MEMORANDUM

From: Program Executive Officer, Command, Control, Communications, Computers and Intelligence (PEO C4I)

To: Distribution

Subj: PEO C4I 2018 ACQUISITION GAPS FOR SCIENCE & TECHNOLOGY

Ref: (a) SPAWARINST 5238.2B, SPAWAR CONOPS for S&T Forecasting, Investment and Transition
     (b) PEO C4I Masterplan of 1 Dec 17

Encl: (1) PEO C4I 2018 Capability Gaps for Science and Technology

1. **Purpose.** The purpose of this memorandum is to present capability focus areas and gaps driving the future PEO C4I architecture. This memorandum provides PEO C4I’s annual acquisition gaps for Science and Technology (S&T) in accordance with reference (a). The PEO C4I Capability Focus Areas are characterized in chapters 5 and 6 of reference (b).

2. **Background.** PEO C4I has compiled Acquisition Programs of Record gaps for Science and Technology based on current and projected needs, an associated timeframe when the capability is needed (near-term (0-3 years), mid-term (3-8 years), or far-term (9+ years)) and PEO C4I Capability Focus Areas that include Assured Command and Control (AC2), Battlespace Awareness (BA), Integrated Fires (IF) and Enterprise Alignment Efforts (EAE).

3. **PEO C4I S&T Gaps.** The intent is to articulate enough detail to engage with the Naval Research and Development Establishment (NRDE), industry and academia to align efforts and optimize AC2, BA, IF and EAE related investments. While not a specific S&T focus area, innovations that can reduce Total Ownership Costs through reductions in procurement and sustainment costs are always a priority. PEO C4I reviews the Defense S&T community’s investment portfolio, such as Rapid Innovation Fund, Future Naval Capability, Small Business Innovative Research, Naval Innovative Science and Engineering and many others, to provide technologies to address our gaps.

4. Enclosure (1) provides an approved for public release list of identified PEO C4I S&T gaps with a brief description of the desired capability. The gaps are presented with the associated program offices to facilitate their resolution by the DoD/DON Science and Technology Enterprise. Recommendations, questions or comments regarding this memo should be addressed to Mr. Rafe Pel, APEO for S&T, at (619)524-4536 or raphael.peli@navy.mil.

C. P. CHEBI
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Acquisition gaps for Science and Technology are based on a collective examination of capability needs, threats and requirements, which inform the near, mid, and far-term strategy.

- Department of Navy Acquisition (ACQ) organizations focus on valuation and transition of technology that has application to a C4I capability for the Navy’s Information Warfare domain to ensure superior capabilities are being funded and delivered.

- Department of Navy Science and Technology (S&T) organizations focus on the identification of science, technology and concepts that have utility for the Navy’s Information Warfare domain to ensure the most promising technologies are being funded and developed.

These two communities collaborate to provision for today, and the future of Information Warfare. Through plan, shape, and forecast strategies, ACQ and S&T partnerships are instrumental in demonstrating, evaluating, and simplifying the transition of advanced technologies to provide C4I capability in support of Information Warfare.

While there are myriad of operational, programmatic, policy and technical drivers that impact the fielding of the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) portfolio, the Assistant Program Executive Office for Science and Technology (APEO S&T) is actively engaged in rapidly evaluating and delivering S&T developed technology.
The nexus between Acquisition and Science & Technology is the naval capability that is influencing the fielding of C4ISR/Information Operations for Information Warfare.

### Alignment Summary

<table>
<thead>
<tr>
<th>Naval Research and Development with PEO C4I FY18 Capability Focus Areas</th>
<th>Naval Research Enterprise Addendum to the USN &amp; USMC After Next Framework Research Focus Areas</th>
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<tbody>
<tr>
<td><strong>Augmented Warfighter (AC2)</strong></td>
<td>• Mitigate tactical-level risk to our people and command, control and communications degradation (AC, TL, CR)</td>
<td>Algorithmic phenomenology; autonomy; artificial intelligence</td>
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<tr>
<td><strong>Augmented Warfighter (BA)</strong></td>
<td>• Enhance decision-making speed and quality (MBC2, BMA)</td>
<td>Algorithmic phenomenology; autonomy; artificial intelligence; machine reasoning; cognitive science; decision-making; human systems design; human-machine interaction</td>
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<tr>
<td><strong>Augmented Warfighter (EAE)</strong></td>
<td>• Enhance decision-making speed and quality (ICA, NTAF)</td>
<td>Algorithmic phenomenology; autonomy; artificial intelligence; machine reasoning; cognitive science; decision-making; human systems design; human-machine interaction; and training and education</td>
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<td><strong>Integrated &amp; Distributed Forces (AC2)</strong></td>
<td>• Enhance dynamic, synchronized actions across forces (AC)</td>
<td>Autonomous platforms; communications and networks; networked sensors and weapons; and coordinated spectrum and signature management</td>
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<tr>
<td><strong>Integrated &amp; Distributed Forces (EAE)</strong></td>
<td>• Enhance dynamic, synchronized actions across forces (ICA, PW)</td>
<td>Communications and networks; positioning; navigation and timing; and coordinated spectrum and signature management</td>
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<td><strong>Operational Endurance (AC2)</strong></td>
<td>• Enable maneuverability, efficiency, and resiliency for sustained operations by warfighters, systems and platforms (regardless of the threat or operating environment) (AC, CR, TL)</td>
<td>Survivability, endurance and availability; security/ protection; platform affordability; high-performance materials; Power generation, storage, energy efficiency;</td>
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<tr>
<td><strong>Operational Endurance (IF)</strong></td>
<td>• Develop wide-area and force wide disinformation deception and decoys. (IO/NKF)</td>
<td>Survival; endurance and availability; high-performance materials</td>
</tr>
<tr>
<td><strong>Operational Endurance (EAE)</strong></td>
<td>• Enable maneuverability, efficiency, and resiliency for sustained operations by warfighters, systems and platforms (regardless of the threat or operating environment) (ICA, NTAF, PW)</td>
<td>Platform affordability; high-performance materials; and logistics and sustainment</td>
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<tr>
<td><strong>Sensing &amp; Sense-Making (BA)</strong></td>
<td>• Transform vast data into timely knowledge (MBC2)</td>
<td>Digital algorithms and data sciences; quantum information sciences; and modeling, simulation and forecasting of the operational environment</td>
</tr>
<tr>
<td><strong>Sensing &amp; Sense-Making (IF)</strong></td>
<td>• Enable persistent awareness and understanding, and optimized operation (regardless of the threat or operating environment) (BMA)</td>
<td>Multi-domain and multi-spectral sensors; algorithms, and modeling; simulation and forecasting of the operational environment</td>
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<tr>
<td><strong>Scalable Lethality (IF)</strong></td>
<td>• Enable offensive and defensive actions that are multi-domain, integrated, cost-effective, and kinetic and non-kinetic (IO/NKF)</td>
<td>Cyber/algorithmic effects; countermeasures and decoys; counter-weapons, threat neutralization; targeting sensors</td>
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<tr>
<td><strong>Scalable Lethality (EAE)</strong></td>
<td>• Enable offensive and defensive actions that are multi-domain, integrated, cost-effective, and kinetic and non-kinetic (ICA, PW)</td>
<td>Lower cost, higher performance weapons</td>
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Assured Command and Control (AC2)

AC2 is the ability of our naval commanders to exercise authority and direction over assigned and attached forces in the accomplishment of a mission while access to and use of critical information, systems and services are denied, degraded or exploited. Sensing the environment, understanding our adversaries and operating and defending our communications and networked systems are inextricably linked to AC2. AC2 requires a more robust, protected, resilient and reliable information infrastructure that undergirds the Navy’s overall information environment and allow uninterrupted worldwide communication. AC2 is enabled by essential network and data link services across secured segments of the electromagnetic spectrum to transport, share, store, protect and disseminate critical mission information.

FY18 Acquisition and Science & Technology Strategy Alignment

Assured Command and Control Focus (ACQ)
- Assured Communications
- Cyber Resilience
- Thin Line
- Undersea Networking

Navy and Marine Corps After Next (S&T)
- Augmented Warfighter
- Integrated & Distributed Forces
- Operational Endurance

Assured Communication (AC) Focus Area

This capability focus area is central to the Assured Command and Control (AC2) framework. The objective for AC is to enable certainty of priority electronic transmissions when needed by the strategic, operational, and tactical force. Transport (stealth, waveforms, bandwidth efficiencies, and algorithms), Network (gateway access, enclave access, security, analytics) and data (transfer and dissemination) are the general elements that will enable AC.

Cyber Resilience (CR) Focus Area

This capability focus area includes all actions to ensure access to and defense of naval networks and telecommunications systems from cyber threats. This includes resilience against hostile actions that result in data exploitation (espionage) or loss (sabotage or theft), denial or disruption of cyber services, COMSEC compromise, and loss of defensive cyber operational Command and Control (C2). The key objective enables Defensive Cyber Operations (DCO) and the coordination of Network Condition (NETCON) across all Navy operating areas ( interoperable across space, air, sea, undersea and shore), operation levels (integrated at operational and tactical) and mission areas.

Thin Line (TL) Focus Area

This capability focus area supports the resilient Command, Control and Communication (C3) pillar of Electromagnetic Maneuver Warfare (EMW) by operationalization of a mission or warfare area “thin-line” (minimum information exchange requirement in any operating scenario) utilizing Network Condition (NETCON) methods, throughput management techniques and the family of C4I systems to maintain critical functions in a contested cyberspace environment (deliberate exploitation).

Undersea Networking (UN) Focus Area

This capability focus area involves enhanced Command, Control, Communications (C3) through the employment of sensor and information systems acting within the undersea domain addressing the OPNAV N97 Undersea Warfare (USW) sea based strategic deterrent priority to provide a survivable and effective asymmetric advantage through enhancements in communications, unmanned operations, and the use of distributed systems to conduct USW missions.

Enabling Technology: Fielding within 2018–2022
Innovative Technology: Fielding beyond 2023
Inspired Technology: Fielding beyond 2028

Existing Alignments

Program Management, Warfare (Products & Platform Integration)
- Information Assurance and Cyber Security
- Command and Control Systems
- Tactical Networks
- Communications and GPS Navigation
- Shore and Expeditionary Integration
- Undersea Networking
- Carrier and Air
- Ship

Science and Technology, Office (Invention & Prototype)
- None

Capability Component: Communications, Networks, Common & Cross-cutting Services
- SATCOM/Non-SATCOM
- WAN/LAN/Network & Circuit Management
- Basic Info Services
- QoS/Cybersecurity

Capability Component: Science & Technology Programs
- Small Business Innovation Research
- Rapid Innovation Fund
Significant quantities of data may align with Navy Tasking, shedding strategies and data dissemination strategies for mobile platforms. Technology should incorporate load-maintain Size, Weight, Power and Cost (SWAP-C) constraints. Technology must be achieved in a small form factor to afloat, and ashore platforms and far beyond current capacity. Rapidly transferred. Technology must be applicable to air, provide for significant quantities of data to be efficiently and proven improvement, such as anti-biofouling and anti-corrosion.

Data Transfer/Dissemination. This technology would provide for significant quantities of data to be efficiently and rapidly transferred. Technology must be applicable to air, afloat, and ashore platforms and far beyond current capacity. Technology must be achieved in a small form factor to maintain Size, Weight, Power and Cost (SWAP-C) constraints for mobile platforms. Technology should incorporate load-shedding strategies and data dissemination strategies. Significant quantities of data may align with Navy Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) data transfer or Big Data transfer or planned increases in the quantity of data being generated for a set timeframe.

Mission Based (On-Demand) Agile Network and Data Center Solutions. This technology would provide the various layers of the Network, Data Center and Application Hosting Environment to morph from one identity (addressing, domain naming, logical location, etc.) to another with similar function but with a unique identity and utilizing existing hardware resources (e.g., compute, memory, storage, and bandwidth). This would be accomplished rapidly with maximum automation and with minimal user input. This mission based agile network would be spun up or torn down based on various mission demands.

- Allow operator/user to stand up or expand new routing functions to support a large deployment of new nodes, such as what would be required to support a unmanned vehicle swarm.
- In response to an anticipated or detected threat to one enclave, allow operator/user to stand up a security function to isolate that disrupted enclave.
- Allow operator/user to create networks for communicating with coalition partners for other mission scenarios, for example standing up live networks to facilitate train-like-you-fight exercises, or as a possible deception network, etc.

Assured Communication (AC) Focus Area
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Near-Term Science & Technology

Submarine Antenna Stealth Improvements without Compromise of RF Performance. This technology would provide improved Submarine Outboard Systems Line of Sight (LOS) & Beyond Line of Sight (BLOS) through capability upgrades and reliability improvements. Technology must be a proven improvement, such as anti-biofouling and anti-corrosion.

Bandwidth Efficient and Resilient Communications System. This technology would provide maximal communications availability to ensure that dependent C4I systems can continue to function in a communication challenged environment. Wideband amplifiers with adequate dynamic range and ancillary devices (e.g., comb limiting combiners) do not currently exist to support the integration of new highly survivable and efficient waveforms such as HF Over-the-horizon Communication (HFORCE).

Bandwidth Efficient and Resilient Communications System. This technology would provide maximal communications availability to ensure that dependent C4I systems can continue to function in a communication challenged environment with little to no interactions from the warfighter. Develop new communications technologies (e.g., adaptive coding, dynamic resource allocation, radio aware routing, protected waveforms, interference excision) to yield the best combination of higher user data throughput, spectral efficiency, communications resiliency, and ease of integration with Wide-area Network.

Improved Submarine Strategic Systems. This technology would provide improved electrical efficiency of transmitter for Submarine Strategic Systems. Modernize and reduce size to High-altitude Electromagnetic Pulse (HEMP) resistance of components.

Develop High Dynamic Range HF Amplifiers and Ancillaries. This technology would provide maximal communications availability to ensure that dependent C4I systems can continue to function in a communication challenged environment. Wideband amplifiers with adequate dynamic range and ancillary devices (e.g., comb limiting combiners) do not currently exist to support the integration of new highly survivable and efficient waveforms such as HF Over-the-horizon Communication (HFORCE).

Secure Cloud. This technology would provide TacMobile a porting capability onto secure cloud technologies. Investigate and propose implementation for porting onto secure cloud technologies for data storage in the Collateral Secret domain (GENSER SECRET).

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Autonomous Scanning and Patching of Security Software. This technology would provide relevant security patches to endpoint systems in a bandwidth limited environment, mitigating security vulnerabilities. Technology developed for automated scanning and vulnerability patching in a degraded, intermittent, and limited (DIL) communication environment support.

Enabling Technology: Fielding within 2018–2022
S&T Delivery: 2018–2021
PoR Alignment: ADNS, C2P, CBSP, CND, DMR, OE-538, NMT, SubHDR, TacMobile
Technology Readiness Level: Start: 5/6 End: 6-8

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**Mid-Term Science & Technology**

Keyless TRANSEC. This technology would enable communication security for short-range wireless circuits without the need for expensive key modernization infrastructure. Develop a communication security algorithm that leverages the existing lower level algorithms to provide robust transmission security (TRANSEC) while minimizing the requirement for key management and oversight.

Optimization of Radio Routing Interface. This technology would enable Navy warfighters and supporting forces to achieve assured C2 in a disconnected-degraded, intermittent, and limited (D-DIL) environment by providing the necessary WAN connectivity. Develop technologies to optimize the radio-router interface that allows dynamic routing strategies based on changing link status. Load distribution/flow control/dynamic Quality of Service (QoS) between WAN gateway (such as ADNS and SATCOM) functionality needs to be optimized due to ever increasing data rates and the asymmetric nature among data links. This technology will allow deeper levels of integration between the router and radio to maximize data throughput, link efficiency and thus facilitating mission completion.

UHF SATCOM Control Systems. This technology would enable modernization and consolidation of both software and hardware components for the UHF SATCOM Control Systems. Provide a solution that is radio independent or non-proprietary. Reduce procurement cost and equipment footprint by combining three different UHF SATCOM control systems into a single unified control system, lowering Life Cycle Costs through reduced hardware and software architecture and non-proprietary radios.

Secure Coalition Information Sharing. This technology would enable the sharing of information with partners without compromising or exposing the data content. Develop the capability for use with mission databases shared between allied and coalition partners and provide the ability to perform database updates without exposing controlled content.

**Far-Term Science & Technology**

Automated Baseband Switching. This technology would allow for the standardization of shipboard communications components; develop Automated Baseband Switching that is modular, scalable, and incorporates automation for input vs output selection and mapping across the tactical Wide Area Network (WAN - (red/black)) input/output and the switching components, thus eliminating non-standard design and implementation issues.

**Near-Term Science & Technology**

Cloud Based Security. This technology would provide a defense capability for a cloud-based environment against the most advanced, nation-state commanded persistent threat (APT). This includes the ability to detect, monitor, and respond to offensive actions; reconnaissance, weaponization, delivery, exploitation, and installation command control.

Cloud Based Network Infrastructure. This technology would provide redundancy and improve overall failover capabilities across all security enclaves to provide Continuity of Operations Planning (COOP). The capability would provide a cloud based failover service, seamless to network and application, that responds to changing network conditions and automates software updates/patching consistent with changes to operational conditions such as, limited connectivity, mission requirements, and extended disconnected periods.

Leverage Navy Defensive Cyber Operations (DCO). This technology would leverage DCO systems incident detection, response, and reporting to automate NETCON course of action to out-maneuver cyber threat. Capabilities may include machine learning for advanced threat detection, predicted anticipatory cyber reconfiguration, alerting and predictive reporting, or analytics.
Detection and Eradication of Advance Persistent Threats (APT). This technology would provide real time incident analysis of APT cyber threats to naval tactical networks and telecommunications systems. The solution would be a real-time anti-lateral maneuver technology to protect, detect and react to APTs by embracing automation beyond traditional "scanning and cleaning." These technologies would be able to:

- Detect and react to rootkits, exploit kits, downloader kits, drive by downloads, DNS and routing modifications, use of rogue Wi-Fi devices and any other threats
- Detect and react to pre-placed, zero day, and traditional attacks
- Detect and react to subscribed security threat intelligence feeds containing endpoint data (such as IP package, hashes, filenames, device, users, signatures and other indicators)
- Real time incident analysis easy enough to operate by a minimally trained user
- Can conduct interactive malware analysis
- Engineer processes for automated verification of receipt of indicators on all endpoints

**Enabling Technology:** Fielding within 2018–2022
**S&T Delivery:** 2018-2021
**PoR Alignment:** ADNS, CANES, CND, Expeditionary C4I, VSE
**Technology Readiness Level:** Start: 5/6 End: 6-8

Cybersecurity Data Structure. This technology would enable the Navy's cybersecurity warfighters consistency of information for improved analysis and integrity of information to promote data reuse. The solution would include a data structure that allows ease of cybersecurity data tagging, indexing, categorizing, and mapping. It should leverage existing data sources such as DoD Dictionary and Intelligence Community Meta Data Specifications, Industry data standardization and best practices. The data architecture should include data management as well as data flow that will provide data traceability, information fusion and presentation.

**Innovative Technology:** Fielding beyond 2023
**S&T Delivery:** 2021-2026
**PMO Alignment:** 130, 790
**Technology Readiness Level:** Start: 3-5 End: 6-8

Mid-Term Science & Technology

Modeling and Simulation (M&S) of Human Behavior. This technology will enable human behavioral analysis and profiling to promote vulnerability reductions for cybersecurity. Modeling and Simulation (M&S) of human cyber behaviors and patterns should include the motivation, intention, and the circumstances of the individual's access as well as the activities within the network environment defining the assessment of potential risk indicators, factors, and predictive analysis to support a respond, monitor, or mitigate action.

Microservices and DevOps Processes. This technology would enable an increased agility, deployability, and elasticity of cloud infrastructure for situational awareness. Solution would provide access to comprehensive mission capabilities with efficient bandwidth and minimal threat surface (applications/data). Capability should provide automation tools that leverage an increasingly programmable and dynamic infrastructure at the Tactical edge (zero and thin-client access to mission applications and mobile cloud-based service permitting updates to Command and Control (C2) applications).

Precision Time Synchronization for Cyber Security. This technology would enable accurate precision time synchronization for all timestamping across the USN enterprise. Enable analytic algorithms to mitigate time drift and spread found in event time stamps. The technology will provide accuracy and precision of Defensive Cyber Operations event correlation worldwide.

Far-Term Science & Technology

Cybersecurity Detection Accuracy and Integrity. This technology would allow integrity of analytics tools and maximize the efficiency of the cybersecurity operators by reducing false positives and to provide a confidence factor for the warnings and alerts. Capability would ensure statistical methods used in various situational awareness products utilize standardized methods for all modeling and simulation tools.

**Innovative Technology:** Fielding beyond 2028
**S&T Delivery:** 2027+
**PMO Alignment:** 130
**Technology Readiness Level:** Start: Various End: 6-8

Inspired Technology:** Fielding beyond 2028
**S&T Delivery:** 2027+
**PMO Alignment:** 130
**Technology Readiness Level:** Start: Various End: 6-8
Thin Line (TL) Focus Area
This capability focus area supports the resilient Command, Control and Communication (C3) pillar of Electromagnetic Maneuver Warfare (EMW) by operationalization of a mission or warfare area “thin-line” (minimum information exchange requirement in any operating scenario) utilizing Network Condition (NETCON) methods, throughput management techniques and the family of C4I systems to maintain critical functions in a contested cyberspace environment (deliberate exploitation).

Mid-Term Science & Technology

Thin Line Simplify Network Automation. This technology would enable an automated preemptive configuration changes to networks, services, and applications in Active Server Pages (ASP)-to-ASP maneuvers. The solution would include software-defined capabilities to provide hardware independent solution with API. Capability would include hardware virtualization to enable adaptive, agile, and dynamic communication and configuration while reducing SWAP and simplifying network administration. Automate capability to control and monitor network, data and application access to provide Network operations centers relief from the manual and time-consuming configuration tasks and focus on analyzing critical events and verifying the result of the changes during mission execution.

Thin Line Bandwidth Management. These technologies would enable the tactical operator/user to address the operational impact to network resources supporting critical warfighting functions of manned, unmanned or unattended sensors across all domains (air, afloat, ashore, undersea, and space). The technology will leverage Navy C4ISR applications/systems; Maritime Operations Centers Resilient Command and Control (C2), Assured C2 processes for NETCON (network condition), the C2 Thin Line Ashore (MOC and Naval Operations Centers (NOC)), the Global C2 Thin Line (Networks and WAN Gateways afloat) and protected SATCOM/transport. The solution would allow for operations in highly contested/denied environments (cyberspace and the physical domains, including space). Develop technologies that are capable of Cyber maneuver to cut off all but highly trusted critical users and optimize the WAN gateway architecture (currently ADNS POR). Develop new technologies to integrate newer commercial technologies such as Software Defined Networking and IPv6, to support both current capability enhancements as well as provide for growth in the future. Develop technologies that could convey increased throughput for a given sector of the RF spectrum; reduce channel spacing; increase channelization; reduce transmission power requirements and provide low-probability of intercept and counter-measure-resistant qualities. Future growth could also include such capabilities as terminating non-Navy sites utilizing non-traditional RF, emerging Low Probability of Intercept/Low Probability of Detection (LPD/LPI) technologies, and updated network without shore requirements (NOWS).

Thin Line Virtualization of Tactical Conferencing Systems. This technology would enable prioritization and dynamic management for real-time applications such as Tactical Conferencing systems. Develop automatic bandwidth resource allocation for use in disaster recovery (DR) failover and fallback situations.

Far-Term Science & Technology

Thin Line Detect and Predict Changing Network Conditions. This technology would allow Network operators timely data exchange of critical mission data by alerting to changing conditions and monitor the maneuvers of the intelligent network systems. Develop the capability for Tactical networks to detect and predict changing network conditions and adapt automatically to ensure efficient use of available network links and deliver mission-critical traffic. Simplify and secure methods of data access with Mission prioritized/optimized applications/data, compute resources, and services (bandwidth, communications) in highly denied/contested environments.

Thin Line Optimized Ship-to-Ship Communication without Shore Connectivity. This technology would allow for operations in highly contested/denied environments (cyberspace and the physical domains, including space). This would include development of technologies to enhance ship to ship communication when there is no shore connectivity. The technology could allow an agile WAN Gateway routing architecture to be scalable as tactical Internet Protocol (IP)-enabled systems increase in number dynamically. The technologies could have tighter integration between data-link and network for increased bandwidth efficiency to operate through spectrum denial due to Advanced Red anti-space/electronic-warfare capabilities. For example, the new technologies could enable the tactical WAN to be flexible enough to allow the network operator/user to scale up to accommodate Unmanned Air Vehicle (UAV) missions without critical trade-offs impacting other missions.

Inspired Technology: Fielding beyond 2028

S&T Delivery: 2027+

PMO Alignment: 160, 790

Technology Readiness Level: Start: Various End: 6-8

Innovative Technology: Fielding beyond 2023

S&T Delivery: 2021-2026

PMO Alignment: 160, 170, 790

Technology Readiness Level: Start: 3-5 End: 6-8
Undersea Networking (UN) Focus Area

This capability focus area involves enhanced Command, Control, Communications (C3) through the employment of sensor and information systems acting within the undersea domain addressing the OPNAV N97 Undersea Warfare (USW) sea based strategic deterrent priority to provide a survivable and effective asymmetric advantage through enhancements in communications, unmanned operations, and the use of distributed systems to conduct USW missions.

Undersea Networking (UN) Focus Area

Mid-Term Science & Technology

Improve Reliability of Expendable Tethered Buoy. This technology would enable a reduction of size, weight, power and cost (SWAP-C) and improve the reliability of expendable tethered buoys. This includes inexpensive manufacturing techniques for carbon fiber/nanotubes, smaller antennas and electrical/optical components, more tension tolerant optical fiber cables.

Reliable Communications through Water and across the Air-Water Interface. This technology would enable reliable communication through water and across the air-water interface. Development of hardware, waveforms, or communication modes that could include improved free space optical components and increased power handling of optical fiber in the blue-green spectrum or reliable and time-sensitive communications (full range of speed and depth) with other fleet platforms and systems.

Far-Term Science & Technology

Reliable Connect and Transfer of Data/Energy. This technology would allow distributed systems to conduct USW missions by leveraging a common architecture and standards to develop protocols, interfaces, and physical connectors for reliable undersea communications and/or power transfer within the undersea domain.

Undersea Connectivity (Network Vulnerability). This technology would allow secure Command and Control (C2) in the Undersea Domain by leveraging a dynamic mobile undersea multi-point network to develop methods of securing and transporting data to ensure Command and Control (C2)/Identification Friend or Foe (IFF).

Innovative Technology: Fielding beyond 2023
S&T Delivery: 2021-2026
PMO Alignment: 770
Technology Readiness Level: Start: 3-5 End: 6-8
Battlespace Awareness (BA)

BA is the ability to have awareness of the environment and the status of adversary and friendly forces, yielding an interactive picture that provides timely, relevant and accurate assessments of friendly and adversary operations within the battlespace. BA will require enhanced and advanced means to rapidly sense, collect, process, analyze, and evaluate information content to exploit the operating environment. The understanding of the operating environment will serve as the basis from which nearly all decisions will be made, enabling our forces to more effectively maneuver and coordinate actions that engage and target enemy forces. Unique to BA are the decisions which require levels of synchronized Assured Command and Control (AC2) and Integrated Fires (IF) elements to provide characteristics and conditions ensuring the understanding of the operating environment and to effectively use AC2/IF elements to exploit the operating environment to our advantage. BA is aided by passive discrimination, identification and tracking of objects, persistent sensing and real-time/multi-spectral awareness, and cyber situational awareness within the operating environment.

FY18 Acquisition and Science & Technology Strategy Alignment

Battlespace Awareness Focus (ACQ)
- Battle Management Aid
- Maritime Battlespace C2

Navy and Marine Corps After Next (S&T)
- Augmented Warfighter
- Sensing & Sense-making

Battle Management Aid (BMA) Focus Area

This capability focus area is typically a collateral component of Battlespace Awareness fielded across all operational/tactical commands (i.e., unit level to force level and Fleet Headquarters) to enable battle management for all warfare missions. BMA includes operational planning tools and tactical decision aids. Examples of planning tools/tactical decision aids outputs include prioritization of targets and resources, developing and accessing courses of action; developing and aligning commander’s intent, synchronize timelines, allocate organic resources, assign information requirements to organic sensors, route multiple platforms to maximize collection opportunities, conduct cooperative engagement(s), planning kinetic and/or non-kinetic action, assess the effects of engagements (Measures of Effectiveness (MOEs) and Measures of Performance (MOPs)), or allocate and monitor platform operations and re-plan in accordance with shared context (tasking/re-tasking). BMA’s primarily analyze and evaluate the operating environment by continually mining external data sources to improve situational awareness, a concept that involves mission adaptive command and control (C2). Mission Adaptive C2 is focused hypotheses to maintain own force as multiple mission-capable by understanding the current and potential future operating environment.

Maritime Battlespace C2 (MBC2) Focus Area

This capability focus area includes sensor predictive awareness, planning and collection management and is primarily associated with technical elements of situational awareness. MBC2 is applied across all maritime mission areas and domains. The concepts involve predictive awareness (to rapidly sense, collect, exploit), planning and collection (to rapidly process, analyze, evaluate) from all-sources and in all domains. All-source passive discrimination sensing involves characteristics and conditions of the Electromagnetic Spectrum (ESM) operating environment and is often associated with technical elements such as but not limited too: space-based sensors, SIGINT sensors, MASINT sensors, Electro-Optical (EO) radar, Infrared (IR) radar. All domains encompass the characteristics and conditions that are often generalized as surface, subsurface, air, space, environmental sciences, cyber, or classification levels.

Existing Alignments

Program Management, Warfare (Products)
- Battlespace Awareness & Information Operations
- Command and Control Systems
- Tactical Networks

Science and Technology, Office (Invention & Prototype)
- Office of Innovation Technology Requirements, and Test & Evaluation (OPNAV N94)
- Office of Innovation (OPNAV N2N6FX)
- Office of Naval Research (ONR)

Capability Component: Application Services
- Battlespace Awareness
- Command and Control
- Support Systems

Capability Component: Science & Technology Programs
- Future Naval Capability
- Small Business Innovation Research
- Rapid Innovation Fund
- OPNAV N2N6-FX Projects

Enabling Technology: Fielding within 2018–2022
Innovative Technology: Fielding beyond 2023
Inspired Technology: Fielding beyond 2028
Battle Management Aid (BMA) Focus Area

This capability focus area is typically a collateral component of Battlespace Awareness fielded across all operational/tactical commands (i.e., unit level to force level and Fleet Headquarters) to enable battle management for all warfare missions. BMA includes operational planning tools and tactical decision aids. Examples of planning tools/tactical decision aids outputs include prioritization of targets and resources, developing and accessing courses of action; developing and aligning commander's intent, synchronize timelines, allocate organic resources, assign information requirements to organic sensors, route multiple platforms to maximize collection opportunities, conduct cooperative engagement(s), planning kinetic and/or non-kinetic action, assess the effects of engagements (Measures of Effectiveness (MOEs) and Measures of Performance (MOPs)), or allocate and monitor platform operations and re-plan in accordance with shared context (tasking/re-tasking). BMA’s primarily analyze and evaluate the operating environment by continually mining external data sources to improve situational awareness, a concept that involves mission adaptive command and control (C2). Mission Adaptive C2 is focused hypotheses to maintain own force as multiple mission-capable by understanding the current and potential future operating environment.

Mid-Term Science & Technology

Battle Management at the Operational Level of War (OLW).

This technology would enable unit suitability, survivability and supportability assessment using processed and fused information from a variety of authoritative data sources. A unit’s suitability assessments consist of unit readiness, availability and capability to perform a task or mission objective. A unit’s survivability assessment is contingent on integrated tactical situation (TACSIT) capabilities than can aid in the C2 of physical and electromagnetic (EM) maneuver. A unit’s supportability assessments consist of the feasibility of the logistics plan to ensure a capacity to support, and availability and survivability of the logistical components. Develop methods to automatically ingest mission relevant data and calculate an assessment to expedite vertical and horizontal blue force status awareness. TACSIT estimation would support current and projected tactical situations based on PIMTRACKs (Path of Intended Movement). Electromagnetic propagation data models and EM posture would be used in the generation of friendly and threat radar assessment. This survivability assessment tool would also incorporate Satellite Vulnerability (SATVUL) and METOC information to support an automated impact to mission assessment in concert with alerts to warfare commanders.

Decoupled and Modular Planning. This technology would enable a collaborative planning capability to assist in the creation and execution of navigation and tactical plans for Composite Warfare Commander (CWC) staff. This would include modular decision support services and analytic tools that are decoupled from a specific architecture. Solutions would be enabled by common user interfaces and integrated decision analytics to support planning, execution monitoring, and continuous assessment for the staff and a modular framework enables the delivery of BMAs that can deliver upgraded capabilities as they are developed, integrated, and tested.

Artificial Intelligence and Machine Learning for Theater Operations. This technology would enable rapidly composed course of actions for Theater Operations by enhancing analytics that assess unit suitability and mission risk. This would include development of neural network prescriptive analytics that will recommend actions based on predictions and assessment decision effects of each recommendation. The solution would include prescriptive analytics that leverage, predictive and descriptive analytics, genetic algorithms, case base reasoning, and consider the effects generated from outcomes or selected courses of action.

Future Mission Tasking. This technology would enable CWC staff to determine platform(s) ability to conduct future mission tasking by providing analysts and decision makers the ability to pivot the underlying data for analysis by numbered fleet, ship type, or strike group. The solution would develop the ability to expose data from Hull, Mechanical, & Electrical (HM&E) systems to support descriptive and predictive analytics. Analytics will enable C2 systems to analyze large amounts of HM&E monitoring and maintenance data. Analytics will support the development of logistics models for individual platforms, components, and systems.

Innovative Technology: Fielding beyond 2023
S&T Delivery: 2021-2026
PMO Alignment: 150
Technology Readiness Level: Start: 3-5 End: 6-8

Far-Term Science & Technology

Machine-to-Machine (M2M) Transactions. This technology would allow incremental architecture adjustments to support big data ingest for future mission tasking. The number of objects connected to Internet of Things (IoT) is expected to reach 50 billion by 2020 due to the massive influx of diverse objects. As the IoT increases data volume and velocity, using Machine-to-Machine (M2M) transactions and the resulting data would be combined with machine learning and other next-generation analytics to determine platform(s) capability to conduct future mission tasking.

Inspired Technology: Fielding beyond 2028
S&T Delivery: 2027+
PMO Alignment: 150
Technology Readiness Level: Start: Various End: 6-8
**Maritime Battlespace C2 (MBC2) Focus Area**

This capability focus area includes sensor predictive awareness, planning and collection management and is primarily associated with technical elements of situational awareness. MBC2 is applied across all maritime mission areas and domains. The concepts involve predictive awareness (to rapidly sense, collect, exploit), planning and collection (to rapidly process, analyze, evaluate) from all-sources and in all domains. All-source passive discrimination sensing involves characteristics and conditions of the Electromagnetic Spectrum (ESM) operating environment and is often associated with technical elements such as but not limited too: space-based sensors, SIGINT sensors, MASINT sensors, Electro-Optical (EO) radar, Infrared (IR) radar. All domains encompass the characteristics and conditions that are often generalized as surface, subsurface, air, space, environmental sciences, cyber, or classification levels.

**Near-Term Science & Technology**

**Tactically Synchronized Track Data.** This technology would provide improved situational awareness by incorporating sensor data into the organic tactical picture. The capability would develop the means for sanitization and transfer of track data between the Sensitive Compartmented Information (SCI) enclave and the Combat System (CS) enclave for the presentation of new tracks or augmentation of existing tracks. This technology will significantly improve time-constraints introduced by existing cueing and manual means methods.

**A Tactical Data Enterprise to Support Maritime Battlespace C2.** This technology would provide situational awareness through modernized Command and Control (C2) data formats and protocols that can be hosted on any supported infrastructure: C4I enclaves, Combat and Weapons Control enclaves, or Coalition system. Establishing a mission-needs data profile for the intelligent movement of information will minimize the bandwidth required by C2 systems. The solution would develop methods to intelligently move mission relevant information across platforms in a Command and Control Denied and Degraded Environment (C2D2E) while ensuring data consistency across C2 nodes and across enclaves within a platform. The technologies would provide timely and consistent inter-node and intra-node data-sharing and function/operate under denied and disconnected, intermittent, and latent (D-DIL) conditions.

**Enhanced Planning for Integrated Fires.** This technology would provide a multiple security enclave architecture that integrates and fuses SCI networks data and provides it to Combat Systems. The capability will coordinate and integrate Intelligence, Surveillance, Reconnaissance and Combat Systems data to maximize Integrated Fires (IF). The capability will automate applications leveraging multi-domain data that will provide Battlespace Awareness (BA) at all levels (Tactical Action Officer (TAO) to the Composite Warfare Commander (CWC)). Force Application requires development of a capability (e.g. operational planning aids with automated tools and Dynamic Weapons Coordination (DWC)) to inform the CWC with actionable information for weapons system selection in support of desired effects chain. Force Application requires a multiple security enclave (Joint Worldwide Intelligence Communications System (JWICS)/Secret Internet Protocol Router Network (SIPRNET)/Intelligence Surveillance and Reconnaissance (ISR) systems/Combat Systems (CS)/Coalition) architecture that integrates and fuses (level 3) federated data (Force Level and Unit Level) from SCI networks and provides it to CS networks. The architecture will enable coordinated counter ISR activities via automated tools to support combat identification (95% confidence level) and synchronization of kinetic and non-kinetic fires. The architecture requires high speed, automated machine to machine processing across multiple security enclaves servicing Integrated Fires (IF). The tool will have the capability to (automatically/selectively) synchronize data in a dynamic operational environment providing the Tactical Action Officer (TAO) a real time Common Operating Picture. It will integrate national, theater, and tactical data in a Denied, Degraded, Intermittent, or Limited (DDIL) environment.

**Enabling Technology:** Fielding within 2018–2022  
**S&T Delivery:** 2018-2021  
**PoR Alignment:** DGCS-N, MTC2  
**Technology Readiness Level:** Start: 5/6 End: 6-8
**Mid-Term Science & Technology**

**Tasking, Collection, Processing, Exploitation and Dissemination (TCPED) Network Architecture.** This technology would enable Joint Director of Laboratories (JDL) level 3 fusion. This architecture requires automated data tagging of security information (IC-ISM data elements) at the fused entity (Observed Entity and Maritime Object of Interest) level. Solutions must be interoperable and provide ship to shore data fusion and analytics, access, transfer, and multi-level solutions (MLS). Develop capabilities that enable analysts, at the GENSER level, to acquire GENSER data from SCI documents. This capability will support ship to shore all source multi-domain information ingest, automated analysis, multi-INT correlation, real time fusion, and outcome prediction in a Denied, Degraded, Intermittent, or Limited (DDIL) environment.

**Artificial Intelligence (AI) to Support the Automation of Routine TCPED Functions.** This technology would enable the automation and acceleration of routine tasks that will allow human analysts to focus on CWC tasking. Provide a capability so that the analyst has a 95% confidence level that the information is correct. The solution would include a range of software applications, advanced analytical tools, widgets, and decision aids, that would automate and accelerate analysis of adversary intent and enemy courses of action as well as synchronize information for multiple analysts. This capability is a critical component in providing actionable information in a Denied, Degraded, Intermittent, or Limited (DDIL) environment.

**Secure Web-Based Applications Afloat.** This technology would enable ubiquitous access to off ship processing and storage resources. Provide analysts enhanced access to intelligence information (e.g. software tools and databases), cross-collaboration with multiple agencies, and access to multi-INT data regardless of location. A secure and cost-effective web based application/architecture will enhance collaboration and planning using any device at any point of need. The web based applications will be interoperable, resilient, and provide: high data transfer rates, minimal latency, intensive computing power (e.g., CPU, RAM, GPU), and large data storage (i.e. beyond petabyte) capability. Technologies that will enable uninterrupted access and implementation of rapid and secure web based applications afloat, enabling better planning and decision making when utilizing data fusion and analytics to analyze and search large (i.e. beyond petabyte scale) data sets in support of maritime operations and non-kinetic fires.

**Far-Term Science & Technology**

**Collection Management (CM) Tool to fully automate Intelligence Surveillance and Reconnaissance (ISR) Planning.** This technology would allow for a centralized fleet collection management (CM) tool to support both standing and ad hoc requirements across diverse intelligence disciplines. The solution would develop the capability to support follow on tasking of ISR assets and sensors in response to fleet requirements. These tools will employ artificial intelligence (AI) to discern pattern recognitions, detect unknown informational gaps in the User-Defined Operational Picture (UDOP), and automatically generate associated messages requesting ISR tasking of assets. This would include integration of current and disparate sensors (IMINT, SIGINT, MASINT) and associated ISR assets (national, theater and tactical). These tools must provide predicative analytic capabilities, including high level Joint Director of Laboratories (JDL) fusion. The tools will be written in a language that adheres to tactical intelligence systems coding standards (e.g. DCGS-N INC 2) and application platform interface requirements.

**Inspired Technology:** Fielding beyond 2028  
S&T Delivery: 2027+  
PMO Alignment: 120  
Technology Readiness Level: Start: Various End: 6-8
Integrated Fires (IF)

IF is the ability to fully employ integrated information in warfare by expanding the use of advanced electronic warfare and offensive cyber effects to complement existing and planned air, surface and subsurface kinetic weapons within the battlespace. IF effects will be designed to impact and change adversary behavior, or when necessary, to control, manipulate, deny, degrade or destroy his warfighting capabilities. IF will use networks, cyberspace and space capabilities to achieve non-kinetic effects (active and passive discrimination) and kinetic effects (direct support to Fires) to exploit and attack the vulnerabilities of adversaries. IF will expand, in a deliberate and systematic methodology, both kinetic and non-kinetic weapons desired effects. IF is enabled using advanced electronic warfare and offensive cyber effects to complement existing and planned air, surface and subsurface kinetic weapons within the battlespace.

FY18 Acquisition and Science & Technology Strategy Alignment

Integrated Fires Focus (ACQ)
- Counter C4I
- Over The Horizon-Target
- IO/Non-Kinetic Fires

Navy and Marine Corps After Next (S&T)
- Operational Endurance
- Sensing & Sense-making
- Scalable Lethality

Counter C4I (C-C4I) Focus Area

This capability focus area involves activities to disrupt a threat’s “C3 and targeting loop” and to minimize threats to own forces, key Command and Control (C2) nodes, networks, surveillance capabilities, and communications linkages in all domains and dimensions to adversely affect attacks and disrupt a threat’s “C3 and targeting loop” to minimize direct threats to own forces.

Over the Horizon-Target (OTH-T) Focus Area

This capability focus area involves the use of integrated all-source surveillance and sensor information to automatically and seamlessly provide targeting-quality track information to shooters and/or weapons systems. This capability has a dependency on the Battlespace Awareness core focus area, specifically on the targeting/engagement portions of warfare mission areas kill chain/effects chain to provide ISR targeting support at distances well beyond the detection ranges of organic sensors. This capability also has a dependency on assured command and control that requires communications transport to be secure and reliable where the objective is provide ISR targeting support before own forces can be targeted by threat systems.

Information Operations/Non-Kinetic Fires (IO/NKF) Focus Area

This capability focus area includes actions taken in the Electromagnetic Spectrum (EMS) to impair, degrade, deny, destroy, and counter threat-related use of the EMS including the achievement of “soft kill” on designated threats/threat systems. Implementation of IO and NKF capabilities will require coordination with kinetic fires capabilities for overall command and control (C2). Seamless sharing of integrated all-source surveillance and sensor information is needed to enable this coordination and to support iterative C2 planning, execution, monitoring, and assessment (see MBC2) of kinetic and non-kinetic fires.

Enabling Technology: Fielding within 2018–2022
Innovative Technology: Fielding beyond 2023
Inspired Technology: Fielding beyond 2028
Information Operations/Non-Kinetic Fires (IO/NKF) Focus Area

This capability focus area includes actions taken in the Electromagnetic Spectrum (EMS) to impair, degrade, deny, destroy, and counter threat-related use of the EMS including the achievement of “soft kill” on designated threats/threat systems. Implementation of IO and NKF capabilities will require coordination with kinetic fires capabilities for overall command and control (C2). Seamless sharing of integrated all-source surveillance and sensor information is needed to enable this coordination and to support iterative C2 planning, execution, monitoring, and assessment (see MBC2) of kinetic and non-kinetic fires.

Near-Term Science & Technology

Real-Time Electromagnetic Warfare. This technology would provide real time electromagnetic warfare that will sense the EM spectrum, improve sensor performance, and enhance electronic attack capabilities like standoff ranges needed to improve maritime force application (Electronic Support (ES) and Electronic Attack (EA)). The solution would develop algorithms (e.g. high order statistical, machine learning/artificial intelligence, cognitive intelligent agents), low-cost, radio frequency (RF) apertures (S-band through Ku-, K-, Ka-bands), and modular signal-conditioning technologies (i.e. photonic, superconducting) that support Cyber Operations over the electromagnetic spectrum enabling ES and EA functional requirements against Signals of Interests. Algorithms will also detect, recognize, demodulate, and post process communications, narrow/wide band signals, agile signals, and frequencies which are attenuated by absorption due to environmental conditions. The solution would include low-cost, multi-mission RF antenna with low radar cross sections (RCS) that support simultaneous transmit and receive (STAR) of signals at tactical standoff distances without low probability of intercept/low probability of detect (LPI/LPD) impacting receive capability. Technology will have high sensitivity with low noise figures and high gain. This will provide the Composite Warfare Commander (CWC) and Information Warfare Commander (IWC) an increased capability to acquire and exploit signals of interest, via advanced aperture technology, associated algorithms, and signals exploitation.

Non-Kinetic Effects. This technology would provide Information Operations (IO) advanced algorithms and analytical tools to coordinate and deliver non-kinetic cyber effects in support of Integrated Fires (IF). The solution would develop surveillance and reconnaissance analytical tools and algorithm to assess tactical effects of Counter-ISR (C-ISR) actions, and provide courses of actions to re-engage, disengage or execute tactical maneuvers. The capability will evaluate the effects quality for non-kinetic targeting and engagement, and electronic attack, prior to or during engagements. Development of operational planning aids and tactical tools to coordinate Integrated Fires and conduct assessments against adversary C4ISR will improve IO non-kinetic attack capabilities and surveillance and reconnaissance systems to monitor/assess the effects.

Enabling Technology: Fielding within 2018–2022
S&T Delivery: 2018-2021
PoR Alignment: DCGS-N, SSEE
Technology Readiness Level: Start: 5/6 End: 6-8

Far-Term Science & Technology

Environment Predictions. This technology would allow multi-platform architectures to enable the sharing of sensor data from air, surface, subsurface, and space manned and unmanned systems. Environmental sensor payloads must be versatile and appropriately designed (e.g. small size, light weight, and ample power) to support lengthy operations in their respective environments. The solution would include an atmospheric prediction capability which gathers and integrates environmental data (e.g. temperature, humidity, optical density, and aerosol content). The system will sense, filter, categorize, and transmit raw data to analytical tools in support of atmospheric predictions. The data will be collected, processed and fused to support optimized employment of laser weapon systems. An integrated environmental planning capability that ingests manned and unmanned (e.g. air, surface and subsurface) sensor data is necessary to allow an analysis of atmospheric properties to predict optimal propagation paths of high energy weapons (laser) systems.

Inspired Technology: Fielding beyond 2028
S&T Delivery: 2027+
PMO Alignment: 120
Technology Readiness Level: Start: Various End: 6-8
**Enterprise Alignment Efforts (EAE)**

EAE is focused on core conditions that support battlefield requirements that enable Joint and Product Interoperability. EAE is aligned to corporate functions to build interoperable product lines, promote cost effectiveness, and integrated capability for the fleet.

**FY18 Acquisition and Science & Technology Strategy Alignment**

<table>
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<tr>
<th>Enterprise Alignment Efforts Focus (ACQ)</th>
<th>Navy and Marine Corps After Next (S&amp;T)</th>
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<tbody>
<tr>
<td>• Joint Capability Alignments</td>
<td>• Augmented Warfighter</td>
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<td>• Navy Tactical Analytic Framework</td>
<td>• Integrated &amp; Distributed Forces</td>
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<td>• Platform Wholeness</td>
<td>• Operational Endurance</td>
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<td>• Scalable Lethality</td>
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**Joint Capability Alignment (JCA) Focus Area**

This capability focus area includes various Department of Defense (DoD) and Intelligence Community (IC) initiatives that have a direct impact on PEO C4I programs and need to be properly engineered and/or adapted to promote integrated capabilities beneficial to the warfighter. Three examples of initiatives are: Joint Information Environment (JIE) alignment; Multi, Mission Partner Environment (MPE) alignment; and IC Information Technology Enterprise (IC ITE) alignment.

**Navy Tactical Analytic Framework (NTAF) Focus Area**

This capability focus area includes development of operationally responsive data architecture and explores enterprise analytics to serve tactical users. NTAF is addressing initial challenges with POR coordination across program offices and alignment of technical solutions, specifically provided as common software services to enable an agile and scalable framework for data analytics. Tactical analytics that support operational decision making must be based on internationally standardized mathematical principles, securely coded applications, validated modeling and simulation, and jointly accepted data taxonomies.

**Platform Wholeness (PW) Focus Area**

This capability focus area will increase commonality and reduce System-of-System configuration variance. The Operational Capability Builds (OCBs) generally improve user-focused information sharing, information fusion, collaboration, and decision-making across the battlespace for the warfighter. There are four C4I OCBs applicable in FY18: Cyber Secure Networks and Applications OCB, Tactical Data Links OCB, Voice Communications OCB, and Information Operations/Intelligence, Surveillance Reconnaissance OCB.

**Total Ownership Cost (TOC)**

PEO C4I seeks technologies to provide scalable energy solutions for diverse environments; reduce energy consumption through greater efficiency and power management; improve reliability and operational readiness; reduce installation costs; mitigate system or component obsolescence; reduce maintenance, manpower and training costs; and extend service life.

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**Existing Alignments**

**Program Management, Warfare (Products & Platform Integration)**

- Command and Control Systems
- Tactical Networks
- Communications and GPS Navigation
- Undersea Networking
- Carrier and Air
- Ship

**Science and Technology, Office (Invention & Prototype)**

- None

**Capability Component: Networks, Common, Application & Cross-Cutting Services**

- None

**Capability Component: Science & Technology Programs**

- None
Joint Capability Alignment (JCA) Focus Area

This capability focus area includes various Department of Defense (DoD) and Intelligence Community (IC) initiatives that have a direct impact on PEO C4I programs and need to be properly engineered and/or adapted to promote integrated capabilities beneficial to the warfighter. Three examples of initiatives are: Joint Information Environment (JIE) alignment; Multi, Mission Partner Environment (MPE) alignment; and IC Information Technology Enterprise (IC ITE) alignment.

Near-Term Science & Technology

**GPS Independent PNT Solutions.** This technology would provide Joint interoperable and precise position and time references services for surface, sub-surface, air, and space-borne assets that enable safety of navigation, communications, command and control, combat and weapon systems operating in Global Positioning System (GPS) challenged domains. It would provide Assured Positioning, Navigation and Timing (APNT) capabilities based on GPS-independent PNT solutions to address cyber security issues including confidentiality, availability, and integrity.

**Diverse Sensor Applications.** This technology would provide/develop/leverage multi-sensor integration and algorithms that complement existing navigation sensors to provide APNT service during operations with limited navigational information and when sensor degradation occurs. This solution includes multi-sensor and fusion to produce reliable PNT solutions that enhance mission performance and success.

*Enabling Technology:* Fielding within 2018–2022  
*S&T Delivery:* 2018-2021  
*PoR Alignment:* GPNTS  
*Technology Readiness Level:* Start: 5/6 End: 6-8

Mid-Term Science & Technology

**Miniaturized and Scalable PNT Solutions for Unmanned Vehicles.** This technology would enable diverse application of APNT on unmanned vehicles and requires the solutions to addresses Size, Weight and Power (SwaP) reductions. Development and deployment of miniaturized and scalable APNT solutions with emphasis on reduced SwaP GPS receivers and chip scale atomic clocks. The solution would allow employment of APNT technologies on SwaP constrained platforms to improve C4I dependent mission performance and completion.

*Low SwaP-C LEO Satellite Antennas.* This technology would enable Low Earth Orbit (LEO) satellites which are maturing rapidly and have demonstrated significant potential to providing assured communications capability. The solution should focus on development of low SwaP and low-cost LEO satellite antennas. This includes development of rapidly fieldable antennas that can track fast moving LEO satellites to include Active Electronically Scanned Arrays (AESA), printed antennas, and associated control systems. The solution would augment current shipboard satellite communications capabilities to allow for greater data throughput and availability which will enhance mission performance and completion.

Optimization Gateway Interface between SATCOM and WAN.** This technology would enable enhanced SATCOM gateway connectivity to allow tactical users to access any SATCOM gateway for services and enhanced shore multi-exit gateways. It would provide enhanced SATCOM gateway access to facilitate the following (not limited to):

- Enable WAN (such as ADNS or NTWAN, or SWAN) to pull NIPR/SIPR from Teleport.
- Provide access to multiple Virtual Private Network (VPN) services for specialized service points.
- Align the JIE SATCOM gateway architecture.
- Allow tactical users to access commercial internet and satellite facilities via fully integrated transportation networks.

*Innovative Technology:* Fielding beyond 2023  
*S&T Delivery:* 2021-2026  
*PMO Alignment:* 160, 170, 790  
*Technology Readiness Level:* Start: 3-5 End: 6-8

Far-Term Science & Technology

**Enhanced SATCOM Gateway Access for Coalition Interoperability.** This capability would allow tactical users to access any SATCOM gateway for services that align with the JIE SATCOM gateway architecture. It would provide access to multiple VPN services for specialized service points and allow tactical users to access commercial internet and satellite facilities via fully integrated transportation networks. The solution should include simplified network administration for end user and Coalition interoperability.

*Inspired Technology:* Fielding beyond 2028  
*S&T Delivery:* 2027+  
*PMO Alignment:* 160, 790  
*Technology Readiness Level:* Start: Various End: 6-8
Navy Tactical Analytic Framework (NTAF) Focus Area

This capability focus area includes development of operationally responsive data architecture and explores enterprise analytics to serve tactical users. NTAF is addressing initial challenges with POR coordination across program offices and alignment of technical solutions, specifically provided as common software services to enable an agile and scalable framework for data analytics. Tactical analytics that support operational decision making must be based on internationally standardized mathematical principles, securely coded applications, validated modeling and simulation, and jointly accepted data taxonomies.

Far-Term Science & Technology

Predictive Logistics to Forecast Equipment Failure. This capability would allow for predictive logistics to forecast equipment failure and provide logistical support in advance. The solution would provide warfare commanders with the ability to automatically determine platform(s) capability to conduct future mission tasking.

Platform Wholeness (PW) Focus Area

This capability focus area will increase commonality and reduce System-of-System configuration variance. The Operational Capability Builds (OCBs) generally improve user-focused information sharing, information fusion, collaboration, and decision-making across the battlespace for the warfighter. There are four C4I OCBs applicable in FY18: Cyber Secure Networks and Applications OCB, Tactical Data Links OCB, Voice Communications OCB, and Information Operations/Intelligence, Surveillance Reconnaissance OCB.

Mid-Term Science & Technology

Improve Submarine Inboard Systems. This technology would enable a reduction of manpower needs in the radio room by centralizing control to reduce number of operator consoles or increasing automation of crypto key distribution.

Dynamic Monitoring of the Configuration of the C4I Operational Baseline. This technology would enable continual dynamic monitoring of the configuration of the C4I Operational Baseline (including the HW/SW Baseline) to determine and maintain a configuration-managed C4I operational baseline. The capability would allow for dynamic restoration of the network to a previous operational configuration including network, communications, applications, and peripherals. Provide a method to optimally establish a baseline that reflects both the “as designed” and “as delivered” C4I Operational baseline. Support delivery to the Fleet a documented baseline as part of the installation and SOT processes. Allow the Fleet Users to manage and remain within the “as delivered” Baseline and perform self restoral actions as necessary. Allow CB-ISEAs to reference when providing distance support. Supports Platform PMW to ensure interoperability between systems.

Sustainment of Pervasive and Persistent C4I Knowledge Continuity. This technology would enable pervasive and persistent C4I System of Systems (SoS) Knowledge Continuity including utilizing expert knowledge on platforms, assuring knowledge is current, relevant, and always available for machine learning. The solution would tie in data analytics from fault data and lessons learned data, Expert Level Fault Isolation Everywhere and On Demand Expert Tutoring. The solution would have an open, modular design that is able to keep pace with deployed C4I Capabilities, and implement a full-featured development environment allowing human-machine collaboration through implementation of a rule-based expert system.

C4I System Installation Enablers. This technology would enable a platform to be war ready within 90 days by allowing for C4I capabilities to be delivered or upgraded to pace threats, integrate new missions and advance new technologies. Allow for no more than 10 days for physical installation or replacement, with no more than 80 days for test and certification, focusing on technology enablers that allow for rapid C4I insertion and meet the intent of the Future Surface Combatant Force (FSCF) Initial Capabilities Document (ICD).

Machine Learning is employed to characterize C4I Baseline. This technology would enable machine learning to characterize C4I baseline behaviors against tactical/operational missions and associated applications. The results would produce impacts on processing and bandwidth demands, data capacities and analytics, digital twinning services including next baseline “as delivered”. Characterization will also ensure they are scaled appropriately according for mission effectiveness.

Innovative Technology: Fielding beyond 2023
S&T Delivery: 2021-2026
PMO Alignment: 160, 750, 760, 770
Technology Readiness Level: Start: 3-5 End: 6-8

Far-Term Science & Technology

Low Probability of Intercept (LPI)/Low Probability of Detection (LPD). This technology would allow future platform-to-platform communications to support the Future Surface Combatant Force (FSCF) enhanced lethality, distribution of forces, and integration of effects by improved Information Warfare (IW) mission effectiveness and warfighter support. Develop terrestrial communications (High Bandwidth and LPI/LPD) that are well beyond today’s capacity (transmit, relay, receive) to provide early Indications and Warnings.

Innovative Technology: Fielding beyond 2028
S&T Delivery: 2027+
PMO Alignment: 150, 170, 750, 760
Technology Readiness Level: Start: Various End: 6-8
Terms for Reference for Enclosure

Acquisition (ACQ): PEO C4I is responsible for a sub-set of the C4I/Space portfolio. Components of the Command, Control, Communication, Computer and Intelligence, Surveillance, Reconnaissance (C4ISR) and Information Operation (IO) portfolio are aligned to 10 Program Management Offices (PMOs) within PEO C4I. The 10 PMOs are: PMW 120: Battlespace Awareness and Information Operations, PMW 130: Information Assurance and Cyber Security, PMW 150: Command and Control, PMW 160: Tactical Networks, PMW/A 170: Communications and GPS Navigation, PMW 740: International C4I Integration, PMW 750: Carrier and Air Integration, PMW 760: Ship Integration, PMW 770: Undersea Integration, PMW 790: Shore and Expeditionary Integration.

Capability: Standardized set of United States military definitions that cover the complete range of military activities. A collection of like DoD capabilities functionally grouped to support capability analysis, strategy development, investment decision making, capability portfolio management, and capabilities-based force development and operational planning.

Capability Focus Area: Naval capability that is influencing the fielding of C4ISR/IO for Information Warfare.
- Each capability is shaping PEO C4I’s strategic planning in terms of how it will impact multiple components and warfighting capability. May also be referenced as, Capability Package.

Component: A self-contained process or service with predetermined functionality that exposes a business process or technology interface within the prescribed architecture. The effective identification, assembly, and usage of components allows for aggregate capabilities to be shared across platforms.

Delivery: Science and Technology (S&T) solutions into the acquisition process within the Future Years Defense Program (FYDP) or specified term. Also, associated with the term transition.

Enabling Technology: Requires a Military Utility assessment or User Assessment, which would result in acquisition fielding of capability within the current FYDP/ time-frame (2018-2022).

Environment: The circumstances, objects, or conditions related to the capability. May be distinctly applied to a specific platform, to a specific mission, to a specific meaning, to a specific sphere, or to a technical interface from which various tasks can be performed, e.g. ship, cyber, operational/tactical, hydrosphere, internet.

Far-Term: Requires long-term S&T investment to mature technology, expressed as 9+ years [+2027]. Is high payoff research that provides the basis for technological progress and may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, navigation, mobility, command and control, navigation, or energy conversion.

Fielding: As the C4ISR portfolio target baseline is being established, fielding plans are developed that map the material solutions to platform availability periods.
- The PEO C4I C4ISR/IO portfolio will be migrated from the legacy configuration to an integrated Information Warfare Platform over the FYDP and beyond time-frame.

Gap (PEO C4I Acquisition Gaps for Science and Technology): Technical issues and capability shortfalls are presented capability focus areas, component, and time-frame to support transition planning for the infusion of proven Science and Technology (S&T) capabilities.

Information Warfare (IW): Actions and capabilities to defeat any enemy by using assured command and control, battlespace awareness, integrated fires, and freedom of maneuver in and through the information environment.

Innovative Technology: Requires development and maturation that would result in acquisition fielding of capability beyond FY23 time-frame.

Inspired Technology: Requires development and maturation that would result in acquisition fielding of capability beyond FY28 time-frame.

Invention: Combines the ideas, insights, discovery, research, and technology advancements in new ways to benefit the naval warfighter.

Mid-Term: Requires S&T investment to mature technology for acquisition, expressed as delivery within 3-8 years [2021-2026], during the development the approach may include non-system specific technology efforts. Solutions can include broadly defined military needs, concept exploration efforts, and paper studies of alternative concepts for meeting a mission need or a capability focus.

Near-Term: Requires S&T investment to deliver advanced technology to a program of record, expressed as delivery within 0-3 years [2018-2021]. Technology delivery trends towards proof of technological feasibility of a prototype, rather than the development of hardware for service (fielding). Are solutions that have a direct relevance to identified military need and have military utility. Subsystems or system models demonstrate the general military utility or cost reduction potential of technology when applied to different types of military equipment or techniques or which can integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

Platform: A vehicle, vessel, craft, structure or person that performs a mission in support of US National Security policy; or a fielded DoD national security or business system.

Portfolio: C4I/SPACE portfolio includes 8 sub-sets which are command and control, communications, computers, intelligence/surveillance/ reconnaissance, space systems, information operations, Information Resource Management (IRM), and information technology. The Naval Acquisition Executive (NAE) or DASN C4I/SPACE facilitates trade-off analysis; the total cost for all portfolios within the future total budget projection. The NAE is presented specific analysis during program’s review, to gain relevant understanding and facilitate Various of life-cycle costs and inventories of related acquisition systems at the Acquisition and Requirements/Resource levels. See also, acquisition.

Program: (1) Acquisition: Acquisition Category (ACAT) and Projects (significant programs that do not meet ACAT designation thresholds are called Projects). (2) Science and Technology (S&T): Advanced Technology Development (ATD) and has a stated condition of moving out of S&T and into the
acquisition process. (3) Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Naval Innovative Science and Engineering (NISE) and Rapid Innovation Fund (RIF) are considered S&T Programs but are not executed as S&T ATD.

Program Management Office (PMO): Supports the NAE/PEO portfolio analysis and manages the cost, schedule and performance of assigned programs. A Program Manager (PM) is vested with the authority, accountability, and resources necessary to manage all aspects of assigned acquisition programs from concept development to demilitarization and disposal. The PEO/PMO affordability analyses should be consistent with any relevant existing portfolio plans and strategies such as those required by statute (i.e., Title 10, United States Code, DoDI 5000.74).

Program Manager, Warfare (PMW): A PMO aligned to the DASN C4I/IO/Space portfolio for acquisition duties and to the Space and Naval Warfare (SPAWAR) competency for DASN C4I/IO/Space portfolio for acquisition duties and to the PMO aligned to the Program Manager, Warfare (PMW): Supports the NAE/PEO portfolio analysis and manages the cost, schedule and performance of assigned programs. A Program Manager (PM) is vested with the authority, accountability, and resources necessary to manage all aspects of assigned acquisition programs from concept development to demilitarization and disposal. The PEO/PMO affordability analyses should be consistent with any relevant existing portfolio plans and strategies such as those required by statute (i.e., Title 10, United States Code, DoDI 5000.74).

Program Manager, Warfare (PMW): A PMO aligned to the DASN C4I/IO/Space portfolio for acquisition duties and to the Space and Naval Warfare (SPAWAR) competency for engineering duties.

- **Product:** C4ISR portfolio components.
- **Integration:** C4ISR components packaged for a platform.

Program of Record (Por): A portfolio, component, program or project that is documented in the DoD budget as an appropriation, per regulations outlined in DOD 7000.14. This designation does not automatically mean funded. In context of this enclosure it does mean acquisition and within the PEO C4I C4ISR portfolio.

Prototype: Development is limited to that needed to evaluate or to prove the technical or manufacturing feasibility or the military utility of a technology; process, concept, end item, system, physical or virtual model. Generically is dependent upon the plan or acceptance criterion that is directly relevant to a capability or proposed acquisition or system. For example:

- Prototype that does not support Full Rate Production decisions (technology demonstrators, mockups, or simulations).
- Prototype to meet urgent needs of deployed forces (the ability to complete a task or execute a course of action under specified conditions and level of performance).
- Prototype to react immediately to a newly discovered enemy threat, potential enemy threat or to respond to significant and urgent safety situations (using off-the-shelf technology).
- Prototype delivered to an acquisition organization, as required by contractual obligation or memorandum (deliverable, physical or virtual model or component).

Research: The systematic investigation into and study of materials and sources to establish facts and reach new conclusions.

**Science and Technology (S&T):** Consists of projects funded by the Research, Development, Test, and Evaluation (RDT&E) Budget Activities (BA) of basic research, applied research, and advanced technology development. Also associated with Office of the Secretary of the Navy, which generally includes coordination by the Assistants, Deputies and Chiefs for annual budgets, S&T policy and reviews of scientific advancement, technological analysis, planning and execution.

S&T Project: Any effort, initiative or technology development funded with S&T. Performer can be Government, Academia or Industry (or foreign partnership).

- **Technology:** The technical means that uses the application of knowledge for practical ends, such as a scientific or industrial process, invention, or method. The creation of the interrelational with the environment, drawing upon such subjects as engineering, applied science, and pure science.

**Technology Readiness Levels (TRL):** Is a management tool used to emphasis technical maturity as applied to an environment and are the underpinnings for partnerships.

- **Start TRL:** PEO C4I considers the S&T TRL when assessing the technical maturity against a gap and the associated timeframe.
- **End TRL:** PEO C4I may identify factors that contribute to a TRL calculation at a different technical maturity than S&T.

Factors can originate from a multitude of sources, such as Deskbook references, Department of Defense Instructions or other governances (examples: Manufacturing Readiness Level (MRL) Deskbook, DoDI (3115.07, 4630.09, 5000.02/5000.75, DoD/DON Policy Series (52##, 54##, 59##, 85##)), or NIST/IEEE/NATO Standards). The assessment or calculation should not be interpreted as the technology is not addressing the gap relatively the impact may be to PMO transition commitment as a prototype or to the specific timeframe.

**Technology Transition Agreement (TTA):** Is a management tool used to improve S&T Program transitions. In principle, a TTA, documents the development, capability and fiscal commitments of the S&T principal, Acquisition principle, and any other decision maker in the transition path. Technology Transition Agreement (TTA), Memorandum of Agreement (MOA), Transition Strategy Plan (TSP), Program Execution Plan (PEP), and Letter of Endorsement (LOE) are all examples of Technology Transition Agreements.

Transition: The delivery of technology for fielding.

**Acquisition and Science & Technology references (Publically available)**
1. PEO C4I Technology Programs and Products (www.public.navy.mil/spawar/Pages/default)
2. The SPAWAR List (Programs, Projects, and Funded Work Efforts Associated with SPAWAR HQ and PEO’s) (www.public.navy.mil/spawar/Pages/default)
5. Addendum to the Naval Research and Development Framework (https://www.onr.navy.mil)