needs. Leveraging State Department avenues may help get the undersea field laid and the capability deployed and start the training. The next step is to begin communicating securely via the technology that is now available. Intending to leverage blue-green wavelength laser communications from the surface or above the surface of the water to talk to these vehicles, the green lines on the OV-1 represent that second "signal" step (*see Figure 25, dotted green lines*). Finally, in the deployment phase the team noted that some of these pods are still on the bottom while other are on the surface or on their way to the surface, and some may be above the surface using lighter than air gases or other means to get above the surface of the water (*see Figure 25, yellow circled "P"s*). The range of physical domains available to the JUJITSU pods in *The Kelp Road* are more than simply tethered to the ocean floor up to the surface.

These JUJITSU "seeds" are vulnerable to interception – *"we can go out and find these things and take them."* To protect these assets from being used against us there needs to be an activation key to switch pods between modes remotely. The ability to communicate with the pods using this key makes them

throttleable, perhaps organically because the pods "know" through programming how to respond to a particular set of stimuli. Mobility is also an important attribute – the ability to activate and move, to crawl, or to move along a cable. Although the pre-deployed JUJITSU pods are generally passive in their lie-in-wait state, when activated remotely perhaps using blue-green wavelength, the pods are capable of periodic maneuvers. Although cyber capability is critical, there are some old school technologies that can be really disruptive. Conventional or unconventional explosives with variable yield are an example. Finally, the JUJITSU pods could serve as seabed to surface to atmosphere delivery systems.

Questions & Discussion

Workshop lead Jeff Kline started the discussion stating that *The Kelp Road* was a well thought out in force structure, philosophy, and detailed constructs for engineering and potential prototyping. He went on to note the points of compliment with other presented concepts, and on the opportunities. *"I find this appealing because I think we need to learn to fight in the EM night. You've just proposed creating that night, but the person with the candle may win in that environment."*

The first question put to the team was *How do you protect a static infrastructure like a cable from open or covert sabotage from enemy submarine forces?* The team representative replied that first we have got to be careful not to depend too much on a cable, especially if it's in the shape of a long tree where it comes to one stem and can be and can be cut and severed. If we're going to leverage the cable, it should be segmented. It should have resiliency built into it but remember that it doesn't have to be a physical cable. Rather, it can be a coordinated distribution of vehicles over time. The important thing is getting that infrastructure established, and eventually it just becomes too hard to deal with. The team representative likened it to the building of artificial islands underway by the Chinese – *"it's that they're there and there's too many to resist."* Once the segments of the proposed *Kelp Road* are laid and the JUJITSU pods are pre-deployed to lie-in-wait it would likely be too expensive to find them all, especially if they're expendable. An undersea cable might not do you harm if you tamper with it, but a JUJITSU pod might, depending on what its payload is.

The next question had to do with cost. For the seeds themselves the cost will vary a lot depending on the payload. It is important to have as many of these things be cheap and expendable as possible. However, there might be some higher value seeds that that don't stay on a cable. They may be hard to find and carry a payload that's a little more special.

The next question was, *What is a reasonable time frame to build the whole Kelp Road undersea infrastructure, and how will you keep it secret from the opponents during that construction process?* While secrecy will be important to start, over time it's almost unrealistic to think that a large-scale effort spanning years will remain secret, so that's why the team emphasized the need to leverage the humanitarian aspects of developing the infrastructure. First you get that network in place but at some point, the full capability and intent will become clear. *"You got to expect that the cat will be out of the bag."*

Next, there was a question about how the team might, from an international legal perspective, justify deploying mine-like asset or ammunition in open seas – international waters. When the bullets start

flying there will be more to worry about, but ideally a system like this might prove enough of a deterrent to prevent kinetic conflict altogether because we have leveraged *shi* and changed the state of the environment. If we change the state of the space – the war environment – to where kinetic conflict does not happen, we still need to be careful about materials. *"We've got to make sure that what we're putting in doesn't cause undue harm to the environment, for sure."*

The importance of establishing and building relationships with partners and allies early is key to *The Kelp Road* since that this infrastructure will be built in their territorial waters. When the cat's out of the bag there must be some strong strategic messaging and partnerships with allies in place. Imagine a ship that suddenly finds itself disabled on the open ocean and needs rescue, and we've got a JUJITSU pod waiting to assist. *"Aren't you glad it was there?"*

Workshop lead Jeff Kline closed the discussion period with one more observation. The connectivity between the ideas that are generated in the first two teams and then explored by the next two teams will further efforts here at NPS and beyond. The Red Belt CONOPs described here would likely involve intermediate force capabilities, and these would fit in quite nicely with our future NWSI Maritime Gray Zone Research Task Force that will be launching with a rapid concept generation workshop in November specifically to address intermediate force capabilities.

E. Team SEA RRS

Figure 26. Members of Team SEA RRS *(pictured from left to right)* J. O'Day, LT J. Schultz, LT J. Brown, H. Wu, CDR C. O'Connor USN, LT A. Groff USN, September 2021.

The members of this team (*see Figure 26 and Table 5*) included six officers from the U.S. Navy and U.S. Marine Corps, and four engineers from warfare centers, academia, and industry. The team was facilitated by an NPS faculty member and a guest from NATO SHAPE, and included three NPS students.

Table 5. Members of Team SEA RRS (*alphabetical by last name*)

NAME	PERSPECTIVE	AFFILIATION
LT Jeremy Brown USN	*Submarine Officer*	NPS Systems Engineering Analysis
LT Aly Groff USN	*Surface Warfare Officer*	NPS Systems Engineering Analysis
Dr. Vijay Kowtha	*Machine learning*	Zeltech

CDR Chris O'Connor USN	*Facilitator*	NATO SHAPE
Joshua O'Day	*Security Studies*	Georgetown
Mike Pfeiffer	*Systems Engineer*	LMCO
Col Randy Pugh USMC	*Facilitator*	NPS NWSI
LT Joshua Schultz NPS	*Surface Warfare Officer*	NPS Systems Engineering Analysis
Dr. Justin Sellers	*(Mentor)*	NIWC Atlantic
Sinker Wu	*Operations research analyst*	Raytheon

This team worked the design challenge in a classified space and a full summary of their final concepts is available by vetted request through appropriate channels. What follows is an unclassified overview of their work. This team generated four concepts: 1) *Morpheus*, 2) PIRHANA, 3) the ROAM Boat, and 4) *Cranky Casper*.

Morpheus

This is a two-pronged iterative training tool for the future human-machine team. Training for AI/ML systems is based on mission analysis, and training for the human part of the team is based on AI analysis of scenarios and threats. Considerations discussed included individual human performance limitation and enhancements. The proposed complete immersive spatial learning takes advantage of all senses. Time-sensitive turn around in processing and learning would enable fleet integration and feedback to be distributed as soon as processing can commence. Morpheus could also be used for screening of leadership in real-life scenarios, and training in high-risk environments.

Portable, Integrated, Reconfigurable, Hi-Speed, Adaptive Naval Architecture (PIRHANA)

This high-speed, low-cost, highly maneuverable offensive stealth capability would be built using open architecture with flexible integration for modular scalability. Deployed in high quantity, the PIRHANA could encourage desensitization of the adversary. Considerations discussed included distributed manufacturing and logistics, and the availability of ports. Functionally sleek, the PIRANA is reconfigured based on the mission based rather than configured to accomplish every mission. The PIRHANA is envisioned to be either lightly or remotely manned, driven by mission parameters. Range would be dependent on power sources with alternate options to supply vessel and support platforms, and replenishment burden is minimal which makes PIRANA highly sustainable with low resource demand to maintain a dispersed high quantity of assets.

Robotic Automated Manufacturing (ROAM) Boat

The ROAM Boat is both a vessel and a concept. Optimally manned, hybrid powered logistics support vessel capable of on-site, on-demand, additive manufacturing processes (*see Figure 27*) would support small alternate platforms such as PIRANA.

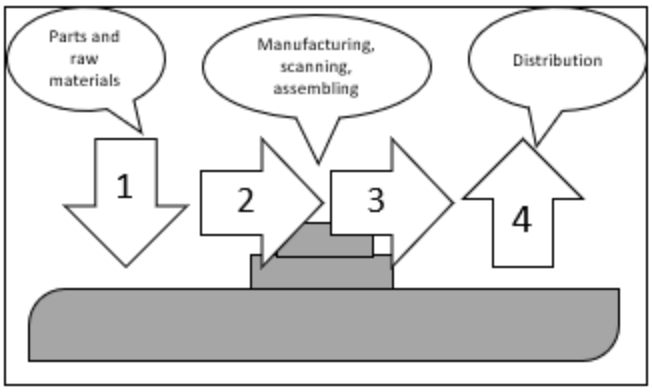

Figure 27. The Robotic automated manufacturing (ROAM) boat concept.

The manufacturing concept to implement on existing platforms would facilitate trust and confidence in the AI and manufacturing processes available. Considerations discussed included the fact that the ROAM Boat leverages CVN, LPD, MSC, commercial, and aircraft for effective distributed mobile manufacturing. This reduces resupply burden, supports real-time warfighting needs, and distributes adversarial targeting. The ROAM Boat enables additive manufacturing or 3D printing, scanning, and repurposing of parts and material for sub-assemblies and final assemblies. Hybrid onboard power sources include wave, geothermal, hydrogen sourced energy. The team proposed embarking fleet mechanics and technical reps to support any fleets needs with associated parts. The ROAM Boat also has the potential to incorporate *Cranky Casper* for C-ISR.

Cranky Casper

This concept is a deception system of systems (SoS) for Hybrid Force 2045 employing shapeshifting, color-changing, and long-distance encrypted communications to create secure network to operate with platforms such as ROAM-Boat and PIRHANA. Possible decoy and countermeasures include:

- Cheap, inflatables, drones
- Software-defined
- Sensor (RADAR and Satellite) countermeasures – material and build

Considerations discussed included the increase in adversary response that is delayed, disrupted, or denied by the use of:

- Decoy and countermeasures
- Drones
- Shapeshifting
- Color-changing
- Encourage saturation and desensitization of adversary decision making

The increased human performance and training accelerated through Morpheus, immersive and experiential training curriculum, and facilities to qualify operatives and operators for mission success.

F. Team USARPAC

Figure 28. Members of Team USARPAC *(pictured from left to right)* A. Gallenson, Maj S. Black USMC, S. Mellon, J. Rodriguez, CDR E. Jatho USN, D. Ockerman, M. Swendsen, M. von Fahnestock, C. McLemore, G. Campbell, September 2021.

The members of this team (*see Figure 28 and Table 6*) included three junior officers from the U.S. Navy and U.S. Marine Corps, five engineers from warfare centers, academia, and industry. The team was facilitated by an NPS faculty member and a warfare center guest, and included three NPS students and an NPS faculty member.

Table 6. Members of Team USARPAC (*alphabetical by last name*)

NAME	PERSPECTIVE	AFFILIATION
Maj Scotty Black USMC	*TACAIR Planner & AI*	NPS MOVES
Georgianna Campbell	*Facilitator*	NIWC Atlantic
Ann Gallenson	*Facilitator*	NPS Center for Executive Education
CDR Edgar Jatho USN	*Information Warfare*	NPS Computer Science
1stLt Eric Jimenez USMC	*Comms Officer*	NPS Information Sciences
CDR Connor McLemore USN (ret)	*Operations Research Analyst*	CANA Advisors
Dr. Sam Mellon	*Physics & Astronomy*	NIWC Atlantic
Dr. Dan Ockerman	*Cyber*	JHU/APL
Dr. June Rodriguez	*Operations Research Analyst*	MITRE
Mary Ann Swendsen	*Strategic planning*	USARPAC
Mike von Fahnestock	*CWMD/CBRN*	USINDOPACOM
Dr. Rudy Yoshida	*Math & optimization*	NPS Operations Research

This team worked the design challenge in a classified space and a full summary of their final concepts is available by vetted request through appropriate channels. The following is an unclassified overview of

their work. The team spit themselves into three subgroups to address the challenge more fully and generated a concept for sustainable, infallible, resupply establishing noise surveillance (SIREN).

The Common Data Layers Problem

The team started with a problem statement:

> *How might we provide a credible conventional capability in a comms contested fight inside first island chain?*

Assumptions:

- The existing U.S. Navy and MC C2 architecture is not optimized to support future distributed autonomous weapons in a communications contested environment inside the 1st island chain
- Initial exquisite weapon fight to enable follow on capacity weapon fight, DDGs and Carriers held back
- Conventional capability must be survivable if Red shoots first
- Fixed ports and airfields not survivable
- Surface assets inside A2AD umbrella not survivable
- Radiating systems, communications or sensors, become targets

Today, we have big detectable shooters with limited number of exquisite tube launched weapons. Track correlation and fusion is all done manually, and data is manually pushed. Common tasks assume the availability of higher bandwidth communications, and we are unable to look backwards in time through easy access to historical data and unable to look forwards in time through AI predictive modeling using real world data sets. Communication paths are stove-piped (i.e. fighters don't have CEC. MOC doesn't have LI6 picture, etc.), and links and communication paths are walled gardens. Machine to machine data transfer between walled gardens requires manual intervention and communication paths are often range limited or dependent on overhead. Asset-target assignments are manual and are done away from the fight.

The envisioned ideal future gave warfighters a way to look backwards in time through easy access to historical data and the ability to look forwards in time through AI predictive modeling using real world data sets. This future includes multi-domain shooters (e.g., air, surface and subsurface weapons mix on unmanned underwater vehicles (UUVs)); distributed, mobile, passive, hidden (submerged) shooters; and shooters use organic sensors and receive offboard targeting information, and mobile broad area sensors broadcast targets to shooters in real-time. Very long-range, one-way communications (>1000nm) at a low bandwidth are standard, and AI would be leveraged to parameterize sensor data on the edge enabling *thinline* communications.

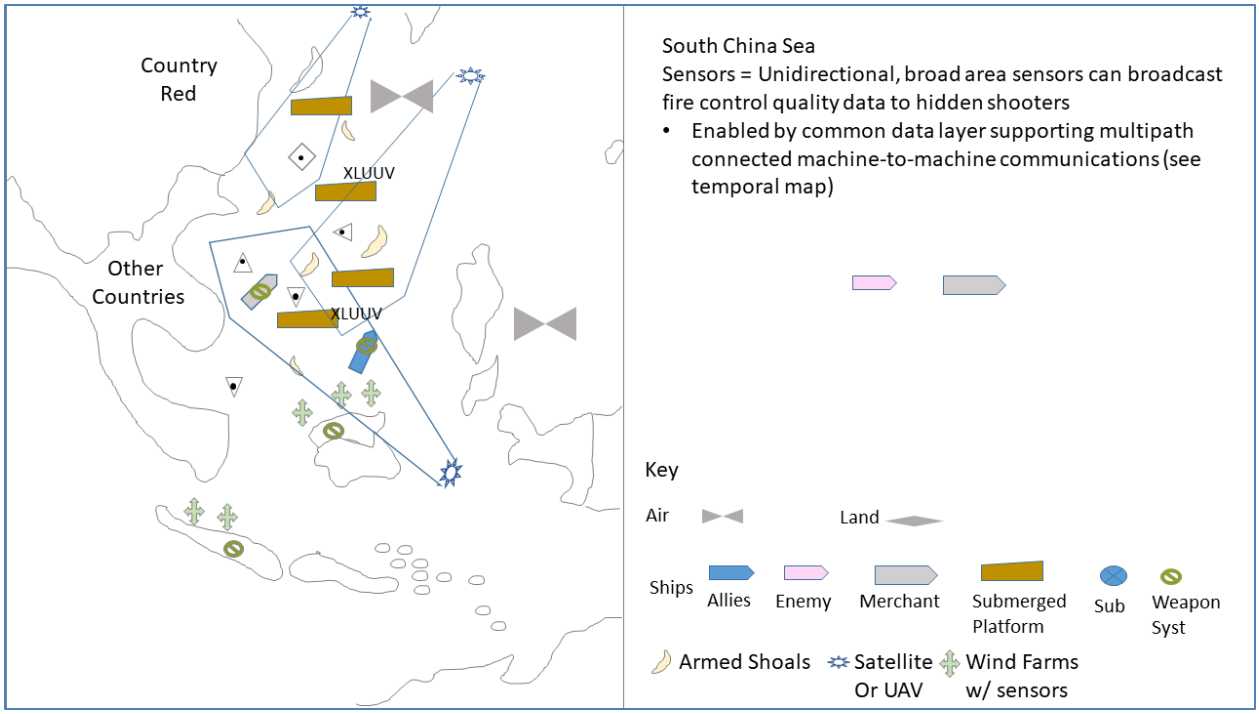

Figure 29. A notional common data layer incorporating multiple inputs for multipath connected machine-to-machine communications.

A common data layer (*see Figure 29*) enables automated machine-machine data transfer between existing systems such as CEC, JTIDS, sonar, and intel with automated track correlation between visual, COMINT, ELINT, and SIGINT. Target quality data is passed in real-time via common data layer rather than a "*walled garden*," and no satellite dependence for sensors or communications. Assets-target assignments are automated using edge computing power near the fight.

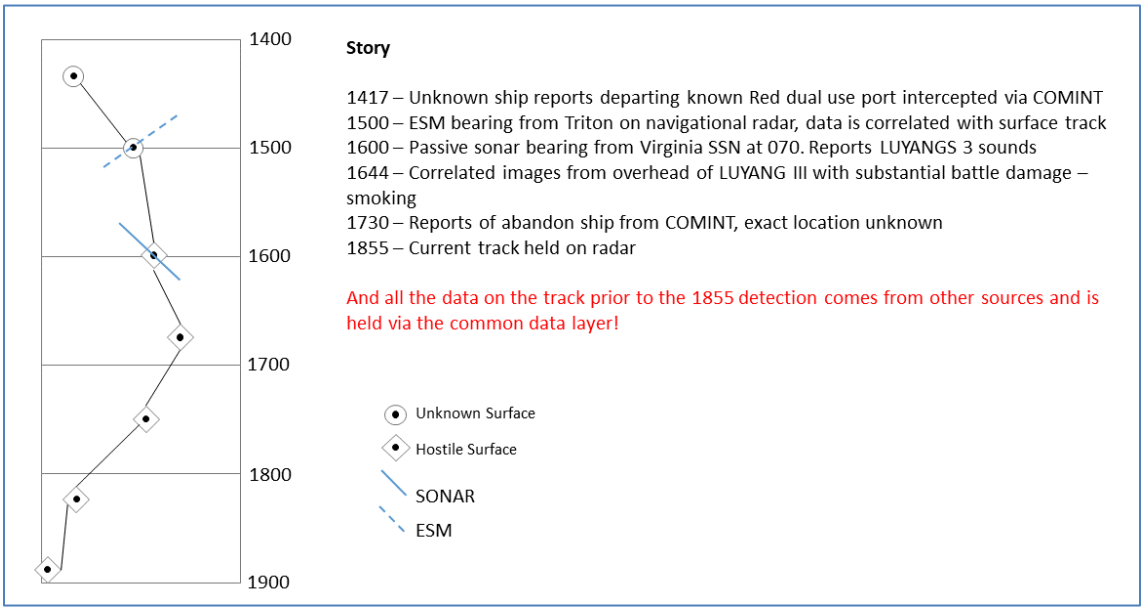

Figure 30. Using common data layers to look back in time and inform AI-enabled predictive modeling to "see" the future.

Their proposed solution involved non-technical means and theater-focused broad-area-surveillance with fused target-quality-deliverable data pushed to common data layer enabled by distributed AI capability on the sensors and shooters. This common data layer would be received by hidden shooters via broadcast then fused via edge AI with data from organic passive sensors. Dynamically-shifted communications and unidirectional in-theater broadcasts of a common data layer to fuse data – including historical data (*see Figure 30*) – from broad area surveillance and intelligence assets provides a credible conventional capability in a comms contested fight inside first island chain.

G. Mentor Corps 2021

Each year the workshop employs a small group of senior level professionals from a variety of perspectives to serve as Mentors. The "Mentor" role is inspired by Homer's Odyssey:

> *When he left Greece for the Trojan War, Odysseus left his son Telemachus in the charge of his old friend Mentor to share knowledge and friendship to guide the son in the absence of his father.*

Mentors in the WIC Workshop serve as trusted advisors, providing expertise and guidance to those at an earlier place in their career to advance their ideas, grow their confidence, and build their networks. Some members of the Mentor Corps were incorporated into the concept generation work of one particular team so they are also listed as members of that team in this appendix. The twelve members of the Mentor Corps 2021 included:

Dr. Chris Bassler, Senior Fellow - Center for Strategic and Budgetary Assessments (CSBA)

Dr. Chris Bassler is Senior Fellow at the Center for Strategic and Budgetary Assessments (CSBA), where he researches maritime operating concepts, joint aerospace capabilities, technology & innovation, and overall U.S. & allied military strategies. He previously served as Chief Strategy Officer for the F-35 Joint Program Office, and in other assignments in OPNAV, ONR, and the Navy labs- as an engineer, scientist, designer, and strategist. He has a PhD in Aerospace Eng. and MA in Security Policy.

Mr. Pete Biggam, CEO – Blacksite Solutions Inc.

Mr. Biggam is a 20+ Entrepreneur located in Santa Cruz and Watsonville regions of the Monterey Bay. He mentors and advises startups in multiple verticals and focus on exponential technologies. Blacksite Solutions is an information security company specializing in protecting data in transit and at rest and getting into gov contracting. The Santa Cruz Founders Institute is the largest Pre-Seed Business Accelerator and just launched in Santa Cruz. The Startup ISAO will specialize in providing Startups with OSINT, Threat Intel, and other tools to better protect US National Security.

Dr. Tom Choinski, Director for Undersea Warfare - NUWC Newport

Dr. Choinski is the Deputy Director for Undersea Warfare at NUWC HQ. He has 40 years of experience in innovation, engineering, science and technology and management culminating in an interdisciplinary approach to innovation. Tom's current pursuits focus on innovation ecosystems and artificial intelligence. Previously, he stood up the Emergent and Transformational Systems Division, served as the CNO Strategic Studies Group's (SSG) Science Advisor, led the first COTS SONAR installation on an SSBN, held engineering positions in industry and served as an adjunct professor at the New York Institute of Technology. He has published over 70 papers, as well as a Ph.D. dissertation on *Dramaturgy,*

Wargaming and Technological Innovation in the United States Navy and a book chapter on *Artificially Intelligent Techniques for the Diffusion and Adoption of Innovation for Crisis Situations*. Tom holds graduate degrees in engineering and business. He completed an MIT Seminar XXI fellowship in Foreign Politics, International Relations and the National Interest. Dr. Choinski received a Meritorious Civilian Service Award for his contributions to the CNO's SSG. The National Society of Professional Engineers selected him as one of the Top Ten Federal Engineers of the Year in 2008.

Dr. William Elmer, Computational Test & Evaluation – Lawrence Livermore National Laboratory, DOE

Dr. Elmer is a principal investigator for "Computational Test and Evaluation" in the Joint Munitions Program between DoD and DOE. He uses high performance computational tools to evaluate munitions design, effectiveness, and collateral damage concerns; and interfaces regularly with DoD civilians in service branch research laboratories and facilitate the adoption of a computer code called ALE3D[20] for achieving these goals. Dr. Elmer served on a concept generation team for the WIC workshop in 2018 and attended the National Labs Entrepreneurship Academy in June of 2016.

Dr. Shelley Gallup, Research Associate Professor – NPS Information Sciences

Dr. Gallup is an NPS research professor engaged in experimentation of new technologies and force structure analyses. He has advised many NPS Masters theses and doctoral students and has written and published on a variety of topics. Dr. Gallup is central to the research team behind the LMACC concept.

Dr. David Kilcullen, Professor of International and Political Studies – University of New South Wales, Canberra Australia

David Kilcullen is Professor of International and Political Studies at UNSW Canberra, Professor of Practice at Arizona State University, and CEO of the research firm Cordillera Applications Group. His expertise is future warfare, guerrilla and unconventional warfare, special operations and counterterrorism. Over a 25-year career with the Australian and U.S. governments as a soldier, intelligence officer and diplomat, he served in Iraq as senior counterinsurgency advisor to General David Petraeus, as advisor to Secretary of State Condoleezza Rice, and in Afghanistan, Somalia, Libya and Colombia. He has worked extensively for NATO and other international organizations, helping to analyze and predict the nature of future threats and conflicts, and has written five prize-winning books and numerous scholarly articles on terrorism, insurgency, urbanization and future warfare.

Mr. Terry McKearney, President - The Ranger Group

As an NPS student, did my thesis for Wayne Hughes on the impact of the original Orange plans on ship design and how they effected the early battles of WWII. He used the data I compiled in Fleet Tactics. I and my company have recently worked on an ONR/NIWC INP/FNC to develop undersea UUV architecture, where we've used wargaming and facilitated workshops to develop fleet user requirements and assess the potential functionality of these systems in Phase to Phase 3.

[20] available free to government and government contractors

Dr. Benjamin M. Rodriguez, Space Exploration, Computer Science and Data Science – JHU

Dr. Rodriguez has a background in statistical signal processing with a focus on data science, intelligent systems and machine learning. His current work duties include research and development in algorithms development, data processing, information retrieval, intelligent system design, recognition techniques, and fusion of multiple data sources, including sensor data for pattern association, decision making and tracking. He has worked on projects related to target identification using SAR, Hyperspectral and Panchromatic imagery along with facial recognition, fingerprint matching, voice recognition, web crawling, and breaking encoded messages within transmitted signals. He also has conducted research in RADAR, LiDAR, and optical sensors for target recognition/tracking using generated features, feature preprocessing techniques, classification models and fusion methods. Other areas of his research include pattern recognition using image, signal, and video processing techniques for face recognition, fingerprint matching, anomaly detection and voice recognition. His software engineering experience includes Unix, Linux, and Window operating systems and programming using assembly, C/C#/C++, ENVI IDL, Java, Matlab, Python and R. Dr. Rodriguez is also a full time Johns Hopkins University – Applied Physics Laboratory (JHU-APL) Principal Professional Staff since 2008 and an Assistant Group Supervisor.

CAPT Marco Romani USN (ret), VP Strategic Growth – Opto-Knowledge Systems Inc.

CAPT Romani USH (ret) spent 20 years reserve and 10 years active duty. His assignments on active duty include Naval Aviator, Joint and CNO Staff. CAPT Romani had reserve tours with multiple CSG staffs, Pacific Fleet Plans (N5) and current ops including as Crisis Action Team Chief. He finished his USN Career as the MQ-25 requirements officer and was twice selected as senior USN rep to ROC Navy during Taiwanese self-defense exercises. He also serves as a mentor for the Stanford Hacking for Defense classes.

CAPT Glen Sears USN (ret), Senior Strategy Analyst – LMCO

CAPT Glen R Sears II, USN(Ret) is a Senior Strategy Analyst in Lockheed Martin's Rotary and Mission Systems Business Area. He joined Lockheed Martin in 2012 following 30 years' as a surface warfare officer in the US Navy. His last Navy assignment was Executive Director of the Chief of Naval Operations Executive Panel facilitating independent civilian advice on national security and technology innovation. His service at sea in six cruisers and destroyers deploying around the world culminated in command of USS TICONDEROGA (CG-47). He later commanded Task Force 53, Naval Logistics and Strategic Sealift Forces Central Command. Ashore his service included Joint Staff assignments in Asia political-military strategy, security assistance policy, and joint capabilities and requirements; as a battalion officer at the US Naval Academy; on the Chief of Naval Operations Staff (N80) managing the Ship Construction Appropriation; and at the AEGIS Program (PMS 400) as a combat system engineer. He is a graduate of the U.S. Naval Academy, the Naval Postgraduate School, the National War College, the Air Command and Staff College, and attended the Department of State Foreign Service Institute's National Security Executive Leadership Seminar.

Dr. Justin Sellers, Expeditionary Warfare Department – NIWC Atlantic

Dr. Sellers serves as the Chief Scientist for the Expeditionary Warfare Department at Navy Information Warfare Center Atlantic. He was the former ONR IPT Tech lead and Supervisor for Software Defined Radio and has over 15 years of experience in variety of radio centric technologies, communications,

sensors, and electronic warfare. Dr. Sellers is an alumni of NPS with a MEEE in Cyber Warfare and Communications.

CDR Nick Ulmer USN, Military Faculty – NPS Operations Research

CDR Ulmer is the Program Officer for the 361 and 362 curricula in the Operations Research Department and also serves as a lecturer for elective courses in Operational Logistics and Energy Logistics. He is a U.S. Navy Supply Corps officer. His sea assignments include USS PASADENA and USS BOXER. His shore assignments include contracting in Naples, Italy and a deployment to Iraq. He has also done tours at NAVSUP Weapon Systems Support (WSS) and the Bureau of Naval Personnel (BUPERS).

Mr. Chuck Yungkurth, Chief Engineer – JHU/APL

Mr. Yungkurth is a senior weapon designer with nearly 40 years of experience in industry and APL. Bachelor's degree and a Master's degree in Aerospace Engineering from the Pennsylvania State University. He began his career at APL under the leadership of men who were the inventors of supersonic guided missile aerodynamics as well as hypersonic air-breathing propulsion. From 2003 until his retirement in 2019, he was senior aerodynamicist for all STANDARD Missile products lines at Raytheon. Chuck came out of retirement to re-join APL as Chief Engineer for air-launched hypersonic weapons at Eglin Air Force Base, with the Long-Range Systems Agile Weapons Directorate (AFLCMC/EBX). He is currently embedded with the acquisition program office for the Hypersonic Air-breathing Cruise Missile (HACM). Chuck brings a wealth of accumulated experience in weapon engineering, mission planning and platform integration across land, sea and air-launched applications.

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APPENDIX B: Scenario

Developed by retired Navy Captain and Professor of the Practice in the NPS Operations Research Department Jeff Kline, the following scenario was the environment given for the design challenge:

All data on platforms and weapon systems have been derived from unclassified sources such as Janes IHS, USNI publications, and other open-source websites. ***Request for information may be addressed to Prof. Jeff Kline at jekline@nps.edu***

FICTIONAL SCENARIO FOR ACADEMIC PURPOSES ONLY

Hybrid War of 2045: A force design scenario

2045 Political, Social, and Economic narrative:

Although the world's economic growth was severely arrested by the 2020 COVID 19 pandemic, countries around the world began studying their own nation's economic fragility with a goal of investing in national capabilities to address the most vulnerable sectors. None more so than the United States. U.S. production industries received significant tax incentives to find reliable sources of metals, commodities, labor, and invest in additive manufacturing technologies. Service and food sectors were granted significant funds to enable additional resident work and home deliveries. The financial sector explored for risk associated with international investments and encouraged to focus on more domestic and regional development.

As other nations followed suit, regional trade blocks began to emerge with various degrees of unity. Lead by the United States, Mexico, Canada, and Brazil, the western hemisphere block is the most stable and near self-reliant. Yet, there are breakaways. Argentina aligns itself with the Asian block after China invested heavily in Argentine infrastructure between 2022 and 2040. The Indo-South East Asian block-- with India and Australia sharing leadership in economic cooperation-- includes Indonesia, the Philippines, Kenya, Singapore, Taiwan, Vietnam, Thailand, and Brunei. The African Union's 55 member states expanded their organization's activities and accelerated their Agenda 2063 resulting in improved economic cooperation, growth, and social programs across the continent.

Less stable is the Russian-European trade region with tensions existing between the oil supplier, Russia, and the oil consumers, the rest of Europe. The most fractious region is Asia, with competition between China and Japan for political, economic and military leadership intensifying daily. Japan maintains her strong relationship with the United States and the Western Hemisphere trade block, while China continues her political, fiscal, economic, and military expansionism**:** bridging the Eurasian trade regions through infrastructure investment between Asia and Europe under the "Belt and Road" program. In 2030

she began deploying forces along sea routes and at critical land junctions to provide security for these trade routes, which now include Arctic sea routes.

Although climate change has enabled Arctic sea route transits for all nations, other less desired effects have arisen including more frequent droughts, storms, heat waves, and droughts. These have resulted in crops and water scarcity in some trading blocks, while in others increasing levels of weather-related damage.

In 2045 China is the world's first economy, has a large and growing middle class population and consequently generates a higher demand for oil and natural gas, which she depends on Russia to provide. She has also achieved her goal of becoming a major space power, operating regular space flights to a Sino Space Station and servicing extensive satellite constellations. She is leading an international effort to go to Mars in 2046.

Various Force Locations for Great Power Competitors

China populated several islands terra-formed through dredging in 2015 with military installations. Fiery Cross Reef has a squadron of older manned J-20B fighters with 30 advanced GJ-11 (Sharp Sword) stealthy UCAVs and 10 WZ-8 supersonic reconnaissance UAVs. These aircraft work in manned-unmanned or unmanned teams. Fiery Reef, Mischief Reef, Gaven Reef, and Hughes Reefs have surface to air installations (S-600), anti-surface DF-17 hypersonic glide vehicles and the supersonic long range, high altitude DF-100 cruise missile, electronic surveillance and communication sites, and ship support facilities.

China also maintains an unmanned squadron and support vessel in Gwadar Pakistan. The squadron is composed of 15 GJ-11 (Sharp Swords), 10 HSU002 UUVs, and 20 advanced JARI USVs. These unmanned vessels exercise frequently with Chinese built Pakistan Type 055 destroyers stationed in Gwadar. China maintains six advanced Type 095 nuclear attack submarines, an advanced Type 004 aircraft carrier with 40 upgraded J-31 stealth fighters, four Xian KJ-600 AEW aircraft, and 40 stealth attack drones embarked; and five Type 52DL destroyers on patrol in the Indian Ocean, which frequently visit Gwadar, Yangon and Djibouti for logistics support.

As a show of "good will", China always deploys regularly outside of the Western Pacific and Indian Ocean to the Mediterranean, Argentina, and Cuba. These deployments are usually conducted by an older Type 003 aircraft carrier, two Type 55 destroyers, a Type 95 SSN, and two logistic support ships.

Russia has continued to build her undersea capabilities and has manned and unmanned forces stationed in the Arctic along the Northern Sea Route in locations like Murmansk, Alexandra Island, Kotelny Island, and Wrangle Island. From these bases Russia can threaten all the Arctic nations and the shipping route and defend her Arctic port and oil infrastructure. Forces and weapons include hypersonic anti-ship missiles, Poseidon 2M39 nuclear long-range torpedo, land forces, and patrolling submarines.

Japan and the United States have strengthened their social, economic, and military ties in response to the growing influence of both China and Russia and instability in the Asian region. The Yokosuka naval facility is a joint JMSDF and United States Navy base. In Sasebo, the United States Navy retains

expeditionary lift and logistics capability for both the U.S. Marine Corps and the Japan Maritime Defense Forces.

The United States maintains six Constellation Class Frigates in **Singapore**, an unmanned support squadron with 10,000-ton tender, and a variety of unmanned systems which are shared with the city-nation, including 6 advanced unmanned MMA patterned after the MQ-4 Triton. The United States now maintains logistic support bases in Diego Garcia and pre-positioned expeditionary supplies in Subic, with joint agreements with the U.K. and Philippines respectively. These bases can act as "rapid build-up" support bases if the host country agrees. Additionally, the Philippines have invited the United States Air Force to use Clark AFB as an expeditionary field, expanding its role beyond joint training exercises. The United States Air Force has retained Kadena AFB on Okinawa, and III MEF occupies the air base in Henoko village. In addition, a U.S. Marine rotational force is in **Darwin, Australia**.

Australia has built up their air and naval forces with the intent of closer cooperation with the United States. For example, 12 Shortfin Barracuda SSKs are operational, and the RAAF operates 15 MMA P-8 Advanced Aircraft and 9 MQ-4D Triton from Edinburgh conducting frequent bi-lateral exercises with the United States and other countries from the Western hemisphere and Indo-South East Asian trade blocks.

Increasing Tensions Globally

South Atlantic: In 2042, bolstered by China's funding and desire to control the Strait of Magellan traffic, **Argentina** challenges the Beagle Island claims by Chile and revokes the 1984 treaty which gave control of the islands and Straits to Chile. Argentina closes all her western boarders and stops all maritime traffic exiting or entering the Strait of Magellan. China immediately supports Argentina's claim and warns the United States to remain neutral in this local dispute. To ensure the United States neutrality, China moves a deployed naval task group to Puerto de Buenos Aires and warns the United States to keep her forces north of the equator. Russia aligns and supports China declarations and threatens to deploy her Northern fleet into the Atlantic to ensure United States compliance. She also threatens to close all Northern Sea Route traffic heading for United States ports.

South China Sea: While the United States population focuses on the Chile/Argentine dispute, and surprised by China's and Russia's response, China publicly extends her South China Sea Claims to 1 degree north with the justification to protect critical fishing grounds, undersea resources and trade routes into China. She offers to buy or lease the Island of Natuna Basar from Indonesia to establish maritime security forces to be a "sentry" for peace, trade, and fishing in the southern seas. There is a less than vailed threat that should Indonesia fail to accept this offer, China will blockade then invade Natuna Basar as is her right as a guarantee of open trade.

Baltic: While increasing tensions in the Pacific and Southern Atlantic have the attention of the United States and Europe, several media statements released by Russian leaders indicate re-establishing the historical Russian influence in the Baltic Sea. Swedish intelligence has found evidence that Russia is making plans to project its power by taking over the Swedish island of Gotland, a territory Russia claims as part their heritage. Controlling Gotland will give them significantly more port space within the Baltic; achieve greater situational awareness of the maritime approaches to Stockholm, St Petersburg, Tallinn,

Riga, Kaliningrad and Gdansk; and further project their control over shipping and natural resources in the Baltic Sea. Taking Gotland will also give Russia a good indication of how other countries will respond to their expansionist intentions without the risk of a costly war. Specifically, they are interested with the United States' will to support Sweden and its ability to mobilize and stop the island occupation. Due to cramped naval installations at St. Petersburg, the Russian Baltic naval strength is relatively small, and they do not wish to use the time, or give away their intentions, by employing their Northern Fleet to assist in this operation--except for submarines in coordination with their threat to the United States to remain neutral in the Argentine/Chile dispute. Five Sererondvinsk (Yasen) class SSNs, 2 Belgorod SSGN, and 3 older Lada Class SSK are detected to be underway from the Northern Fleet ports and believed to be headed for either the Atlantic or Arctic.

Upon discovering this plan, Swedish authorities have notified the United States and other Baltic nations and asked for their assistance. While the UN is not officially notified, word has spread and Russian representatives at the UN are vehemently denying such an operation is being planned. However, the United States, in cooperation with Swedish and British intelligence, has good indication that not only is this plan in place, but the attack is imminent. Other Baltic countries have agreed to allow United States over flight rights to ensure Gotland's security, but have not yet made commitments of force. Finland, however, has indicated they will come to the aid of Sweden.

Indian Ocean: Emboldened and supported by China, Pakistan begins naval and land patrols near Sir Creek to support their claim of the eastern shore dividing line with India. India has long claimed a center-line division. Although a minor dispute compared to the larger territorial confrontations of Jammu and Kashmir, the Indian Navy takes this challenge seriously and begins to deploy their surface forces. Ship to ship shouldering becomes a common occurrence and warning shots are exchanged. China threatens that if India does not stop her deployments, she will conduct an extended blockade against Indian trade by intercepting ships transiting the Suez and Malacca straits. India calls upon her trading partner Australia for possible support. The United States, Singapore, Japan, and England publicly denounces China's threat and lend their diplomatic support to India and Australia.

The United States, her allies and trading partners, now look for responses to deter further aggression, and if necessary, deploy forces for combat.

Orders of Battle in 2045

The following list is not exhaustive. Programs and/or platforms not listed but programmed for IOC earlier than 2045 may be introduced. From the Order of Battle the disposition of United States Forces are as follows:

US Forces Immediately Available for use in Southern Atlantic Conflict and Atlantic Operations

Maritime Forces

1 DDG and 2 FFG exercising 50 nautical miles west of Manta, Ecuador exercising with Ecuadorian Navy (UNITAS)

1 CVN, 1 Virginia Class SSN, 3 DDG and 4 FFG underway VACAPES in Workups.

1 CVN, 2 Virginia Class SSN, 3 DDG, and 4 FFG on 30-day alert in Norfolk (post deployment readiness)

US Forces Immediately Available for use in the Europe in 2045

Maritime Forces

1 LHD, 2 LPD-17, 4 Light Amphibious Warships with MAGTF embarked conducting bi-lateral exercise with Spain in Bay of Biscay
1 CVN, 2 DDG, 4 FFG underway in transit from Norfolk to Med 150 nm west of STROG
Two Virginia class SSN on patrol in North Atlantic
1 FFG and 2 LCS (One mine warfare and one ASW configured) in port Gothenburg, Sweden
2 DDGs in Rota, Spain
1 DDG in the Eastern Med on TBMD station
Three JHSV's operating in English Channel with French forces

Air Forces

35 F-35Cs in Aviano, Italy
16 P-8s in Italy
2 AWACS from Ramstein USAF

Army forces

2nd Cavalry Rgt (Stryker) in Vilseck, Germany
173rd Airborne Brigade in Vicenza, Italy
41st Field Artillery Brigade Grafenwoehr, Germany
12th Combat Aviation Bde, Ansbach, Germany
10th Army Air and Missile Defense Kaiserslautern, Germany
U.S. Army NATO Brigade, Sembach, Germany
21st Theater Sustainment Command, Kaiserslautern, Germany

US Forces available in Western Pacific

Maritime and Land Forces

Three SSNs on patrol in South and East China Sea
Two SSNs on patrol in Western Philippine Sea
1 CVN, 2 DDG, 4 FFG CSG underway 300 nms east of Guam
Two DDGs and three FFGs in port Guam
Three DDGs with five MSC ships transiting Philippine Sea toward Port of Tacloban, Leyte, Philippines
Squadron of P-8s in Guam and another Squadron in Singapore
Three SSNs, 2 DDGs, 3 FFGs, 2 LDUSV, 10 MDUSV, 3 TRITONs, 10 large displacement unmanned undersea vehicles (LDUUVs) in Guam
Six FFGs, 2 LUSV, 4 MUSV, 4 XLUUV (Orca), and 2 Tritons in Singapore
Three JHSV's currently in port White Beach, Okinawa
Three DDGS, Four FFGs in Yokosuka, Japan
Remaining Pacific Fleet forces in Hawaii and continental U.S. (CONUS) bases

Ready to employ from Hawaii:
40 Anti-ship mobile missile batteries (Naval Strike Missile) USMC/ARMY along first island chain
30 C4ISR mobile sites USMC/ARMY along first island Chain
15 mobile air defense sites USMC/ARMY long first island Chain (Patriot)
4 Marine Corps EABF with 20 F35B in bases along first island Chain

Air Forces
8th and 51st Fighter Wing South Korea (20 F-35 and 30 UCAV Mission Capable)
18th Fighter Wing Kadena, Okinawa (15 F-35 and 10 F-22 Mission Capable)
35th Fighter Wing Misawa, Japan (25 UCAV and 20 F-35 Mission Capable)
3rd Air Wing Elmendorf, Alaska (30 F-22, 20 F-35, 15 Global Star UAV Mission Capable)
15th Air Wing Pearl Harbor (30 F-22, 20 F-35 mission capable)
Expeditionary Air Wing, Andersen AFB, Guam
- 4 B-2, and 8 B21 Mission Capable
- 25 F-35 mission Capable
- 4 E-8C

Expeditionary Air Wing Pearl Harbor
- 4 B-2 and 6 B21 Mission Capable

50 KC 46 Tankers are available throughout theater

Robust Special Operations Forces and logistics exist and many are forward executing the "Global SOF" concept including Riverine Forces (Riverine Forces are currently based in San Diego and Norfolk

Russian Forces available in conflict Regions

Mediterranean, Baltic and Eastern Atlantic (SSNs and SSKs):

NAVY

6- Project 885-M Yasen M-class SSGN (on patrol Atlantic)
4 – Lada class conventional Submarines (Kilo replacement) in Med
2 – Kilo (Project 636) class Submarines in Med
1– Leader class CG (Project 23560)
4 – Grigorovich(Project 11356M) FFGH
3 – Gorshkov (Project 22350) FFGH
4 – Buyan-M class corvette
In Kaliningrad:
4 Gorshkov (Project 11356M) FFGH

AIR FORCE In Syria

10 – SU57 in Syria
20- SU35S in Syria
3 – AN-30 Surveillance A/C in Syria

15 Tu-160 Blackjack in Russia

AIR FORCE In Baltic

15 Kronstadt Sirius medium-altitude long-endurance intelligence, surveillance, and reconnaissance (ISR) and attack UAV
30 S-70 Okhotnik-B (Hunter) stealth-capable combat drone
25 – SU35S in Kaliningrad
5 – AN-30 Surveillance A/C in Kaliningrad
15 Tu-160 Blackjack in Russia

LAND FORCES

336th Marine Brigade (2000 men and fighting vehicles) in Kaliningrad
152nd Guards Missile Brigade SS22 Stone missile in Kaliningrad Oblast
2 Brigades from the 76th Air Assault Division with airlift
5 Brigades in position along Suwalki Gap

Pacific:

NAVY

4 – Petersburg-class conventional Submarines (Kilo replacement)
3 – Dolgorukiy-class SSBN
3 – Severdvinsk-class SSGN
1 – Lider-class CG(N)
2 – Sovremenny DDG
6 – STEREGUSHCHIY Class FFG
2 – Gorshkov FFG
10 SVIYAZHSK class PGM
25 – SU-30M Aircraft
10—Altius M UCAVs

Multiple small vessels and support ships

AIR FORCE

25 – SU57
5 – AN-30 Surveillance A/C

Japan Maritime Self Defense Forces

20 - SSK (Improved Oyashio Class)
4 - DDHM (Future Destroyer Class: aviation capable)

10 - DDGHM (Improved Kongo Class: 5 TBMD capable)
5 - DDGHM (Kongo Class)
6 - DDGHM (Murasame Class)
8 - FFGM (Improvded Abukuma Class)
5 - LPD (Oosumi Class)
20 - PGGF Hayabusa Class
20 LDUUV
50 MDUSV
50 - MMA Boeing 767
50 unmanned next generation fighter drones
30 - F-35C
40 - F-35 VSTOL for Deploying on Future Destroyer Class

China's Forces

8 SSBN (Type 094/096) (All based in Jianggezhuang with one always on patrol)
2 SSN (Type 093) (Based in South China Seas Fleet)
4 SSN (Type 093A) (4 based in South China Fleet and deploy to I/O while remaining in Northern Fleet)
10 SSK (Type 039A/B Yuan) (5 in South China Fleet and deploy to I/O, while remaining 5 are stationed in Northern Fleet)
13 SSK (Type 039 Song) (4 in South China Fleet, 5 in East China fleet and 4 in Northern Fleet)
4 DDGs (Sovermenny-modified) (2 in South China Fleet Deploying to I/O, 2 in North Seas Fleet)
6 DDGs (Type 52D Luyang class) (East China Sea Fleet)
4 DDGs (Type 52C Luyang class) (South China Sea Fleet)
4 DDGs (Type 52B Luyang II class) (All in South China Fleet deploying to I/O)
20 FFGs (Type 054 A Jiangkai II class) (2 based in Burma, 4 always deployed to Pakistan, 8 in South Seas Fleet and 6 in North Seas Fleet)
10 FFGs (Type 053 Jiangwei I class) (All based in East Seas Fleet)
5 FFGs (Type 53 Jianghu V class) (All based in East Seas Fleet)
60 Corvettes (Type 056 Jiangdao corvette) (40 in South China Sea, 10 in North Sea fleet and 10 in East China Sea)
60 PGGF (HUOBEI Class) (8 deployed to Pakistan, 8 deployed to Burma, 30 in South Seas Fleet, 10 in East Seas Fleet, 4 in North Seas Fleet)
2 CV (Shadong) (1 in North Sea Fleet and 1 in South Sea Fleet)
30 Older PTGs of various class. (All deployed in South Seas Fleet)
1 LHD (Type 081 class) In support of Guangzhou Military District Forces
8 LPD (YUZHAO class Type 071) All in support of Guangzhou Military District Forces
25 LST Yuting II Class All in support of Guangzhou Military District Forces

200 Su-33 Flanker Land-based maritime capable aircraft (20 in Woody Island, 20 in Pakistan, 30 in Myanmar and 130 remaining in China)
100 FC-1 Fierce Dragon (20 with Pakistan Air Force, 80 remaining on China mainland)
300 J-10 Vigorous Dragon (20 in Burma, 40 in Pakistan, and 240 remaining in China
100 J-11 Aircraft (20 in Pakistan, 80 remaining in China)

25 J-20 Air superiority fighter (all in China)
60 Chinese Y-8FQ MMA (ASW, ASUW, ELINT and Maritime Search capable with Boeing 767 range. 5 deployed to Pakistan, 5 deployed to Malaysia, 5 deployed to Burma, 5 deployed to the Seychelles, 20 to South Seas Fleet, 10 to East Seas Fleet and the remaining to North Seas Fleet)
24 H-6K/H-6J and 25 H-20 (stealth) bombers ASCM capable
10 TU-154 M/D and 20 Y-8XZ Electronic intelligence and Electronic Warfare aircraft
80 Y-8/Y-9 Transport Lift Aircraft
30 Y-20 Strategic Lift Aircraft and Tanker variants

Guangzhou Military Region Land and Missile Forces

124th Amphib Mech Division
144th Division
121st Infantry Division
123 Motorized Division
80 DF-21Ds (Anti-ship Ballistic Missile) Range 1500 km
40 DF-26 (Anti-ship Ballistic Missile) Range 5000 km
100 CSS-5s
100 CSS-3/DF-4 LRBM

Chinese UAVs

160 Soaring Dragon (High Altitude Long Endurance)
Speed: 470 kts; Range: 4700 nm; Alt: 57,000 ft; Function: ISR

100 Pterodactyl (Stealth Medium Altitude Long Endurance)
Speed: 174 kts; Range: 2500 nm; Alt: 17,000 ft; Function: ISR, Strike

224 ZOND UAV (High Altitude Medium Endurance)
Speed: 135 kts; Range: 6000 nm; Alt: 49,000 ft; Function: ISR, EW

300 ZOND UCAV (High Altitude Long Endurance)
Speed: 135 kts; Range: 6000 nm; Alt: 49,000 ft; Function: ISR, EW, Strike

30 Dark Sword UCAV
Speed: (Unk) Supersonic; Range: Unk; Alt: Unk; Function: Strike, Air-to-Air

Australia Maritime and RAAF forces

8 SSK Barracuda submarines advanced AIP SSKs
3 DDG "SEA 5000" project destroyers. Capabilities similar to FLT III Burke DDG
10 PGMs "SEA 1180" project missile boats or OPVs. Capabilities and size of current Armidale-class boats
24 MH-60R combat helicopters.
20 Next generation Unmanned Fighter Aircraft
70 F-35 Lightning II JSF
12 P-8 Poseidon Maritime Patrol Aircraft
7 Triton UAS
30 MDUSV
5 LDUSV
5 XLUUV

Taiwan Naval Forces and Air Forces

4 New Generation Frigates NCSIST (8 ASCM, phased-array air defense radar and missile capable of 75 nm intercepts)
4 Tuo Jiang Missile Corvettes
30 Kaung Hua 6 upgrade Fast Attack Missile craft
2 Hai Lung II attack submarines
50 MDUSV (ASUW capable)
10 P-8 MMA
25 F-35A
60 F-16E/F

Vietnam Naval Forces

3 SSK (Kilo)
4 FFGM (Gepard)
2 FSGM (Project 12418)
10 FSGM (Tarantul V class)
8 PGM (Svetlyak class)
8 PGM (OSA II)

Singapore's Naval and Air Forces

3 SSK (Challenger Class improvements)
6 FFGM (Formidable Class)
3 Victory Class Corvettes
7 PGM (new class)
4 MCM
32 F-35s
20 Apache Longbow

Other countries contributions limited to their own territorial waters: Philippines and Indonesia

Philippines Forces

3 Blue Water Escorts (Hamilton Class)
1 LCU
3 SSK (Chang Bogo Class)
4 Corvettes (Minerva Class)
1 FFG (Maestral Class)

Indonesia Forces

6 FFG (Yoni Class)
3 SSK (Chang Bogo Class)
2 SSK (Cakra Class)
23 Corvettes (Nakhoda Ragam Class)
Various Fast Attack and Patrol Craft

Indian Forces Available

2 aircraft carriers built in 2030—larger Vikrant design (30 SU35C, 20 Unmanned Aircraft)
INS Vikrant aircraft carrier (40 total aircraft—30 SU35C, 10 Unmanned Aircraft)
10 Visakhapatnam DDGs (Project 15B)
10 Project 75A SSN
20 Next Generation Missile Vessels (ASuW Corvettes)
6 Amphibious Multi-Role Support Vessel (LHD)
20 advanced Saryu class patrol craft
40 SU35 landbased aircraft
15 MMA P-8L aircraft
10 Kamov KA33 AEW aircraft
40 TAPAS-BH-201 (Rustrom-2) Unmanned Combat Aerial Vehicle
50 Rustom H: Large UAV ISR over 24 hours on station time
1 million active land troops; 20K specially trained forces

Pakistan Forces

10 Hangor class SSK (Chinese built)
4 midget submarines
7 Multi-Role Guided Missile and Air Defense DDG (Type 55)
6 Type 54 DDG (Chinese built)
5 Zulfiquar upgraded Frigates
20 Tuzla Class FAC Missile Boats
200 JF-17 Air Interceptor
8 Saab 2000 AEW
560,000 active-duty army personnel

Chilean Forces

4 Upgraded O'Higgins SSK
4 Captan Prat anti-aircraft frigate (AUS Adelaide class)
5 Piloto Off-shore Patrol Vessels
5 Missile Boats
5 MMA (P-8)
20 F-22
50 UAV (various)
80, 000 active-duty Army

Argentina Forces

4 Hangor-class SSK (Chinese built)
4 Type 54 DDG
10 PGMs (updated Hubai class)
30 J-17 Air Interceptor Aircraft
70, 000 active-duty Army

All data on platforms and weapon systems have been derived from unclassified sources such as Janes IHS, USNI publications, and other open-source websites. Request for information may be addressed to ***Prof. Jeff Kline at jekline@nps.edu***

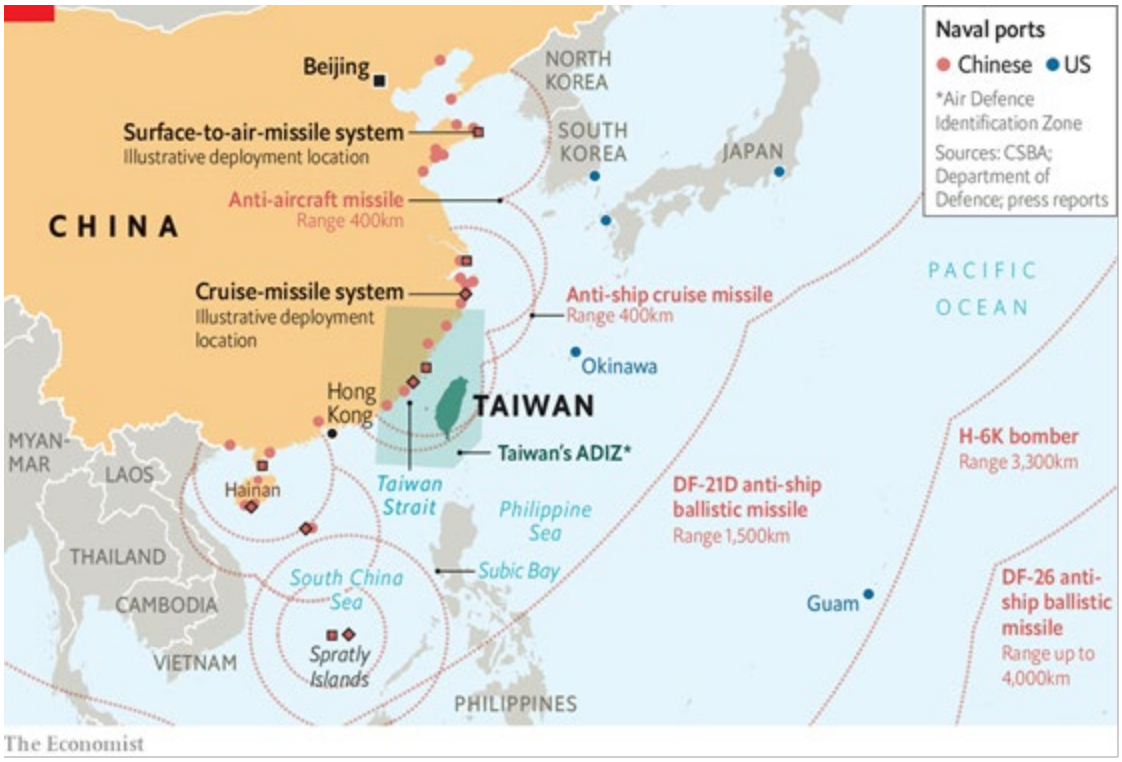

Figure 31. Notional region central in "Hybrid War 2045" scenario (graphic credit *The Economist*).

APPENDIX C: Workshop Schedule

The three-and-a-half-day workshop started on Monday morning with an overview of the workshop, scenario, and design challenge followed by two of three knowledge leveling Discovery Panels. Initial team meetings concluded the first day. Both Tuesday and Wednesday started plenary Discovery Panels followed by a full day of concept generation work. Teams presented their final concepts on Thursday morning and the workshop adjourned on Thursday afternoon.

MON – 20 September

		MAIN ROOM GL 109 and Teams (virtual)
0830	Welcome	VADM Ann Rondeau USN (ret), NPS President
0845	NPS NWSI, Warfare Innovation Continuum & Scenario	CAPT Jeff Kline USN (ret), NPS NWSI WIC Director
0930	Process & Resource Review	Ms. Lyla Englehorn, NPS NWSI Concepts Branch Lead
1000	**BREAK**	
1030	**Discovery Panel I / NWSI Seapower Conversation**	**Global Geopolitics**

Great Power Competition	Dr. Clay Moltz, Dean NPS Graduate School of International and Defense Studies (IDS)
Hybrid Warfare & Cold War	Dr. Daniel Moran, NPS National Security Affairs
Images of Future War	Dr. James Wirtz, NPS National Security Affairs
Maritime Strategy & Doctrine	Dr. Alessio Patalano, King's College London Department of War Studies
MODERATOR	CAPT Doug Otte USN (ret), NPS Operations Research

1200	**BREAK**	
1230	**Discovery Panel II**	**Force Structure**

Surface Ship Design Strategy	VADM David Lewis USN (ret), NPS NWSI Director
Total Ship Systems Engineering	Professor Jarema Didoszak, NPS Mechanical & Aerospace Engineering
Future Fleet Architectures	CDR Phillip Pournelle USN (ret), Group W
Undersea Force Structure Considerations	Mr. Jeff Cares, Alidade Incorporated
Omni-Domain Irregular Warfare	Mr. Isaac Taylor

Energy Considerations and Impacts on Force Structure		Dr. Chris Bassler, Center for Strategic and Budgetary Assessments (CSBA)
MODERATOR		Professor of Practice Jeff Kline, NPS Operations Research
1415	Tasking	CAPT Jeff Kline USN (ret), NPS NWSI WIC Director
1430	Initial Team Meetings	**BREAKOUT ROOMS**
1600	**Networking Social**	Glasgow Plaza

TUES – 21 September		**MAIN ROOM GL 109 and Teams (virtual)**
0830	Welcome	Dr. Brian Bingham, NPS CRUSER Director
0845	**Discovery Panel III**	**Emerging Technology**
Rigging for AI		Mr. Brett Vaughan, Navy Chief AI Officer
Human Machine Teaming		CAPT George Galdorisi USN (ret), NIWC Pacific
Project Trident: *Emerging Technology in Maritime Security*		LCDR Jimmy Drennan USN, CIMSEC President
Rapid Prototyping & Testing		Dr. N. Andrew Browning, AeroVironment
MODERATOR		Dr. Raymond Buettner, NPS Information Sciences
1015	***Common Sense for the Common Good:*** *an evolution of an idea*	Mr. Garth Jensen, NSWC Carderock Innovation Director
1030	**BREAK**	
1045	Concept Generation – **Divergent** and ***Mentor Tasking***	**BREAKOUT ROOMS**
1100	Data Gathering	**BREAKOUT ROOMS**
1300	Concept Generation – **Divergent to Convergent**	**BREAKOUT ROOMS**

WED – 22 September		**MAIN ROOM GL 109 and Teams (virtual)**
0830	Welcome	CAPT Jeff Kline USN (ret), NPS NWSI WIC Director
0845	**Discovery Panel IV**	**Innovation**
Future Warfare Concepts		CDR Justin Davis USN, NPS Defense Analysis
Innovation Model Adaptation		Ms. Laura Masson, Royal Australian Navy Innovation Centre Director
Warfare Center Innovation Ecosystem		Dr. Tom Choinski, NUWC Newport
Are you ready to make a difference? *Innovation beyond Ideation*		Col (Ret) Todd Lyons USMC, NPS Volunteer Faculty, Innovation Leadership
MODERATOR		Mr. Dave Nobles, Microsoft
1015	**BREAK**	

1030	Concept Generation – **Convergent**	**BREAKOUT ROOMS**
1100	Directors & Chairs Rotation	**BREAKOUT ROOMS**
1300	Concept Development – **Final Push**	**BREAKOUT ROOMS**

THUR – 23 September		**MAIN ROOM GL 109 and Teams (virtual)**
0800	Photos & Evaluation	
0830	Final Briefs	*Presentations by teams working unclassified*
1130	**BREAK**	
1300	Final Briefs (*classified*)	**STBL B18** *(by invitation only – no remote)*
1400	**ADJOURN**	

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LIST OF FIGURES

Figure 32. A team in their rapid concept generation "work gear."

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AI	artificial intelligence
AOR	area of responsibility
ASW	anti-submarine warfare
C2	command and control
CD&I	USMC Combat Development and Integration
CNO	Chief of Naval Operations
COA	course of action
CONOPS	concept of operations
CONUS	continental United States
COTS	commercial off the shelf
CRUSER	Consortium for Robotics and Unmanned Systems Education and Research
CSG	Carrier strike group
DAU	Defense Acquisition University
DESRON	Destroyer squadron
DoD	U.S. Department of Defense
EMP	electromagnetic pulse
FOB	forward operating base
F-WiG	fast wing-in-ground effect
ISR	intelligence, surveillance, and reconnaissance
JHU/APL	The Johns Hopkins University Applied Physics Laboratory
LDUUV	large displacement unmanned undersea vehicle
LiDAR	light detection and ranging
LMACC	Lightly manned autonomous combat capability
LRASM	long-range anti-surface cruise missile
MEW	Marine Expeditionary Warfare
MS	Microsoft
MOVES	NPS Modeling Virtual Environments and Simulation Institute
NIWC	Naval Information Warfare Center
NPS	Naval Postgraduate School
NSWC	Naval Surface Warfare Center
NUWC	Naval Undersea Warfare Center
NWDC	Navy Warfare Development Command
NWSI	NPS Naval Warfare Studies Institute
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
RADAR	radio detection and ranging
SEA	NPS Systems Engineering Analysis curriculum
SECNAV	Secretary of the Navy
SONAR	sound navigation and ranging

SoS	system of systems
UAV	unmanned aerial vehicle
USAF	U.S. Air Force
USARPAC	U.S. Army Pacific
USMC	U.S. Marine Corps
USN	U.S. Navy
USNR	U.S. Navy Reserves
USV	unmanned surface vessel
UUV	unmanned undersea vehicle
UxV	unmanned vehicle
WIC	NPS Warfare Innovation Continuum