

Naval Surface Warfare Center
Dahlgren Division

Coherent Control in a Disconnected Fight

Trust, Autonomy, and Integration for the Future Naval Force

Presented by

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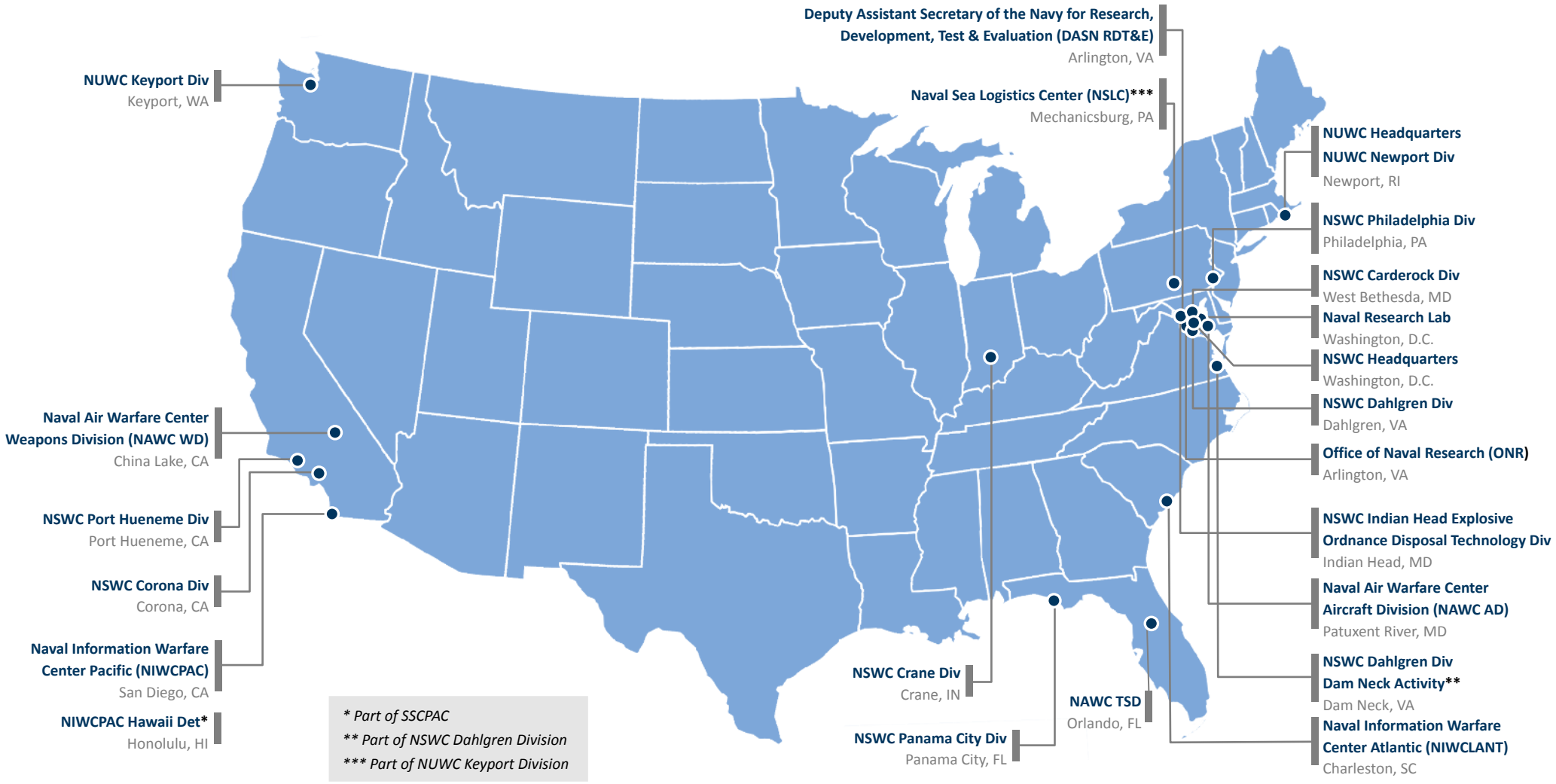
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Naval Research & Development Establishment



NR&DE Quick Facts

- Diverse and highly educated workforce with 30,000 scientists, engineers, and technicians
- 20 commands across the NAVAIR/NAVSEA, NIWC Warfare Centers, ONR and NRL
- Conducts RDT&E for the DoN to discover, develop, transition and field technologically superior naval warfighting capabilities.
- Unique Naval RDT&E facilities including laboratories, test facilities and test ranges
- Serves as principal R&D agents for Navy and Marine Corps Program Executive Offices
- Organizationally aligned to Naval Systems Commands and ONR
  - Naval Sea Systems Command (NSWCs, NUWCs)
  - Naval Air Systems Command (NAWCs)
  - Naval Information Warfare Systems Command

AGGRESSIVE RESEARCH, DEVELOPMENT, TEST & EVALUATION FOR RELIABLE REAL-WORLD SOLUTIONS

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Dahlgren Division Portfolio

ELECTROMAGNETIC & SENSOR SYSTEMS
- Advanced Radar Development and Fielding
- Electronic Warfare (EW) and Spectrum Management
- Electromagnetic Environmental Effects
- Sensor Data Exploitation
- System Safety

WEAPONS CONTROL & INTEGRATION
- Intelligent Automation
- Threat Engineering
- Weapons Lethality, Vulnerabilities and Effectiveness (LVE)
- Asymmetric Warfare
- Weapons Control and Combat Systems

DAM NECK ACTIVITY
- Integrated Training Systems
- Virtual and High Fidelity Maintenance Trainers
- Maritime Intelligence Systems
- Signals Intelligence (SIGINT)
- Cybersecurity Engineering
- Combat Systems Readiness
- Surface Ship ASW
- Sensor Distribution Systems













STRATEGIC & COMPUTING SYSTEMS
- Strategic and Regional Weapons Control (Targeting, Fire Control, Mission Planning, Reentry Systems)
- Critical Infrastructure Analysis & Mission Assurance
- Cyber Engineering
- Shipboard Fiber Optic Technologies
- Software Modernization

INTEGRATED ENGAGEMENT SYSTEMS
- Gun Weapons Systems Fire Control
- Hypersonic Weapons
- Directed Energy Weapons
- Advanced Munitions
- Potomac River Test Range Test & Evaluation
- Weapon Systems Integration

INTEGRATED COMBAT SYSTEMS
- Combat System Development and Delivery
- Future Combat Systems
- Human Systems Integration
- Combat Control Elements
- Mission Engineering
- Live Virtual Constructive Test
- Modeling and Simulations
- Combat System Test and Analysis

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The Operational Problem: Achieving and Maintaining Coherence

What happens when the force has more sensors, more weapons, more data, more autonomy, and more partners—but less time, less certainty, and less connectivity?

⚡ Machine-Paced Speed

The future fight is distributed, contested, and machine-paced.

Contested Tactical Speed

Capability Paradox

More sensors, data, autonomous systems and weapons do not automatically produce combat power

Volume ≠ Combat Lethality

Coherent Control

The primary challenge is acting consistently with commander's intent despite high uncertainty, active disruption, and broken connectivity.

Coordination without Connectivity

The core challenge: The Naval force will continue to rely on coordination; but must do so with decreasing reliance on connectivity

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The Shift We Need to Make: Platform to Force-Level

LEGACY MINDSET

Platform-Centered Combat Systems

- Treats ships, aircraft, and unmanned units as self-contained combat islands.
- Focuses narrowly on manned versus unmanned or centralized versus decentralized.
- Bespoke tactical data-link integration that fragments under network denial.

Vulnerability:
Exquisite platforms that fail if unable to contribute predictably to the larger fight.

FUTURE FORCE ARCHITECTURE

Dynamically Composed Combat System

- Treats the force itself as a dynamically assembled, software-defined ecosystem.
- Integrates data, tracks, spectrum, authorities, and weapons seamlessly.
- Preserves coherent tactical execution even across intermittent, denied, or deceptive links.

Advantage:
Resilient force-level lethality and continuous operational synchronization.

A platform may be exquisite on its own and still be ineffective as part of the force if it cannot contribute predictably to the larger fight.

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The Changing Combat Control Problem

TODAY	TOMORROW	NEXT
DOMINANT CHARACTERISTIC	**DOMINANT CHARACTERISTIC**	**DOMINANT CHARACTERISTIC**
Distributed, predominantly manned force with growing uncrewed augmentation	**Augmented force: crewed warships expanded by uncrewed systems**	**Pervasive autonomy-enabled, software-defined force**
PRIMARY CONTROL PROBLEM	**PRIMARY CONTROL PROBLEM**	**PRIMARY CONTROL PROBLEM**
Extend sensing, targeting, and fires beyond organic formations while operating through degraded C2.	Dynamically compose, control, and reconstitute combat system kill chain elements across heterogeneous nodes.	Govern machine-speed coordination and adaptation within trusted human authorities, constraints, and intent.

The trajectory is not from manned to unmanned; it is from manned-platform-centered control to augmented force-level control.

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Five Design Challenges

1 Trusted Distributed Understanding

Build a coherent operational picture from contested, deceptive, intermittent, and heterogeneous data sources—while conveying confidence and uncertainty to commanders.

2 Authority at Machine Speed

Define which decisions can be delegated, automated, or pre-authorized—and which retain human decision authority because of mission consequence, escalation risk, or ambiguity.

3 Dynamic Force Composition

Rapidly assemble, task, detach, and reconstitute crewed, uncrewed, joint, and allied nodes without creating fragile or bespoke integration dependencies.

4 Force-Level Resource Coordination

Dynamically allocate scarce sensors, weapons, spectrum, bandwidth, energy, computing, and logistics capacity across the force in real time.

5 Resilience and Graceful Degradation

Maintain coherent mission execution when the force loses nodes, communications, data integrity, weapons, energy, or access to centralized control.

> *These are force-design challenges, not simply technology gaps.*

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Considerations for Autonomy

Premise: Autonomy expands the force; humans govern its use

Primarily autonomous — *delegated, bounded, reversible*

- Persistent distributed sensing and data collection
- Environmental monitoring; route, station, and endurance management
- Communications relay, network routing, and emissions management
- Decoys, deception, screening, and selected denial missions
- Track maintenance, data triage, correlation, and confidence scoring
- Logistics forecasting, predictive maintenance, inventory, and routine resupply
- Bounded defensive engagements and time-critical resource optimization, within defined constraints

Human-led — *accountable judgment*

- Commander's intent, campaign priorities, and operational risk acceptance
- Escalation management and decisions with strategic, legal, or political consequence
- Authority to initiate or terminate missions involving significant escalation or uncertainty
- Judgment under ambiguity, deception, conflicting evidence, and novel conditions
- Supervisory control, exception management, and investigation of unexpected machine behavior
- Command of high-value crewed formations, personnel recovery, damage control, and sustainment under duress
- Human-machine team management, training, certification, and adaptation of concepts and authorities

Key question - What can be delegated predictably and reversibly versus what requires accountable human judgment?

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Cohesive Control Guiding Principles

Trust Over Novelty

A new capability is not an improvement if warfighters cannot rely on it in the moment that matters. Confidence is earned through operational suitability and repeatable execution under contested conditions.

Predictability Over Optimization

An understandable, predictable system is more militarily valuable than an elegant system that breaks under stress. Commanders require bounded algorithms whose edge behavior can be anticipated during high-stakes escalation.

Speed With Discipline

The force must transition faster from innovation to fielded capability without bypassing safety or assurance. Speed without disciplined test and evaluation produces fragile shelfware rather than enduring combat advantage.

Integration by Design

Design capabilities to enter, operate within, and adapt to the force architecture—not merely exchange data with adjacent systems. Align technical interfaces, data, authorities, workflows, sustainment, and degraded-mode behavior so a capability can contribute predictably to the larger fight.

Cohesive control delivers operational solution to warfighters characterized by predictability, trust, resiliency, agility

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The Industry Challenge: Five Imperatives for Partnership

1 Design for Integration from Day One

Do not assume a pristine, proprietary, fully connected environment. Build for seamless data, identity, and control exchange with joint/allied systems when networks drop.

2 Deliver Operational Outcomes, Not Just Components

A superior algorithm or vehicle is not automatically combat power. Define what tactical decision is improved, what risk is reduced, and what operator workload is removed.

3 Build Modular, Adaptable & Affordable Systems

Design around open, well-governed interfaces, hardware modularity, and rapid spiral iteration that can be sustained in austere expeditionary conditions.

4 Engage Earlier in Operational Problem-Solving

Do not wait for a rigid RFP. Engage early with fleet operators, warfare center engineers, and testers to shape viable solutions rather than optimizing narrow specs.

5 Move Faster from Innovation to Fielded Capability

Provide mature test data in degraded environments, digital engineering artifacts, and viable production/sustainment paths.

Solve the operational problem – field at speed in a way that is integrated, trusted, affordable, and sustainable

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Closing: The Decisive Advantage

COHERENT CONTROL THAT IS TRUSTED IN COMBAT

The future advantage will not belong simply to the force with the most advanced platforms, the most data, or the most autonomy. It will belong to the force that can turn those things into coherent action—when information is uncertain, communications are contested, and the consequences of getting it wrong are real.

DESIGN FOR COHERENCE

Build systems as contributors to a force-level combat system—not isolated platforms or proprietary technology stacks.

GOVERN AUTONOMY WITH TRUST

Delegate bounded, reversible functions at machine speed while preserving human intent, authority, judgment, and accountability.

FIELDING AS A GOV/INDUSTRY TEAM

Solve operational problems together; integrate, test, sustain, and adapt capabilities fast enough to matter.

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