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Agility and the Combat System

ABSTRACT

As future threats increase in number and capability, the future CG(X) combat system must provide the ability to respond across the spectrum of conflict. In this paper, we present the principles and concepts needed to achieve an agile combat system that can support a wide variety of missions in diverse operating environments.

Within a strategic environment characterized by uncertainty, U.S. Naval forces must possess the ability to adapt to meet new and diverse operational requirements quickly and thereby foreclose opportunities to irregular or conventional forces. Naval Operations Concept, 2006

Introduction

As the interests of the United States evolve to keep pace with changes in international relationships, the environments in which the US Navy works and the support it provides will become increasingly diverse. Whether acting as a warfighter, as a provider of humanitarian relief, as a diplomatic asset, or as a resource enabling others to act in these roles, CG(X) must include a wide range of combat capabilities.

The US Navy will operate CG(X)¹, in environments from the open-ocean to the littorals, both autonomously and in support of other forces. CG(X) must provide combat and battle management

capabilities to execute missions within the Naval Operations Concept. Table 1 presents a notional set of CG(X) missions based on our operational and performance requirements analysis. While executing these missions, CG(X) will operate in challenging environments and situations. Over its service life, CG(X) will face increasing threat numbers, tactical complexity, and technical sophistication compared to today's environment. In these conditions, the Navy must be capable of handling numerous interactions, ranging from nation states with traditional naval assets to terrorist groups and individuals operating asymmetrically.

Primary Missions	CG(X)	Secondary Missions	CG(X)
Air and Missile Defense		Maritime Security Operations	
Crisis Response		Civil Operations	Military Operations
Expeditionary Power Projection		Counter-Proliferation	
Sea Control		Deterrence	
Forward Presence	Naval	Security Cooperation	
		Information Operations	

Table 1 - Ability to evolve through its service life to remain capable and relevant

¹ PEO Ships describes a guided missile cruiser as a “large combat vessel with multiple target response capability. Modern U.S. Navy guided missile cruisers perform primarily in a Battle Force role. These ships are multi-mission [Air Warfare (AW), Undersea Warfare (USW), and Surface Warfare (SUW)] surface combatants capable of supporting carrier battle groups, amphibious forces, or of operating independently and as flagships of surface action groups.” In addition to these warfare missions, cruisers perform Ballistic Missile Defense and Strike missions, and can serve in command roles. We expect that CG(X) will act as an Air Defense Commander, planning, allocating and controlling joint and coalition surface and air assets to conduct counter-air missions over land and sea.

To perform its missions, the CG(X) combat system must provide the warfighter with flexible, adaptable, scalable decision-making capability to allocate and use organic resources and assigned remote assets. Without this capability, CG(X) will not support its commander's operational objectives. To achieve this level decision-

making capability, the CG(X) combat system must demonstrate agility allowing the warfighter to tailor responses, and to regulate responses as the situations unfold. While executing the original plan, the commander adjusts responses in stride when faced with unexpected conditions. Like a versatile quarterback, the CG(X) combat system monitors the tactical situation and provides the flexibility to meet operational tasking easily evolve to meet changing threats. An agile combat system provides the necessary management tools and controls to handle diverse situations and “thrive in a continuously changing unpredictable environment.”²

This paper presents a rationale for an agile CG(X) combat system. In the first part of the paper we look at future operational challenges that drive the need for this kind of combat system. In the second part, we discuss the attributes of an agile combat system, its benefits, and a path toward realizing this versatile behavior.

CG(X) Combat Systems Enabler to Operate in a Unpredictable, Changing World

CG(X) and its combat system must operate in an unpredictable, changing world because politics, evolving technology and economic challenges will continuously change the world landscape. An agile combat system provides increased degrees of freedom to CG(X), allowing it to execute a wide range of missions to protect our Nation’s interests and implement her policies. Whatever the future holds, the CG(X) combat system must allow the warfighter to rapidly configure the capabilities and support flexible decision making to optimize

mission effectiveness. By providing a flexible, adaptable, extendible and automated combat system capability for decision-making and resource use, the Navy achieves the goals of the Naval Operations Concept with a reduction in manning and reduced operational costs. These system attributes enable the warfighter to configure the combat system in the best operating state to handle the threats or situations. Table 2 identifies the focus areas that we feel drive the primary needs for the CG(X) combat system.

Focus Area	Development	Operational
Emerging Threats and Operating Environments	Enable rapid insertion of new capability to address new threats & situations	<ul style="list-style-type: none"> Need Decision Making Flexibility Need flexibility to use organic & non-organic resources in ways not originally planned
Pre-Deployment Configuration Flexibility	Enable extension of combat system	<ul style="list-style-type: none"> Enable reconfiguration of CG(X) resources & decision making enabling changes or new missions or roles
Capabilities & Performance Requirements	Enable combat system elements extension	<ul style="list-style-type: none"> Enable reconfiguration of CG(X) resources & decision making enabling changes or new missions or roles
Technological Changes or Growth (CG(X) Life Cycle)	Enables rapid insertion of new capability into the combat system & into the fleet	<ul style="list-style-type: none"> Manages Capability Gaps between the Baseline Combat System & Threats / Operating Environment

Table 2 Focus areas to build a case for an CG(X) combat system that is flexible, adaptable, scaleable and extendible.

² According to Rick Dove in his 2006 Training Material, “Engineering of Agile Systems and Enterprise of Analysis, Synthesis and Performance”, agility is “the ability to thrive in a continuously changing unpredictable environment.” Agile systems are “are concerned with response ability - for both reactive and proactive response needs and opportunities - when these are unpredictable, uncertain, and likely to change.”

Emerging Threats and Operating Environments (Nation States and Sociological Interactions)

The challenges faced by CG(X) and its crew are predicted to be more complex in the future based on current affairs / events. CG(X) needs the flexibility in allocating, managing resources and decision making to deploy assets to assure access to sea-lanes and operating areas. The CG(X) combat system provides this flexibility for both organic and non-organic resources, whether executing Integrated Air and Missile Defense in a Major Combat Operation, or supporting humanitarian relief after a natural disaster. During execution, the commander must consider both warfighting and sociological interactions in making his key decisions. Table 3 depicts key dimensions in the sociological interactions and describes how the CG(X) combat system provides flexibility to the warfighter. This flexibility enables the warfighter to tailor and configure the response of the combat system using different combinations of tactics, doctrine, rules of engagement (ROE), and policies as necessary to handle emerging situations.

System designers and warfighters achieve combat system agility from two (2) perspectives. First, designers develop and integrate the system to enable the introduction of new technologies and new warfighting capabilities. This approach takes advantage of open architecture and open business models to enable the extensibility of the system’s capability through well-defined interfaces. Through the application of modern engineering principles, engineers design the combat system for capability growth over its life cycle.

Operational versatility is evident in the way the warfighter plans and fights the system. Before deployment, the warfighter conducts planning to determine, assign and allocate resources for the ship and the

force. A balanced plan, keyed toward optimal performance in the expected mission and environment, provides options for the commander to select as conditions become clear. When in the operational area, an agile system enables the warfighter to adapt and reconfigure the combat system to be more in tune with the situation and threats.

	Characteristic	Combat System Capability
Enemy Type	<ul style="list-style-type: none"> Nation States – Warfighting capabilities reflect industrialized production Backward States – Armed with WMD & low cost BM Terrorists – Ideological agendas with low cost, low tech means Traffickers/Pirates – Economic agendas 	<ul style="list-style-type: none"> Right capabilities & resources for situation Flexibility in decision making (manual to automation, resource deployment patterns, dynamic tactics & redeployment opportunities)
Threat Type	<ul style="list-style-type: none"> Stealthy cruise missiles Advanced ballistic missiles Sea-skimming anti-ship missiles High-flying, long-endurance unmanned aerial vehicles Stealthy aircraft 	<ul style="list-style-type: none"> Flexibility in decision making (manual to auto, resource deployment, dynamic tactics) Extend response capability with remote resources Extend from Total Ship to Total Force Response
Operating Area	<ul style="list-style-type: none"> Open Ocean Littorals 	<ul style="list-style-type: none"> Adaptability for CG(X) resources – dynamic verses static usage

Table 3 Combat System versatility provides the freedom to respond in complex operational situations

Configuration Flexibility for Pre-Deployment

While the primary mission of CG(X) is Air and Missile Defense for the force and high value assets, we expect it will acquire new missions over the service life of the ship. With shrinking budgets and corresponding reduction in the number of warships to cover the world, the Navy must develop multi-mission ships that can conduct both war-fighting and non-warfighting actions to support US national interests. The CG(X) combat system must be able to support

other missions. According to the Lexington Institute Report on CG(X), “CG(X) and the Future of Naval Warfare”, the CG(X) ship and combat system must be capable of multi-mission.

“CG(X) must be designed as a multi-mission, versatile warship that can participate in other naval missions such as forward presence, force projection, sea control and counter-terrorism. It also must be able to defend itself against a variety of dangers in addition to the airborne and ballistic threats that are its primary focus. Thus, the final configuration of the cruiser should include both offensive and defensive weapons in sufficient number to make a major contribution to complex military campaigns, and the provisions for on-board surveillance, battle management and communications gear must assure relevance across the various phases of war.” [LEX]

An agile combat system provides the warfighter the capability to configure the response capability to meet the needs of the different missions. The warfighter can optimize the response to the expected or anticipated situations. This flexibility provides the warfighter the ability to operate simultaneous missions using both organic and non-organic resources. This flexibility would allow the introduction of mission packages in the form of additional resources (e.g. UxVs and helos) to expand the core response capabilities when required.

CG(X) Capabilities and Performance Requirements

The CG(X) combat system must be configurable to support the anticipated operations identified in Table 4. It must be capable of optimizing decision-making capability (human and system-based) to deliver appropriate responses under normal and stressing conditions in the projected operating environment for each mission.

Naval Operations Concept	CG(X)
Forward Naval Presence	☑ Major Role
Crisis response	☑ Contributions
Expeditionary power Projection	☑ Major Role
Maritime Security Operations	☑ Contributions
Sea Control	☑ Major Role
Deterrence	☑ Contributions

Security Cooperation	☑ Contributions
Civil Military Operations	☑ Contributions
Counterinsurgency	
Counterterrorism	
Counter-proliferation	☑ Major Role
Air and Missile Defense	☑ Major Role
Information Operations	☑ Contributions
Table 4 CG(X) Needs the flexibility to support these operations under a variety of operating environments	

CG(X) provides the defensive combat power for joint forces to operate under threat of air attack by an enemy. Even though CG(X) will be a potent combat force, it will also provide crises responses during situations such as hurricane search and rescue, tsunami relief and other natural disasters. To deliver the necessary responses, the CG(X) must provide the crew with the flexibility, adaptability and scalability to configure ships systems appropriately. Table 5 summarizes the key areas of agility that CG(X) must provide. Table 6 identifies command roles possibly assigned to CG(X) (indicated by the blue checks)

Capability	Description	Tenets
Air & Cruise Missile Defense	<ul style="list-style-type: none"> Provide capabilities to conduct offensive & defensive air ops for area, high value asset & self Search, detect, track, id, evaluate threat, determine action & prosecute 	<ul style="list-style-type: none"> Provides flexibility to scale response & resources Provide power, range, sensitivity to establish track with enough time to respond Enabler for autonomous & collaboration ops
Ballistic Missile (BM) Defense	<ul style="list-style-type: none"> Provide capability to protect forces, homeland & self against BM Search, detect, track, id, evaluate BM, determine COA & prosecute 	<ul style="list-style-type: none"> Provides flexibility to extend response & resources Provide power, range, sensitivity to establish track with sufficient time to respond to threat
Battle Mgt & Network Centric Operations	<ul style="list-style-type: none"> Serve as command ship for warfare commanders & coordinators (Table 6) Provide capabilities to collect & disseminate info, initiating / controlling actions & managing battlespace 	<ul style="list-style-type: none"> Coordinate (insure resources are available at right time & place) Collaboration between assets Orchestrate responses to defend fleet, joint forces & high valued assets
Multi-Mission Versatility & Simultaneity	<ul style="list-style-type: none"> Defend against other threats & situations (Figure 1) from adversaries (surface threats and subsurface threats) 	<ul style="list-style-type: none"> Flexibility to operate autonomously standalone ops & with other assets Provide flexibility for to configure, adapt & extend response with remote assets

Table 5 CG(X) combat system must accommodate a wide range of operations in unpredictable environments

Principle Warfare Commanders (Cdrts)	<ul style="list-style-type: none"> Air Defense Cdr (ADC) ✓ Antisubmarine Warfare Cdr (ASWC) ✓ Information Warfare Cdr (IWC) Sea Combat Cdr (SCC) ✓ Strike Warfare Cdr (STWC) Surface Warfare Cdr (SUWC) ✓
Functional Warfare Cdrts	<ul style="list-style-type: none"> Maritime Interception Operations Cdr (MOC) ✓ Mine Warfare Cdr (MIWC) Operational Deception Group Cdr (OCDGC) Screen Cdr (SC) ✓ Underway Replenishment Group (URG) Cdr (URG)
Coordinators	<ul style="list-style-type: none"> Air Resource Element Coordinator (AREC) Airspace Control Authority (ACA) ✓ Cryptologic Resources Coordinator (CRC) Force Over-the-Horizon Track Coordinator (FOTC) ✓ Force Track Coordinator (FTC) ✓ Helicopter Element Coordinator (HEC) ✓ Launch Area Coordinator (LAC) Submarine Operations Coordinating Authority (SOCA) TLAM Strike Coordinator (TSC)

Table 6 The CG(X) Combat System supports the assignment of many command roles.

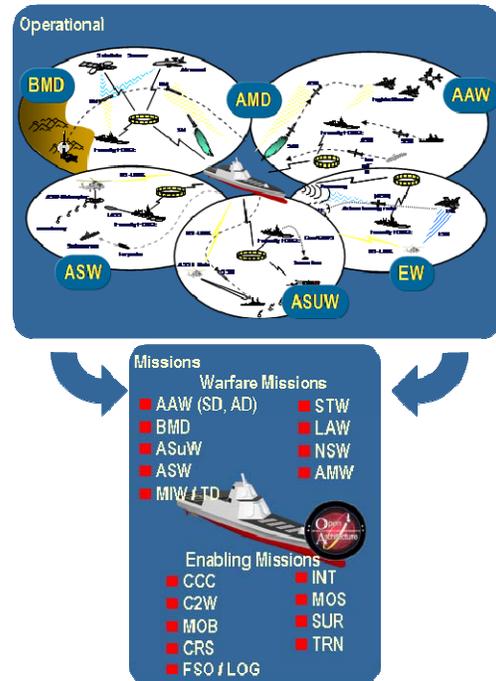


Figure 1 CG(X) Combat System provides the flexibility to support multiple missions

Technological Changes or Growth (CG(X) Life Cycle)

A conservative estimate for the CG(X) combat system life cycle is over 25 years. During this period, technology will continue to evolve, due to replacement of obsolete equipment and introduction of new capabilities. Figure 2 shows notional timelines for key changes in different areas of the combat system and ship, and the blue dashed line highlights the combat system. Some changes, such as the crew turnover and availability of information to the warfighter, are continuous in nature. Other changes are associated with technology refresh cycle such as the computing / networking environment. Introduction of outside systems, such as the Global Information Grid (GIG), also drives changing requirements into the system. Evolving warfighting capabilities, requiring longer time horizons for development, reach the system through upgrades to communication, apertures, sensors and weapons. These changes extend the reach and capability of the combat system to handle the emerging mission objectives and threats.

CG(X) must accommodate the change rates depicted in Figure 2 in two (2) ways. First, it provides a robust decision making capability that can implement new tactics through rules, policies and doctrines, exploiting the sensors and weapons on remote resources as they evolve. This allows the warfighter operating the CG(X) combat system to configure engagement policies to exploit local and remote resources in emerging missions. Second, CG(X) requirements include a set of non-functional requirements that promote growth of combat system capability. These non-functional requirements enable an open architectural design with industry acceptable standards and well defined/controlled interfaces enabling an open business model to develop and integrate new warfighting capabilities.

CG(X) Combat System Versatility

The CG(X) Combat System must demonstrate agility to balance the demands associated with emerging threats and operating environments, performance requirements and life cycle considerations. This helps the warfighter adapt the system

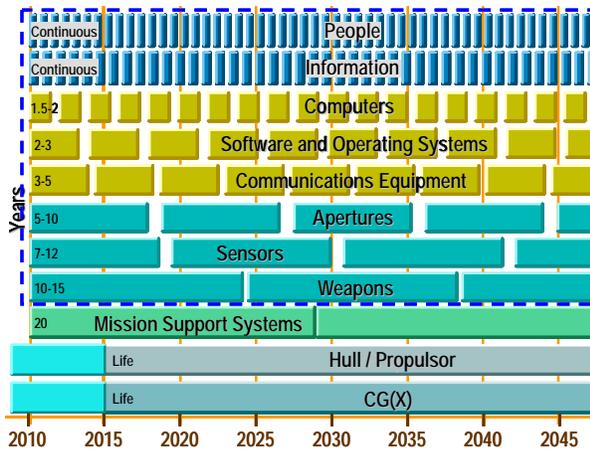


Figure 2 CG(X) Combat System must provide sufficient “design for change” implementation techniques to enable the integration of new warfighting capability while reducing life cycle cost for the US Navy.

to the best possible configuration for a predicted set of situations, and make the best use of organic and assigned resources. This section of the paper addresses the following questions:

What is agile?

How is this kind of system built?

What are the benefits?

What is it?

Given that the future is not predictable with any kind of certainty, the system designers must develop the CG(X) combat system with change in mind. This system tenet leads to a number of system design attributes such as flexibility, adaptability and extensibility, which the combat system must realize. These system attributes enable the CG(X) combat system to demonstrate agility³ in the way warfighter configures the system elements to generate responses to both predictable and unforeseen situations. Table 7 provides a framework on how to understand this system property.

³ According to Rick Dove in his 2006 Training Material, “Engineering of Agile Systems and Enterprise of Analysis, Synthesis and Performance”, the system property is “the ability to thrive in a continuously changing unpredictable environment.” These systems are “are concerned with response ability - for both reactive and proactive response needs and opportunities - when these are unpredictable, uncertain, and likely to change.”

Perspective	Definition
Development	Evolves warfighting capability as the operational needs and missions of the combat system change over the life of the ship and when technology changes.
Operational State	Is both flexible and has the ability to rapidly change between states to achieve the specified level of effectiveness, without large switching costs or increases in system complexity.

Table 7 The desired flexibility and adaptability provided through development and intelligent operational applicability enables flexibility.

What is an Agile Combat System and how do you build one?

The CG(X) combat system is a collection of computer programs and equipment that has the agility to enable the warfighter to adapt to unexpected situations. The combat system has the ability to develop new actions and responses based on the availability of organic and non-organic resources. A decision-making core that optimizes the combat system to handle varied situations controls the response capabilities. This allows the warfighter to focus the right force capabilities and resources to optimize the response for the situation or threat.

To realize this kind of combat system requires a top-down systems engineering process that starts with the concept of operations to identify the missions and then develops system requirements, architecture, and design. Table 8 describes a collection of principles⁴ that influence the system design phases to realize the desired levels of flexibility.

⁴ Extended the Principles identified in Rick Dove’s in his 2006 Training Material, “Engineering of Agile Systems and Enterprise of Analysis, Synthesis and Performance” to the CG(X) Combat System.

Figure 3 depicts a top level architectural pattern for a combat system based on these principles. The warfighter interacts with the combat system via the Decision Core (DC) and the Course of Action Management (COAM) layer. DC contains

the information and functions needed to develop an initial assessment of the situation and select initial actions. These functions include track management, ID, doctrine, threat evaluation, and threat prioritization.

COAM receives the desired actions from the decision core, and then interacts with available resources to develop a detailed, optimal response within limits established by DC. For example, when directed to neutralize an air threat COAM would evaluate the use of CAP, missiles, guns, or soft kill and select the option(s) with the highest probability of success. As the GIG matures and more remote systems publish their capabilities and services, the number of course of action options available to COAM will increase.

Architecture Principle	Feature	Benefit
Combat System (CS) Core Agnostic	Insulate resources from decision-making logic	<ul style="list-style-type: none"> Operate with different C2 decision cores Support different ship classes
CS Element Agnostic	Minimize dependencies on sensors, weapons, comms, associated assets	<ul style="list-style-type: none"> Capability provides management for a broad set of resources
Low Coupling with High Cohesion	Use common interfaces/services, API, data / control for internal/external entities	<ul style="list-style-type: none"> Standards (Stds) based deployed environment Plug & Fight Compatibility
Assembly Flexibility	Support specific domain needs, operating environment, resources and decisions	<ul style="list-style-type: none"> Mission & Combat Power configurability
Reuse Facilitation	Bridge to reuse legacy & new investments	<ul style="list-style-type: none"> Capability to facilitate reuse & Navy investments
Mission Capability Flexibility	Dynamically establish relationships, planning, scheduling using self adapting behaviors	<ul style="list-style-type: none"> Configure combat system for planned missions Establish new applications for existing resources to increase response options
Mission Capacity Flexibility	Adjust number/types of resources & relationships for mission needs	<ul style="list-style-type: none"> Right resources for the right situation under continuously changing operating environment
Redundancy	Provides capacity options and fault tolerance	<ul style="list-style-type: none"> Increase readiness, endurance & survivability
Stds Based	Use industry accepted stds	<ul style="list-style-type: none"> Open Architecture
Well Defined Interfaces (I/F)	Data and control architecture foundation	<ul style="list-style-type: none"> Standardized I/Fs Reduce ownership cost
Deferred Commitment	Commit relationships between decision-making & response as late as possible to ensure properly allocated resources	<ul style="list-style-type: none"> Decision-making flexibility enabling conventional & non-conventional options Avoid conflicts between resources
Distributed Control & Information	Decisions made at point of knowledge & info retained locally accessed via I/Fs	<ul style="list-style-type: none"> Enabler for effects based response
Self Contained Units	Encapsulation & other black box concepts	<ul style="list-style-type: none"> Modularity –3rd Party Supplier Enabler Reduce development cost
Flat Integration	Communicate via peer-to-peer & parallel relationships and rather than sequential	<ul style="list-style-type: none"> Reduced system response time Total Ship Response
Build it for Change	Use open / modern design principles	<ul style="list-style-type: none"> Reduced life cycle costs

Table 8 Architecture Principles of the Top-Down System Engineering Process lead to an agile combat system

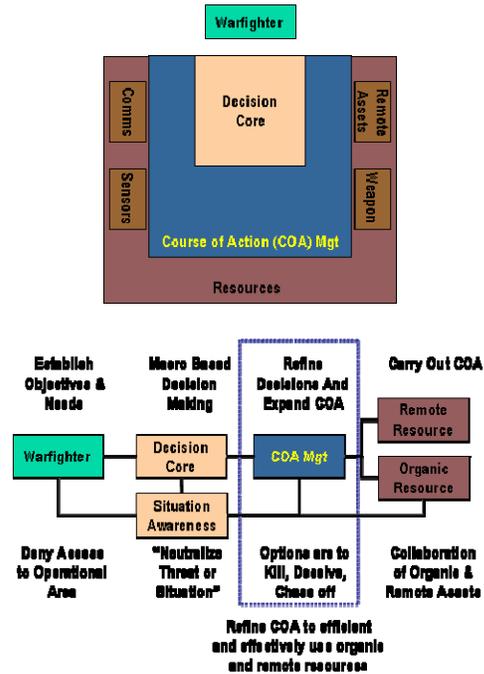


Figure 3 Architectural Pattern that illustrates the COA Mgt layer to provide the necessary versatility in the combat system for CG(X)

Figure 4 depicts a range of anticipated operational attributes for CG(X). The system design for the combat system must provide the degrees of freedom to enable the warfighter to tailor the system response under these different situations. Each table row represents competing considerations for the combat system. Because CG(X) is a multi-mission ship, the combat system design must balance capability across these factors. The combat system approach described in Figure 3 helps to provide this balance by allowing the operator to configure the decision core for the mission. Simultaneously, COAM manages the available resources and provides a consistent interface between them and the decision core. In the simplest possible terms, the decision core decides what response a situation needs, while COAM decides how best to execute.

Within a single deployment, CG(X) may face each of the extreme conditions noted above. By virtue of their mobility, ships can be tasked to transition across the spectrum from major combat operations to humanitarian relief (and back) without warning. A combat system designed only for the most stressing single warfare mission will have limited use in the complex and diverse challenges in Naval

missions of a rapidly changing world.

CG(X) Needs to satisfy and balance a number of parameters in the operational environment

Mission	<ul style="list-style-type: none"> Single Mission Crisis Response Mission of State Humanitarian 	<ul style="list-style-type: none"> Multi-Mission AAW BMD Other warfare Missions
Operating Environment	<ul style="list-style-type: none"> Open-Ocean 	<ul style="list-style-type: none"> Littoral
Threat Environment	<ul style="list-style-type: none"> Nation State 	<ul style="list-style-type: none"> Asymmetric
	<ul style="list-style-type: none"> Single Threat 	<ul style="list-style-type: none"> ↑ Number ↑ Complexity
Unit or Force Level centric	<ul style="list-style-type: none"> Single Ship Operating Autonomously 	<ul style="list-style-type: none"> Collaborating Force
	<ul style="list-style-type: none"> Total Ship Response 	<ul style="list-style-type: none"> Total Force Response
	<ul style="list-style-type: none"> Unit Centric 	<ul style="list-style-type: none"> Battle Management
Decision Making and Action Taking	<ul style="list-style-type: none"> Manual 	<ul style="list-style-type: none"> Automation
	<ul style="list-style-type: none"> Limited response 	<ul style="list-style-type: none"> Many Courses of Action
Response Time	<ul style="list-style-type: none"> Non-Real-Time 	<ul style="list-style-type: none"> Real-Time / Time Critical
	<ul style="list-style-type: none"> Time to think and way options 	<ul style="list-style-type: none"> Short reaction times

Figure 4 The CG(X) combat system must satisfy multiple simultaneous objectives

Combat System Versatility via Development

How can we inject versatility into the CG(X) combat system? Figure 5 shows where system design features contributes to this system property. The perspectives fall into one of two categories. These categories, shown in Table 7 are operational or

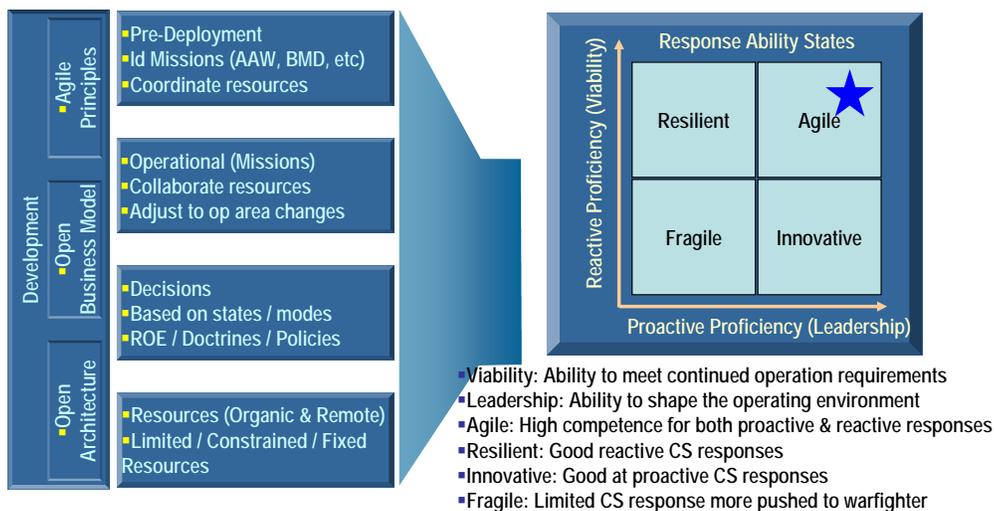


Figure 5 Response ability of the CG(X) Combat System is tempered by a number of elements in development and in the operational perspectives providing the warfighter versatile response capability for planned and unplanned situations

development in nature. The operational perspectives are pre-deployment, operational, resources and decisions. This perspective reflects opportunities that enable the warfighter and system to generate reactive and anticipatory battle space responses. Proactive responses provide a pre-planned set of actions to anticipated situations. Reactive responses provide flexibility to handle unforeseen

situations which the original plan did not anticipate. This operational perspective enables the warfighter increased degrees of freedom in handlings situations either through manual actions or increased automation via the combat system. An agile combat system provides the capabilities to execute planned responses while at the same time afford sufficient freedom for the warfighter to respond to emerging situations. The emerging situations were either not included in the original plan or adversaries adapting their strategy and tactics.

The development perspective crosses all of the operational perspective elements. The development provides the foundation to build agility into the system and into the system responses. First, the combat system design must satisfy the “design for change” architecture principles. In doing so, the Navy can introduce updated and new warfighting capability and mission training/rehearsal to the combat system to address emerging threats and situations. Adding new capability enables the “Pre-Deployment” and “Operational (Missions) additional options for planning and fighting. The development perspective also touches the “Decision” and “Resource” operational perspective elements. This allows the warfighter to modify or add new warfighting logic rules and doctrines to expand the decision-making combat system capability. This allows the warfighter to tailor or expand the set of responses available. In addition,, this allows the warfighter flexibility in the way the resources are used allowing the warfighter to establish new uses for the combat system and corresponding resources. Table 9 presents the perspectives in more detail.

	Description
Pre-Deployment	<ul style="list-style-type: none"> Provide flexibility to configure different mission capabilities prior to deployment anticipating operational area challenges, threats and situations Establish decisional doctrines and rules to anticipated challenges, threats and situations
Operational	<ul style="list-style-type: none"> Provide flexibility to retain a level of effectiveness across a range of missions, operating environments and/or circumstances Collaborate the use of resources Enables management of the operational risks associated with the gaps between the combat system capability and the anticipated threats in the operational area (refer to Figure 6) <ul style="list-style-type: none"> Case A (Figure 6) -- System baseline capability exceeds threat capabilities. Combat system has excess capacity to conduct simultaneous missions, provide redundancy and off load other resources that are pushing their max loads. Case B (Figure 6) – Threats capability exceeds the combat system baseline capability. Combat system provides mechanism to enable the warfighter to operate with different tactics, rules of engagements, doctrines and policies to manage and manage the operational risk. For example, an agile combat system would be able to expand its fighting capability by integrating the remote assets into its decision, management and control capabilities.
Decisions	<ul style="list-style-type: none"> Made in support of the operational behavior to satisfy the assigned missions Provide a robust decision making capability to new tactics using rules, policies and doctrines. <ul style="list-style-type: none"> Allows warfighter to configure new rules of engagement that exploits local & remote resources
Resources	<ul style="list-style-type: none"> Represents all resources available to the combat system and warfighter <ul style="list-style-type: none"> Fixed resources Extend by integrating remote resources Deploy resources according to plans allowing for new configurations & tactics accounting for changes in operating environment & adversary’s tactics
Development	<ul style="list-style-type: none"> Requirements and architecture activities, techniques, principles, non-functional requirements ensure that the combat system is design & built for change Exploit modern design and implementation approaches to establish an open architecture solution enabling an open business model <ul style="list-style-type: none"> Case C (Figure 6) – Threats capability introduces a disruptive technology that increases the gap between the threats and the system capability. Baseline capability expanded / extended with the introduction of new capability due to open architecture principles & concepts.

Table 9 Perspective elements and their contributions to the CG(X) combat system

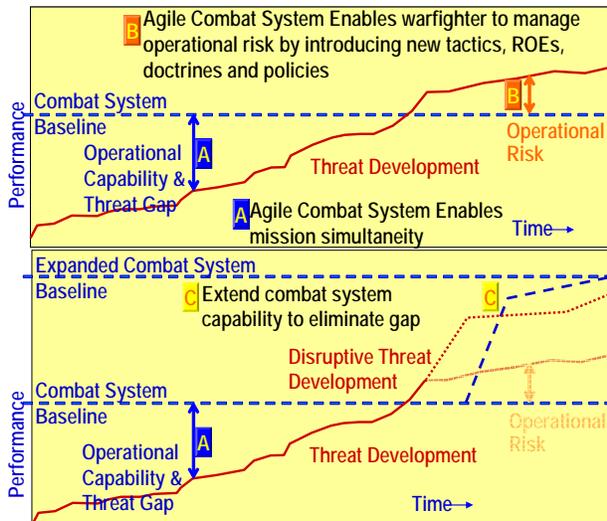


Figure 6 Accommodating Mission Growth and Increase Threat Complexities

Benefits

Table 10 presents the benefits of a CG(X) combat system designed to meet the agility system property.

Feature	CG(X) Attribute	Benefit
Pre-Deployment	<ul style="list-style-type: none"> Flexible Scaleable 	Rapid insertion of new capabilities
Operational	<ul style="list-style-type: none"> Robust Flexible Scaleable 	<ul style="list-style-type: none"> Multi-Mission capable Multi-Unit / Multiple Mission Integrate remote and organic resources
Decision	<ul style="list-style-type: none"> Rapid Results Driven 	<ul style="list-style-type: none"> Effective resources management under shifting priorities Speed of Need
Resource	<ul style="list-style-type: none"> Resilient Responsive 	<ul style="list-style-type: none"> Right weapon at the right time Reduce reaction time Total ship / force response
Development	<ul style="list-style-type: none"> Design for Change Innovative Extendible 	<ul style="list-style-type: none"> Introduce new warfighting capability earlier into the fleet Open Architecture Open Business Model Reuse Navy Investments

Table 10 Feature / Merit and Benefits of the CG(X) combat system

Summary

Given the uncertainty in world politics, emerging threats/situations, natural disasters and the US Navy responsibilities in protecting National Interests, CG(X) combat system must provide the degrees of freedom in decision-making to respond to a given situation. The CG(X) combat system must provide the warfighter response ability that enables flexibility, adaptability and scalability to bring the

right resources to situation. The US Navy must satisfy their assigned missions while responding to the different situations, events and threats in different operating environments.

Having the best equipment and resources is not going to be sufficient to deal the wide range of threats, complex situations and an ever evolving/adapting collection of hostiles. The CG(X) combat system needs to be agile to maximize combat power, persistence, survivability, environmental immunity and battle space management as dictated by the situation, events and doctrines.

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