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14. ABSTRACT
Five years ago, U.S. Chief of Naval Operations, Admiral Michael Mullen, unveiled the concept of the ?Thousand-Ship Navy? as a new taxonomy for international naval cooperation. Embraced by the George W. Bush administration and renamed ?The Global Maritime Partnership (GMP) Initiative? this concept was rapidly embraced by the community of nations as a way to secure the global commons. In the ensuing four years this concept has become a new international norm and the sine qua non for international naval cooperation. But as international navies have gained experience operating together across a wide spectrum of operations from conflict to humanitarian efforts, they have also found that the networking challenges have been daunting and these C4ISR challenges have impeded effective maritime partnering. This paper will address the way C4ISR challenges manifest today as navies unite in a GMP. It will also describe how lessons learned from past networking and coalition efforts can inform global security efforts today. We will share the results of a beta-test among the five AUSCANNZUKUS nations, currently entering its eighth year, which provides one example of how to address these C4ISR these challenges by harmonizing international naval C4ISR acquisition efforts.

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Abstract for
Networking the Global Maritime Partnership

Five years ago, U.S. Chief of Naval Operations, Admiral Michael Mullen, unveiled the concept of the "Thousand-Ship Navy" as a new taxonomy for international naval cooperation. Embraced by the George W. Bush administration and renamed "The Global Maritime Partnership (GMP) Initiative" this concept was rapidly embraced by the community of nations as a way to secure the global commons.

In the ensuing four years this concept has become a new international norm and the *sine qua non* for international naval cooperation. But as international navies have gained experience operating together across a wide spectrum of operations from conflict to humanitarian efforts, they have also found that the networking challenges have been daunting and these C4ISR challenges have impeded effective maritime partnering.

This paper will address the way C4ISR challenges manifest today as navies unite in a GMP. It will also describe how lessons learned from past networking and coalition efforts can inform global security efforts today. We will share the results of a beta-test among the five AUSCANNZUKUS nations, currently entering its eighth year, which provides one example of how to address these C4ISR these challenges by harmonizing international naval C4ISR acquisition efforts.

Networking the Global Maritime Partnership

Perspective

One of the macro-trends of the late-twentieth, and now the twenty-first century, has been globalization. Globalization—generally understood as "the integration of the political, economic, and cultural activities of geographically and/or nationally separated peoples,"[1] involves the international interaction of information, financial capital, commerce, technology and labor at exponentially greater speeds and volumes than previously thought possible—and impacts the lives and fortunes of all mankind. But it is important to recognize that it is in the maritime domain where the interconnected nature of globalization has the greatest impact and influence, as events in one part of the world can swiftly impact the lives of peoples and societies across the globe.

As globalization has grown over the past two decades, we have witnessed an increase in maritime trade on the global commons. The tonnage of goods carried across the oceans by the rapidly growing merchant fleets of the world has more than quadrupled in the past four decades. This global exchange of goods has brought ever-increasing prosperity to the community of nations.

But with globalization and the concomitant dependence on reliable oceanic commerce to undergird increasing world prosperity comes vulnerabilities. Those who would disrupt this trade and the rule of law on the global commons, whether for economic or political gain, now have far more opportunities to attack vessels on the high seas or near-shore waters than ever before. The dramatic increase in piracy in this century, a scourge many thought no longer existed, is but one manifestation of the threat to the rule of law on the global commons that the international community—and especially navies—must deal with today.

Concurrently, the nexus of climate change, growing populations, and a demographic shift to coastal and near-coastal regions has resulted in a significant increase in natural disasters—hurricanes, tsunamis, coastal flooding, volcanic events, earthquakes and a host of others—that bring untold suffering to millions. Often, naval forces are the only ones capable of delivering relief supplies in a timely fashion and in the volumes necessary to bring adequate relief to disaster victims.

But no navy—of any nation—is robust enough to enforce the rule of law on the global commons or respond adequately to a major natural disaster. Today, through practice, global maritime partnerships have become the *sine qua non* for nations working together as global forces for good supporting ever-increasing levels of security, stability, and trust. Six years after then-CNO Admiral Michael Mullen proposed his "Thousand-ship Navy" concept at the 17th International Seapower Symposium in 2005, his notion of a global maritime partnership is gaining increasing

[1] While the term globalization has been defined in many places, the Defense Science Board definition is one of the most widely-accepted. See, Defense Science Board, *Report of the Task Force on Globalization and Security* (Washington, D.C., Defense Science Board, December 1999), pp. xxvii-xxviii.

currency within, between and among navies and the other navies.[2] As Admiral Roughead noted in his remarks at the 19th International Seapower Symposium in 2009, navies worldwide are working mightily to enhance cooperation and interoperability on the global commons.[3]

When navies assemble as a global force for good, a bedrock prerequisite for the ability to work together is that the ships, submarines, aircraft, command centers and forces ashore have the ability to freely and seamlessly exchange data and information—often in vast quantities—and that their effectiveness is directly proportional to the ability to not only communicate, but to network, at sea and ashore. But increasingly, as nations and navies proceed along different technological development paths, the challenges to effective networking are greater today than they were years ago when navies used simpler—and common—communications and rudimentary networking means. Because of this, the ability to interoperate effectively is often challenged.

Nations and navies wishing to secure the global commons have a rich history of working together in maritime coalitions and communicating at sea and there are abundant lessons learned as to how they have dealt with this in the past that can inform how they deal with these challenges today – and in the future. Indeed, navies were the first forces to form coalitions and were the first to embrace the concept of networking, simply due to the fact that naval fleets dealt with wide areas in which relatively small forces were dispersed, while land forces were typically more concentrated.

There are core reasons why navies have been especially challenged to network effectively in this still-new century. While the will is there, and while these nations and navies are aligned through doctrine, operating practice, tactics, techniques and procedures to work and network together at sea, the technical means to realize the promise of "network-centric warfare"—what Norman Friedman has described as "picture-based warfare"—throughout coalitions remains elusive.[4] Achieving that promise means dealing with command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) challenges that currently impede this effective networking. Navies have overcome similar challenges in the past and understanding

[2] Admiral Michael Mullen, "A Global Network of Nations for a Free and Secure Maritime Commons" (keynote address, Seventeenth International Seapower Symposium, Newport, RI, September 19, 2005) accessed at: http://www.usnwc.edu/Publications/International-Sea-Power-Symposium-Proceedings.aspx.

[3] Admiral Gary Roughead, "Remarks at the 19th Biennial International Seapower Symposium" (speech, Nineteenth International Seapower Symposium, Newport, RI, October 07, 2009) accessed at: www.navy.mil/. Admiral Roughead speaks to the extraordinary turnout – 102 countries and 92 maritime leaders – who attended this event (up from 67 countries in 2005) as compelling evidence of the rapidly growing global embrace of the GMP. See, for example, Remarks of Chief of Naval Operations Gary Roughead during the Current Strategy Forum, Newport, Rhode Island, June 8, 2010, accessed at: www.navy.mil/.

[4] Norman Friedman, *Network-Centric Warfare* (Annapolis, MD: Naval Institute Press, 2009), p. 65. See also, Norman Friedman, "Netting and Navies: Achieving a Balance," paper presented at the Royal Australian Navy Sea Power Conference, Sydney, Australia, February 2006, p. 6.

where we have been can help today's naval coalition avoid becoming "victims of limited experience."[5]

Naval Coalitions Through the Ages

"We will be prepared to support and defend our freedom of navigation and access to the global commons. Our partners and allies are our greatest strategic asset."[6]

Admiral Michael Mullen
CJCS Guidance for 2011

Many think of coalition warfare as something new, an artifact of the 20th Century, when nations banded together to fight aggression and totalitarianism. But this is not the case, as coalition warfare goes back well over two millennia. As early as 700 BC there is evidence of the use of naval coalitions to enhance a nation's military power when the Assyrian king organized a coalition naval force to attack the Phoenician city of Tyre in 725 BC.[7] Centuries later, the Peloponnesian War pitted a coalition built around Sparta against one built around Athens in a duel for mastery of what was essentially the Western world at that time. Importantly, as Thucydides relates in *The History of the Peloponnesian War*, and as Victor Davis Hanson describes in *A War Like No Other,* much of this coalition warfare occurred at sea.[8]

Several centuries later, the battle of Actium in 31 BC was not only important in Western history as it solidified the Roman Empire, but it is a telling story of one of the problems that can befall a maritime coalition. At Actium, the outcome was decided in a naval skirmish that Antony had discounted and was ill-prepared to win given his larger ships and the unreliable reserve of Egyptian ships. His coalition at sea came apart as both parties failed in their commitment to the naval battle.[9] Sixteen hundred years later, in 1571, the Battle of Lepanto, the last battle between

[5] Vice Admiral Russ Shalders, RAN Chief of Navy, coined this phrase during his welcoming remarks at the 2007 King-Hall Naval History Conference when he said; "Naval history and its analysis is an important subject that helps alleviate the tyranny of limited experience. Only by studying history can we properly understand our own strengths and weaknesses and those of our friends and enemies." See Proceedings of the 2007 King Hall Naval History Conference, available at www.navy.gov.au/spc/.

[6] Admiral Michael Mullen, *Chairman Joint Chiefs of Staff Guidance for 2011*, available at: http://www.jcs.mil//content/files/2011-01/011011165132_CJCS_Annual_Guidance_2011.pdf. The CJCS Guidance is the annual publication of the priorities of the Chairman of the Joint Chiefs of Staff to guide the work of the Joint Staff.

[7] William Oliver Stevens and Allan Westcott, *A History of Sea Power* (New York: George H. Doran Company, 1920), p. 10.

[8] Thucydides, *History of the Peloponnesian War*, trans. Richard Crawley (New York: Barns & Noble Books, 2006) and Victor Davis Hanson, *A War Like No Other: How the Athenians and Spartans Fought the Peloponnesian War* (New York: Random House, 2005).

[9] Edward Kirk Rawson, *Twenty Famous Naval Battles* (New York: Thomas Y. Crowell & Company, 1909), p. 60. At Actium, the ruler of the Roman Empire was decided in a naval skirmish that Antony had discounted and was ill prepared to win given his larger ships and the reserve of Egyptian ships.

fleets of galleys, was also notable for the wide-ranging European coalition the Venetians cobbled together and for the massive numbers of galleys—over 500—involved in this pitched battle.[10]

The age of sail saw more fluid and, in many ways, more far-flung naval coalitions as sailing ships were able to cover vastly greater distances than their galley predecessors and as "trade followed the flag" and nations developed equities, literally, on the other side of the globe. Naval coalitions of the nineteenth Century were typified by the British-led alliances against Napoleonic France and the balancing of powers between the great empires of that era.[11]

As the age of sail gave way to the age of steam in the 19th and 20th centuries, naval coalitions morphed and changed based on the needs of the nations involved. In one example, the Boxer Uprising of 1900 saw the great powers of Europe, the US, and Japan join together to halt the Chinese attacks on foreigners and foreign properties. The height of the naval activity to protect Western assets in China during the Boxer Uprising was the capture of the forts at Dagu. The multinational naval coalition of British, Russian, French, German, Japanese, Austrian, and U.S. battleships and cruisers laid siege on the Chinese fortifications on the coast of Dagu and thus the seeds of the 1902 Anglo-Japanese alliance were sown in China in the summer of 1900.[12]

This Anglo-Japanese alliance, clearly an alliance of convenience for Britain, which was wary of Japanese influence in the Pacific, was instrumental in enabling the British to checkmate German expansion in the Pacific while simultaneously leading a naval coalition in the Atlantic to defeat Germany in Europe.[13] Naval coalitions proved to be instrumental in saving Paris from the German army during World War I when British and French coastal patrols kept English Channel free of enemy ships and submarines. The ceaseless watch of the coalition naval patrols allowed five divisions of the British Expeditionary Force to cross to France and mounted a successful campaign against the Germans at the First Battle of the Marne.[14]

World War II is perhaps the most classic example of coalition warfare, with the naval experience in the Pacific theater in the opening years of World War II providing a compelling example of navies banding together to improve their odds in battle. One aspect of that naval coalition

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[10] Stevens and Westcott, *A History of Sea Power*, pp. 78-86.

[11] E.B. Potter and Chester W. Nimitz, eds., *Sea Power: A Naval History* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1960), pp. 182-186. For example, the First through the Fourth Coalitions were formed by the Royal Navy with allies from Spain, Russia, Prussia, Sweden, and Austria to counter Napoleon. Potter notes that it was through the British's control of the sea and maritime alliances that stopped Napoleon's march across Europe.

[12] T.G. Otte, "'Dash to Peking:' The International Naval Coalition during the Boxer Uprising in 1900," in *Naval Coalition Warfare: From the Napoleonic War to Operation Iraqi Freedom*, ed. BA Elleman and SCM Paine (New York: Routledge, 2008), pp. 94-95.

[13] Timothy D. Saxon, "Anglo-Japanese Naval Cooperation, 1941-1981," *Naval War College Review* 53 (Winter 2000), p. 65. Saxon noted that the Anglo-Japanese naval cooperation during World War I boosted not only the British effort to control the Mediterranean but was also instrumental in keeping British territories in the Pacific safe from the Germans. See also Naoko Sajima and Kyoichi Tachikawa, *Japanese Sea Power: A Maritime Nation's Struggle for Identity* (Canberra, Australia: Sea Power Centre, 2009), p. 38.

[14] Potter and Nimitz, *Sea Power*, p. 400. The naval coalition that stood watch over the English Channel proved to be successful as the Germans were unable to break it during the duration of the war.

warfare that perhaps presaged today's naval coalitions was the American, British, Dutch and Australian joint force that formed to counter Japan as it conducted its sweep down Asia while the core of the Allied forces were focused on the European front. Known as the ABDACOM, the joint command was established in 1942 to provide a defense of allied territories in the Pacific.[15] The ABDACOM naval component (ABDAFLOAT)[16] comprised of the U.S. Asiatic Fleet along with ships from Britain and the Dutch navy.

The objective of the ABDAFLOAT was to protect the Dutch East Indies and Australia from the Japanese. However, the coalition was faced with competing national interests and limited resources, as air support was sparse and the sheer size of the Pacific greatly stretched allied capabilities. Admiral Thomas C. Hart, commander of the naval element of the ABDAFLOAT had to deal with the conflicting priorities of coalition partners, as the Royal Navy was focused primarily on saving its imperial crown jewel, Singapore.[17] The ABDACOM experience had lasting impact well after the end of the war as it inspired the development of NATO's Standing Naval Force, Atlantic, after 1968.[18]

Although the Cold War conflict was predominantly a political and military contest between the United States and the Soviet Union, it was very much a test of wills between two international coalitions and much of that test of wills played out in the maritime domain. As Bradford Lee of the U.S. Naval War College notes; "The Cold War was a peculiar type of coalition struggle involving naval powers." Lee adds that the staying power of the Western-U.S. led alliance was built on the alliance's naval superiority.[19]

The earliest naval conflict of the Cold War era provides an example of Lee's argument that the maritime coalition of the US and allies were able to maintain sea control in one of the "hot" conflicts of the time. The Korean conflict is perhaps best-known for the brutal land battles in the freezing mountain passes of the Korean peninsula. However, the ability of US and coalition navies to control the waters around Korea made it possible for the troops on the ground to win back ground south of the 48th parallel. The initial invasion of the Korean peninsula by communist troops had overwhelmed the poorly distributed forces of the Republic of Korea (ROK) and Seoul soon fell to the Communists.[20] The small ROK navy was also unable to stop enemy ships from resupplying troops on shore.

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[15] James D. Hornfischer, *Ship of Ghosts: The Story of the USS* Houston*, FDR's Legendary Lost Cruiser, and the Epic Saga of Her Survivors* (New York: Bantam Book, 2006), p. 34.

[16] *The Oxford Companion to World War II Online*, s.v. "ABDA Command," accessed May 23, 2010, http://www.encyclopedia.com/doc/1O129-ABDACommand.html.

[17] Hornfischer, *Ship of Ghosts*, p. 34.

[18] John B. Hattendorf, "Foreword," in *Naval Coalition Warfare: From the Napoleonic War to Operation Iraqi Freedom*, ed. Bruce A. Elleman and S.C.M. Paine (New York: Routledge, 2008), p. xvii.

[19] Bradford A. Lee, "The Cold War as a Coalition Struggle," in *Naval Coalition Warfare: From the Napoleonic War to Operation Iraqi Freedom*, ed. Bruce A. Elleman and S.C.M. Paine (New York: Routledge, 2008), p. 146.

[20] Naval Historical Center, "History of the United States Naval Operations: Korea," Washington, DC: Department of the Navy, accessed October 02, 2010, http://www.history.navy.mil/books/field/ch3c.html.

The arrival of the US Seventh Fleet and naval vessels from the U.K., Australia, New Zealand, Canada, Cambodia, France, Netherlands, and Thailand, helped to ensure that the Communist forces could not be reinforced by sea.[21] The presence of Seventh Fleet also kept China and the Soviet Union from expanding the conflict to Taiwan.[22] In addition to providing air support and shore bombardment the coalition naval force denied the enemy use of the sea to transport troops and supplies. Control of the sea also allowed the U.N. command to stage amphibious landings in the rear of the communist armies fighting along the 38th parallel.[23]

While the Korean conflict showed the power of the emerging Western alliance, it also served to prompt the Truman administration to support the development of the North Atlantic Treaty Organization (NATO). During the Cold War, much of the focus of NATO and the Western alliance were on checking the Soviet encroachment across Europe and building a credible nuclear and conventional deterrent. A key to NATO's strength against the Warsaw Pact was the naval superiority of the West. The Cold War strategy of containment, in particular, also depended heavily on naval superiority to project power across vast seas and made association with the U.S. all the more attractive to its allies in Europe and Asia.[24] Vietnam, while remembered primarily for other reasons, was a conflict that involved the allies cobbling together a naval coalition led by the U.S. Seventh Fleet.[25]

Operation Desert Storm presented the first major post-Cold War test of the ability of military forces in general—and naval forces in particular—to operate in concert with large numbers of coalition partners. As the world's militaries and navies assimilated the lessons of Desert Storm, there was increasing recognition within military circles that the command, control, and reconnaissance systems that undergirded the entire coalition war effort were, on the one hand, the most important key to victory, while on the other, the systems that needed to become more adaptable to link partner militaries and navies.[26]

Concurrently, the world's major maritime powers also began to realize that Desert Storm was likely the last force-on-force war they would see for some time and that the world was rapidly becoming a place where "brush-fire wars," would require agile coalitions of nations operating in virtual pick-up games to deal with emergent crises.[27] Naval coalitions today tend to be

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[21] Edward J. Marolda, "The Cold War's First Conflict," US Naval Institute, accessed on October 02, 2010 at: www.usni.org/magazines/navalhistory/2010-06/cold-wars-first-conflict.

[22] Potter and Nimitz, *Sea Power*, p. 859.

[23] Marolda, "The Cold War's First Conflict."

[24] Lee, "The Cold War," p.146.

[25] Norman Friedman, "Wide Open Space: Navies Exploit Satellite Revolution," *Jane's Navy International*, vol. 105, no. 3, 2000.

[26] Max Boot, *War Made New: Technology, Warfare, and the Course of History 1500 to Today* (New York: Gotham Books, New York, 2006), pp. 318-351. See also, Bruce Berkowitz, *The New Face of War: How War Will be Fought in the 21st Century*, (New York: The Free Press, 2003) for a revealing look at the evolution of "information-based warfare" and the challenges of networking with other militaries.

[27] See Boot, *War Made New*, pp. 318-351.

heterogeneous in the types of navies represented while the types of operations of naval coalitions have also expanded to include disaster relief and humanitarian missions. The importance of the ability to communicate with coalition partners transcends warfare and impacts coalition naval partners in literally every endeavor. This was dramatically demonstrated in December 2004 and early 2005 during the tsunami relief efforts in the Western Pacific where 18 nations worked together, primarily on and from the sea, to deliver relief supplies from naval vessels.[28]

Naval Communications: From the Flame to the Net

"Most think that bigger, faster, and more is best when talking about providing technology to naval forces. But this is not always the case. What matters is not how *much* you communicate, but rather getting the right information to the right people at the right time."[29]

Professor Nicholas Rodger
Exeter University
Keynote Address
2007 King Hall Naval History Conference

Naval communications have evolved over several millennia from the time when signal fires were used onboard Greek triremes, to the development of network-centric warfare. This latter development sometimes thought of as an artifact of the 21st Century, has antecedents at least a century old.

The term communications, as it relates to maritime affairs, has two meanings. The first meaning refers to the sea lanes that encircle the globe. Communications in this regard refers to the means of the movement of commercial goods and services along with military supplies and troops via sea lanes. The second meaning of communications at sea refers to what Webster's Dictionary defines as "a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior."[30] This meaning of communications with a small "c" is what this paper will address—the continuing evolution of how maritime forces exchange information at sea.

The key part of our definition of communications is "information exchange"—the ability to exchange information between members of one nation's naval force or across a maritime coalition.[31] In the arena of naval warfare, communications is needed to maintain dominant battle space awareness—to know where your enemies are and where your own forces are arrayed. Out of this knowledge comes the ability to plan and strategize to defeat the enemy. As

[28] Bruce A. Elleman, *Waves of Hope: The US Navy's Response to the Tsunami in Northern Indonesia*, Newport Paper 28, (Newport, RI: Naval War College Press, February 2007).

[29] *Proceedings of the 2007 King Hall Naval History Conference*, accessed at: www.navy.gov.au/spc/.

[30] *Webster's Ninth New Collegiate Dictionary*, 9th ed., s.v. "communication."

[31] Naval force, here, refers to communications within a single navy while a maritime coalition refers to communications between ships of many nations working together.

the Duke of Wellington aptly noted; "All the business of war, and indeed all the business of life, is to endeavor to find out what you don't know by what you do; that's what I call guessing what's on the other side of the hill."[32]

Since the beginning of time, commanders have tried to guess "what is on the other side of the hill" and as part of that effort, have developed means of communication to build that common tactical picture of the battlefield. And naval commanders, without the ability to see other ships in their often far-flung forces and without the ability to dispatch runners to assess the situation or deliver orders to other parts of their armies, led the efforts to push communications technologies to the edge.[33]

One of the earliest accounts of communications at sea can be found in the histories of the Greco-Persian War (499 BC – 449 BC).[34] Naval communications at this time were characterized by rudimentary forms of communications from shouts of command from ship-to-ship to the lighting of signal fires on board to signal the start of action.[35] Communications between Greek ships were usually limited to signaling the start of the attack by the sound of a trumpet or by a shouted command. Naval communications in the age of galley warfare was rudimentary as tactics were basic and did not require complex coordination.[36] The Greek playwright Aeschylus recounts the activities during the battle of Salamis, "[a]nd the trumpet, with its clang inflamed their whole line; and forth – with at the blow of the dashing oar, at the word of command they smote the roaring brine."[37]

Sailing ships made it possible to expand the area of operations from coastal waters to the open sea and thus led to the development of more complex means of naval communications. The invention of the telescope and binoculars in the early 1600's also facilitated the ability of ships to

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[32] Duke of Wellington, cited in Louis J. Jennings, ed., *The Correspondence and Diaries of the Late Right Honourable John Wilson Croker, Secretary to the Admiralty from 1809 to 1830* (London: John Murray, Albemarle Street, 1885), p. 276.

[33] See Boot, *War Made New*, pp. 318-351, Berkowitz, *The New Face of War*, and Martin Van Creveld, *Technology and War: From 2000 B.C. to the Present* (New York: The Free Press, 1991), pp. 199-216.

[34] This is the earliest time period where historians have adequate historical records. As Arthur Shepard noted in *Sea Power in Ancient History*, "…[f]leets of war had existed, fair-sized naval battles had been fought, long before that date; but the records of these are so scanty, the details so sparse, that a chronological narrative would perforce be little more than a catalogue of dates and events." (Arthur M. Shepard, *Sea Power in Ancient History* (Boston, MA: Little, Brown, and Company, 1924), p. 40. Shepard's observations still apply years later but research in ancient Western and non-Western naval warfare is now on the rise. For example see Dr. Gregory P. Gilbert, *Ancient Egyptian Sea Power and the Origin of Naval Forces* (Canberra, Australia: Seapower Centre, 2008).

[35] Linwood S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington, DC: Bureau of Ships and Office of Naval History, 1963), p. 3.

[36] HP Willmott, *Sea Warfare: Weapons, Tactics and Strategy* (Strettington, England: Antony Bird Publication, 1981), p. 17.

[37] Taken from Aeschylus' account of Salamis in his play "The Persians." Quoted in William L. Rodgers, *Greek and Roman Naval Warfare: A Study of Strategy, Tactics, and Ship Design from Salamis (480 B.C.) to Actium (31 B.C.)* (Annapolis, MD: United States Naval Institute, 1964), p. 106.

communicate with each other at greater distances.[38] The primary means of communications were signal flags that were used to convey simple instructions and warnings to the fleet.[39] In addition to signal flags, cannon fire, lanterns, and messages sent by small boats between ships were also used to communicate commands or information.[40] Commands were conveyed by a series of flags or a single flag in accordance to a common signal book.

In perhaps one of most well-known and often-cited examples of the state of the art of naval communications in the days of sail was the use of signaling flags during the Battle of Trafalgar. Admiral Horatio Nelson took great advantage of the flag signaling techniques to obtain a tactical picture of the French and Spanish fleet harbored at Cádiz. In the days leading up to the Battle of Trafalgar (1805), Nelson had positioned his fleet out of sight of the coast of Cádiz in order to trick the combined fleet of French and Spanish ships to leave port for open water. At 80 kilometers away, Nelson was unable to keep the enemy fleet in sight. To compensate for this he established an information relay system of frigates that would pass back information on the movements of the enemy fleet. The method of communications was a combination of flag signals based on Rear Admiral Popham's numerical flag system and night signaling—usually a series of lanterns set at agreed-to patterns. The relay system allowed Nelson to obtain a better picture of the French and Spanish fleet than they had of the British fleet.[41]

The Industrial Revolution ended the domination of the sailing ship as it brought about the application of the steam engine, the iron hull, and electronic communications to naval warfare.[42] These advancements in naval technology allowed ships to conduct more complex maneuvers and allowed them to travel faster than ships at the mercy of the wind.[43] But perhaps the most

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[38] Howeth, *History of Communications-Electronics in the United States Navy,* p. 4.

[39] Signal flags of the time of the Age of Sail were composed of different colours and geometric designs along with numeric characters that conformed to a standard set of words or instructions that were provided to ship commanders in book form – for example publications like the *Sailing and Fighting Instructions for His Majesty's Fleet* were issued to the fleet of the Royal Navy to inform commanders ships were to be controlled and arranged in battle. For further reading of signals, fighting instructions and naval tactics in the Age of Sail see WP Hughes, Jr., *Fleet Tactics: Theory and Practice* (Annapolis, MD: Naval Institute Press, 1986) and Michael A. Palmer, *Command at Sea: Naval Command and Control Since the Sixteenth Century* (Cambridge, MA: Harvard University Press, 2005).

[40] Brian Tunstall, *Naval Warfare in the Age of Sail: The Evolution of Fighting Tactics 1650-1815* (London: Conway Maritime Press Limited, 1990), pp. 8-9.

[41] In the days leading up to the Battle of Trafalgar (1805), Nelson had positioned his fleet out of sight of the coast of Cádiz in order to trick the combined fleet of French and Spanish ships to leave port for open water. At 80 kilometres away, Nelson was unable to keep the enemy fleet in sight. To compensate for this he established an information relay system of frigates that would pass back information on the movements of the enemy fleet. The method of communications was a combination of flag signals based on Rear Admiral Popham's numerical flag system and night signaling – usually a series of lanterns set at agreed-to patterns. The relay system allowed Nelson to obtain a better picture of the French and Spanish fleet than they had of the British fleet. The combined fleet under the command of Vice-Admiral Villeneuve was not able to keep similar tabs on the British as they did not have scout ships deployed due to the earlier British blockade; they could only see to the horizon from their position in the Cadiz harbor. See, for example, Tunstall, *Naval Warfare in the Age of Sail,* pp. 8-9, and Roy Adkins, "Trafalgar: A Signal Victory," *Geographical* 77, no. 10, 2005, p. 59, about Nelson's strategy.

[42] Willmott, *Sea Warfare,* p. 27 and also Potter and Nimitz, *Sea Power,* p. 109.

[43] Sea Power Centre – Australia, "Visual Signalling in the Royal Australian Navy," *Semaphore* 8, 2006.

important contribution of electricity to naval warfare was the increase in the speed and quality of communications. Naval communications between ship and shore and between ships before the electric telegraph typically took weeks or months.[44]

The introduction of the telegraph, promised instantaneous communications across vast distances. No longer would messages take months to traverse continents as telegraph cables and networks made it possible for messages to be relayed in days. The Royal Navy found the telegraph to be an important tool in communicating with its global fleet, but that ease and speed of communications came with a price. During times of tension, fleet commanders were often found on their command ship docked at port in order to have access to telegraph messages rather than out at sea with their ships.

But the telegraph, a breakthrough technology that all assumed would "cure" a universe of communications ills, had another downside. Prior to the invention of the telegraph, expatriates at the far end of the British Empire received the news regarding events transpiring in the British Isles via bundles of newspapers that were delivered via sailing vessel. This typically took anywhere from four to six weeks but when the news arrived it was robust, detailed, and provided the reader with virtually all they could want to know about these events—absent being there in person.

The Victorians eagerly embraced the telegraph as something that was "faster and better" than waiting for newspapers to arrive via ship and something that would provide them the news of the home islands instantly and without the weeks-long time delay. However, this new technology had a downside: telegraph transmissions were expensive so those putting together telegraph messages placed a premium on brevity and news was truncated to the bare essentials. Additionally, transmissions were sent from one way-station to the next where one operator had to manually key in what he or she had just received, a process that was fraught with error—and was doubly chancy since not all operators at these way-stations spoke English. The net result was that when the news finally arrived it was truncated, error-prone and often bore little resemblance to the initial information that was transmitted.[45]

The speed-up of communications due to the electronic telegraph allowed naval commanders to keep better track of their forces and ongoing events around the world.[46] In 1904, Britain's First Sea Lord, Admiral John Fisher, took advantage of the new technology and developed what

[44] For example, the United States Navy's Pacific Squadron had to communicate with the Navy Department in Washington by dispatch vessel sailing round Cape Horn. Consequently in 1846 they did not know of an outbreak of war with Mexico until an officer travelling overland managed to get a message through privately. See, Arthur Hezlet, *Electronics and Sea Power* (New York: Stein and Day, 1975), p. 3.

[45] NAM Rodger, author's personal notes taken at the Royal Australian Navy King-Hall Naval History Conference, Sydney/Canberra, Australia , 24 and 26-27 July 2007.

[46] Howeth wrote of the U.S. Navy's experience with the electric telegraph: "By 1890 commercial telegraphic or cable facilities were available in practically every port frequented by the Navy. These facilities provided rapid communication between the Navy Department and the commanders of squadrons, when in port. This permitted the Navy Department to keep its commanders advised of the political situation, but lessened the amount of discretion allowed them." Howeth, *History of Communications-Electronics*, pp. 10-11.

Norman Friedman calls “picture-based warfare.”[47] Admiral Fisher established war rooms to build a tactical picture of where French raiding ships were attacking British merchant ships. The information from these sources was fed into two different war rooms—the first war room tracked ship movements around the world, while the second war room tracked ship movements in the North Sea. Armed with this picture-based view of the world, Admiral Fisher was able to direct British battlecruisers to the spots where British ships were being attacked by French raiders.[48]

Future British commanders built on Admiral Fisher’s successful harnessing of communications technologies to construct a global tactical picture and it served them well in the years leading up to World War I. In the time period between Admiral Fisher’s war rooms and World War I, radio technology had matured and was slowly being adopted in Britain as well as in the United States and other countries.

The introduction of the radio revolutionized naval communications. The first radios used for naval communications used high frequency (HF) waves that provided good quality voice transmission but required very large antennas and the transmissions were easily detected by the enemy.[49] The Battle of Jutland serves as the earliest example of the revolutionary nature of radio communications in naval warfare as it allowed some commanders on shore and at sea to obtain a timely tactical picture when each were separated from each other by great distances.[50]

The success of the use of radio to provide fleet commanders with a timely tactical picture during World War I helped push forward the development of more compact and reliable radio equipment. HF radio remained an important part of the naval communications tool kit as it did very well in long range communications due to its ability to broadcast over the horizon. However, due to the newness of this technology, naval commanders demanded back-up means of communication, and semaphore and homing pigeons were also used during the early 1900s as a back up in the event of radio failures.[51]

But wireless had a huge disadvantage, another unintended consequence of new technology. While this wireless technology helped commanders reach far-flung units and communicate in real time, enemy units could also copy these same transmissions and thus gain the tactical

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[47] Norman Friedman, “Netting and Navies: Achieving a Balance,” paper presented at the Royal Australian Navy Sea Power Conference, Sydney, Australia, February 2006, p. 6.

[48] Friedman, “Netting and Navies,” p. 6.

[49] See M Witt, “Of Signal Significance,” *Asian Defence Journal*, December 1997, pp. 34-40.

[50] Norman Friedman, “Netting and Navies,” p. 7. See also Hezlet, *Electronics and Sea Power* for a more detailed description of the role of the British Naval Intelligence Department’s Room 40 in detecting the German radio signals.

[51] Great care was taken to ensure the health and well being of these important birds. In 1918, the Office of Naval Operations published the *Instructions on Reception, Care and Training of Homing Pigeons in Newly Installed Lofts at U.S. Navy Air Bases* to spell out the proper care and feeding of all Navy homing pigeons. An electronic version of the document can be found at the Navy Department’s library website: http://www.history.navy.mil/library/special/homing_pigeons.html.

advantage over the forces communicating via this wireless technology. History is replete with examples of navies and other forces suffering defeat because the enemy intercepted wireless communications. But clearly, none of this downside was anticipated when the new technology was initially developed and placed on naval units. The Germans learned of the insecurity of HF transmissions during the Battle of Jutland 1916. The British were able to use the information their radio intelligence teams were getting from intercepting German radio signals to steer their fleet to intercept the German High Sea fleet in the North Sea.[52]

By the time of World War II, radio technology had incorporated the use of Very High Frequency (VHF) and Ultra High Frequency (UHF) that allowed for better quality of the transmission of information between ships and between ships and airplanes. The advantage of VHF and UHF signals were that both required smaller antennas and could carry more data that allowed for clear voice conversations and text messages. The disadvantages of the VHF and UHF signals were that their effective range is short—mostly limited to line-of-sight communications—and susceptible to atmospheric disturbances.

Radio remained the chief means of communications through the early part of the Cold War period from the Korean War to the Vietnam War. Ultimately, satellite transmissions became the primary form of naval communications allowing for high tempo maneuvers at sea and real time coordination between the commanders on shore and at sea. The development of tactical data links allowed the almost instantaneous sharing of sensor data between ships and aircraft, allowed commanders a common view of force sensors and the ability to rapidly coordinate operations. Tactical data links and computerization proved to be invaluable assets to the US Navy during operations in the waters and airspace of North Vietnam. Naval Tactical Data Systems (NTDS) along with ultrahigh frequency radio systems made it possible for the US Navy to network their ships and aircraft with each other and with the U.S. Air Force. This early "netting" of assets allowed the U.S. fleet to obtain an operational picture deep into North Vietnam to counter the North Vietnamese MiG threat.[53]

It was in this environment of balancing the U.S. military's increased engagement in "operations other than war" (OOTW) and decreasing force structure that military leaders and strategists examined the promise of information communication technologies and netting as a means to do more with less. In a 1993 Army Strategic Studies Institute publication, General Gordon Sullivan, US Army Chief of Staff from 1991-1995, and his co-author Lieutenant Colonel Dusik argued that:

> Integrative technologies will enhance the ability of commanders and their units to fight with scarce assets. The complete use of integrative technologies will revolutionize command and staff procedures. Software will allow much of the information now transmitted by radio and synchronized on acetate and charts to be self-synchronized automatically, computer-to-computer. Smart command and

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[52] Friedman, "Netting and Navies," p. 7.

[53] Norman Friedman, *Network-Centric Warfare: How Navies Learned to Fight Smarter through Three World Wars* (Annapolis: MD, Naval Institute Press, 2009), p.124.

> control systems will create a common perception of the battlefield and the theater among members of a joint task force.[54]

Throughout the 1990s and into the 21st century, other initiatives, from National Defense University's Dominant Battlespace Concept, to Admiral William Owens' "system of systems" concept, to military transformation and the so-called revolution in military affairs (RMA), to the concept of Network-Centric Warfare popularized by Vice Admiral Arthur Cebrowski and John Garstka, all focused on using communications to give U.S. forces and their coalition partners the ability to better "guess what is on the other side of the hill," and in so doing, secure the tactical, operational and strategic advantage. But what these reformers—and others like them—were *really* talking about was moving beyond merely communicating between and among units to *networking* forces and forming them into a single fighting entity.

Communications Evolves to "Networking" for Modern Navies

"When John Fisher became First Sea Lord in 1904, his main pledge was to solve this intractable problem…Fisher in effect invented picture-based warfare. He created a pair of war rooms in the Admiralty, one built around a world (trade) map, the other around a North Sea map."[55]

Dr. Norman Friedman
"Netting and Navies: Achieving a Balance"
Sea Power: Challenges Old and New

In the latter part of the 20th Century, the U.S. Navy, reflecting its traditional style of operations which entailed the continuous forward deployment of a distributed force far from U.S. territory or supporting infrastructure, developed the concept of networking to ensure timely and reliable communications links to ensure the most effective employment of scattered forces. As early as 1975, the U.S. Navy was experimenting with the Tactical Data Information Exchange System (TADIXS), which was the progenitor of the tactical data systems such as Link 11 shared by many navies today.

Armed with increasing reliable tactical data links, global navies began to recognize the potential of this ability to link ships at vast distances to revolutionize naval warfare. As Loren Thompson points out in *Networking the Navy: A Model for Modern Warfare*, many of the concepts driving the networking of military forces today began to evolve two decades ago:

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[54] General Gordon R. Sullivan and Lieutenant Colonel James M. Dubik, *Land Warfare in the 21st Century* (Carlisle Barracks, PA: Strategic Studies Institute, 1993), p. xx.

[55] Norman Friedman, "Netting and Navies, Achieving a Balance," in *Sea Power: Challenges Old and New* (Sydney, Australia: Halstead Press, 2007), pp. 185-186. This publication provides the proceedings of the 2006 Royal Australian Navy Sea Power Conference. Dr. Friedman is an internationally-recognized expert on naval matters who speaks frequently at international symposia on network-centric operations. As Dr. Friedman points out, Admiral Fisher used the information gleaned from shipping reports and reports from his own fleets to build a tactical picture of where pirates were attacking British merchant ships. Information from these sources was fed into two different war rooms—the first war room tracked ship movements around the world while the second war room tracked ship movements in the North Sea. Armed with this "picture-based" view of the world, Admiral Fisher was able to direct warships to the spots where British ships were being attacked by pirates. See also, Friedman, *Network-Centric Warfare*.

> In 1990, long before network-centric warfare became a central feature of joint doctrine, the Navy established a program called "Copernicus" to assimilate emerging information technologies…The admirals managing Copernicus understood that information technologies had the potential to revolutionize naval operations. The Navy adopted the phrase "network-centric warfare" to describe this nascent warfighting paradigm, because it stressed integration and communications over autonomy in conducting naval operations.[56]

Over time, Copernicus evolved into what the U.S. Navy called "IT-21." As pointed out by Admiral Archie Clemins, then-commander of the U.S. Pacific Fleet, in an article in *CHIPS* magazine in 1997; "IT-21 was a reprioritization of existing C4I programs of record focused on accelerating the transition of a PC-based tactical and support warfighting network…The goal of IT-21 was to link all U.S. forces and eventually even our allies together in a network that enables voices, video and data transmissions from a single desktop PC."[57]

The following year, in what many consider a seminal article, "Network-Centric Warfare: It's Origin and Future," describing the potential of network-centric concepts to alter the nature of warfare itself, moving decisively from platform-centric warfare to network-centric warfare, Vice Admiral Arthur Cebrowski and John Garstka built upon Copernicus and IT-21 to envision warfighting in the 21st Century. Though published well over a decade ago, their vision of network-centric warfare proved remarkably prescient:

> Network-Centric Warfare derives its power from the strong networking of a well-informed but geographically dispersed force. The enabling elements are a high-performance information grid, access to all appropriate information sources, weapons reach and maneuver with precision and speed of response, value-adding command and control (C2) processes—to include high-speed automated assignment of resources to need—and integrated sensor grids closely coupled in time to shooters and C2 processes. Network-centric warfare is applicable to all levels of warfare and contributes to the coalescence of strategy, operations, and tactics. It is transparent to mission, force size and composition, and geography.[58]

Theory met reality in the early part of the 21st Century, when the United States, in response to the terrorist attacks of September 11, 2001, launched Operation Enduring Freedom (OEF) to attack terrorist strongholds in Afghanistan. This vindicated what the proponents of network-centric warfare had been advocating all along. As Chief of Naval Operations Admiral Vern Clark pointed out regarding the U.S. Navy's experience in OEF; "Eighty percent of the Navy strike

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[56] Loren Thompson, *Networking the Navy: A Model for Modern Warfare* (Arlington, VA: Lexington Institute, 2003), pp. 3-4. At the core of Copernicus were four overriding goals: to provide a common tactical picture to all members of the naval force; to comprehensively connect them in a web of instantaneous voice and data links; to compress the steps involved in moving information from sensors to shooters; and to conduct information operations that would degrade enemy warfighting capabilities.

[57] Admiral Archie Clemins, "IT-21: The path to information superiority," *CHIPS*, July 1997, pp. 4-7.

[58] Arthur K. Cebrowski and John J. Garstka, "Network Centric Warfare: Its Origin and Future," U.S. Naval Institute *Proceedings* (January 1998), pp. 29-35.

sorties attacked targets that were unknown to the aircrews when they left the carriers. They relied upon networked sensors and joint communications to swiftly respond to targets of opportunity."[59]

Admiral Clark evolved a vision for the U.S. Navy called *Sea Power 21: Operational Concepts for a New Era*.[60] While some critics described three of the pillars of Sea Power 21; Sea Strike, Sea Shield, and Sea Basing, as "old wine in new bottles," he introduced a new term, FORCEnet, which he described as "an initiative to tie together naval, joint and national information grids to achieve unprecedented situational awareness and knowledge management."[61] While new to some, FORCEnet was clearly the next step in the evolution of the Navy's networking capabilities.

Loren Thompson points out that; "Forcenet was the greatest system-integration challenge ever proposed in the history of warfare."[62] Regardless of whether this is true or not, the U.S. Navy is making an enormous capital investment in FORCEnet and a wide array of programs that instantiate this warfighting concept.[63] This enormous U.S. Navy investment in FORCEnet provides navies united in global or regional maritime partnerships with a ready-made infrastructure to leverage to support their networking efforts.

As C4ISR technologies have advanced over the past several decades, they have dramatically enhanced the ability of navies to not only communicate, but to "network" vast amounts of data and information at increasingly speed, often over vast distances. This ability to network has ushered in heretofore-unknown capabilities and has enabled navies to push the edge of the information envelope and evolve the art of the possible at sea. It is not an overstatement to say that C4ISR systems have become the *sine qua non* of success for most modern navies. And navies have found, conclusively, that their effectiveness is directly proportional to their ability to

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[59] Thompson, *Networking the Navy: A Model for Modern Warfare*, p. 6.

[60] See Admiral Vernon E. Clark, "Sea Power 21: projecting decisive joint capabilities," U.S. Naval Institute *Proceedings* (October 2002), available at www.navy.mil/navydata/cno/proceedings.html.

[61] See, Vice Admiral Richard W. Mayo and Vice Admiral John Nathman, "ForceNet: Turning information into power," U.S. Naval Institute *Proceedings* (February 2003), pp. 42-46.

[62] Thompson, *Networking the Navy: A Model for Modern Warfare*, p. 6. See also Loren Thompson, *Netting the Navy* (Arlington, VA: Lexington Institute, 2008), pp. 1-7 for a more contemporary look at the same subject. Also, it should be noted that the word "Forcenet" is spelled differently in different resources in the expansive literature on the subject. Generally, in U.S. Navy parlance, it is spelled FORCEnet. This is because, then-CNO Admiral Vern Clark wanted to emphasize that this was something that supported "the FORCE" (meaning naval forces).

[63] Until 2010, the U.S. Navy Program Guide, the yearly overview of the systems, programs and initiatives the U.S. Navy is pursuing to deliver a future navy, was organized around the four Sea Power 21 "pillars" of Sea Strike, Sea Shield, Sea Basing and FORCEnet. Grouped under FORCEnet were all the U.S. Navy's C4ISR systems that supported network-centric warfare. And while the Navy *Program Guide 2010* (Washington, DC: U.S. Navy, 2001), accessed at: www.navy.mil/navydfata/policy/seapower/spne10/top-spne10.html, did not carry forward this Sea Power 21 taxonomy of grouping USN programs, the C4ISR section of the *Program Guide* featured all of the USN programs supporting network-centric warfare, from CANES (Common Afloat Network Enterprise System), to JTIDS (Joint Tactical Information Distribution System), to CENTRIXS-M (Combined Enterprise Regional Information Exchange System Maritime) to literally dozens of others.

not only communicate, but to network, both at sea and ashore. Because of this, every modern navy has sought to install C4ISR networking technologies—often as rapidly as they can afford them—in order to gain that technological edge at sea.

In the concluding chapter of *Network-Centric Warfare: How Navies Learned to Fight Smarter Through Three World Wars*, Norman Friedman draws a direct path to the pioneering work of Admiral John Fisher and the notion of using centralized command and control systems in the maritime regime to make up for a lack of ships and sums up the advantages that accrue to a robustly-networked force this way:

> Creating effective tactical pictures makes systems work, and it supports a new kind of warfare. The better the picture, the more efficient the operation…Picture-centric approaches are attractive because they justify reducing the numbers of ships or airplanes or troops or weapons…Overall, networking can make individual units more lethal if they are equipped to take advantage of it… [and] by widely distributing the tactical picture networking can give individual lower-level commanders more autonomy and can thus make for more flexible and effective—and rapid—operations.[64]

Drawing on real-world results from the U.S-led coalition conflicts in Kosovo, Afghanistan, and Iraq, the GAO summed up the results of these conflicts by noting:

> Network-centric operating concepts have improved battlefield situation awareness for commanders and their forces. DoD has indicated that technological improvements in information-gathering systems allow commanders and unprecedented view of the battlefield. Such improvements provide for greater shared situational awareness, which, in turn, speeds command and control…Improvements in networking the force and the use of precision weapons are the primary reasons for the overwhelming combat power demonstrated in recent operations.[65]

C4ISR advances not only benefit so-called "high-end" navies, but any navy investing in naval C4ISR technologies can gain a tactical edge. As pointed out by Dr. Paul Mitchell in the Spring 2003 *U.S. Naval War College Review*:

> Network-centric warfare aims at increasing the efficiency of the transfer of maritime information among participating units (or nodes). By optimizing the efficiency of operations through information exchange, often-small naval formations can generate additional combat power. Data is manipulated by a series of dynamic and interlinked "grids:" sensor grids that gather the data;

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[64] Friedman, *Network-Centric Warfare*, pp. 240-242.

[65] General Accounting Office, *Military Operations: Recent Campaigns Benefitted from Improved Communications and Technology but Barriers to Continued Progress Remain* (Washington, D.C.: GAO, 2004), p.10.

> information grids that fuse and process it and engagement grids manage the operations generated.[66]

As mentioned earlier, these new C4ISR technologies have had a dramatic impact on the ability of many navies to network with their own ships, submarines, craft, aircraft and command centers. This has led to a situation where various naval components can exchange vast amounts of information *within* each navy. As they have done this, these navies have found that they become more effective across the spectrum of conflict, from peacemaking, to counter-insurgency, to major conflicts.

However, this rush to install the latest cutting-edge technology in each navy has had just the *opposite* effect on the ability of navies to network effectively between and among the ships, submarines, craft, aircraft and command centers of *other* navies. And because of this inexorable trend, naval cooperation with other navies is increasingly under stress. This challenge is exacerbated as nations and navies proceed along different technological development paths, as the challenges to effective networking are greater today than they were years ago when navies used simpler—and common—communications and rudimentary networking means.

Networking the Global Maritime Partnership: How Big a Challenge?

"In today's world, nothing significant can get done outside of a coalition context, but we have been *humbled* by the challenges of devising effective coalition communications."[67]

Dr. David Alberts
Opening remarks at the 7th Annual International Command and Control Research and Technology Symposium
September 2002

The experience of the Canadian Navy in multiple deployments with U.S. Navy carrier strike groups offers one example of the challenges that exist and persist just among two modern, technologically advanced, navies, let alone between and among multiple navies at various levels of technological maturity. Based on this documented experience—as well as other compelling data—it is becoming increasingly apparent that the very technology that has helped each navy communicate between and among forces *within* that navy, has *impeded* effective communications with forces of other navies. Dr. Mitchell, then-Director of Academics at Canadian Forces College, put this dilemma in stark terms:

> Is there a place for small navies in network-centric warfare? Will they be able to make any sort of contribution in multinational naval operations of the future? Or will they be relegated to the sidelines, undertaking the most menial of tasks, encouraged to stay out of the way – or stay at home…The "need for speed" in

[66] Paul T. Mitchell, "Small Navies and Network-Centric Warfare: Is There a Role?," *Naval War College Review* 61, no. 2 (Spring 2003), p. 85.

[67] Dr. David Alberts, opening remarks at the annual 7th International Command and Control Research and Technology Symposium, Québec City, Canada, September 2002.

> network-centric operations places the whole notion of multinational operations at risk.[68]

More contemporaneously, at the 2010 Joint Warfighting Conference co-sponsored by the Armed Forces Communications and Electronics Association and the U.S. Naval Institute, General James Mattis, then-Commander of the U.S. Joint Forces Command, echoed Dr. Mitchell's specific themes as well as the more general themes regarding networking when he noted:

> In this age, I don't care how tactically or operationally brilliant you are, if you cannot create harmony – even vicious harmony – on the battlefield based on trust across service lines, across coalition and national lines, and a cross civilian/military lines, you really need to go home, because your leadership style is obsolete.[69]

But how important is coalition networking and what is the "state of play" of this networking today, especially when United States Navy combat formations attempt to communicate and share data with coalition partners and achieve shared situational awareness?[70] Some would say that it is not yet where it should be. As Dr. Mitchell noted in his *Naval War College Review* article, absent more effective means to network and exchange data, navies may even stop attempting to operate together. He raises what is perhaps the most important question regarding coalition naval communications – what level of communications and networking is required to make coalition operations at sea effective?

Dr. Mitchell did not ask this question off-handily. For a number of years the Canadian Navy has deployed a surface combatant with United States Navy Carrier Strike Groups (CSGs) for an extended six-month deployment. This is an environment where the effectiveness of coalition interoperability moves from theory to the reality of high-tempo, forward-deployed naval operations—and operations that often involved combat. As part of his research, Dr. Mitchell interviewed the commanding officers of seven Canadian ships that deployed with U.S. Navy CSGs to determine how effectively they were able to communicate with their U.S. Navy partners. The results indicated that while significant progress has been made, more work needs to be done.

As Dr. Mitchell noted in his article, the experience of these Canadian commanding officers, as well as the experience of others working with U.S. naval forces in NATO exercises or operations, was that the "need for speed" in network-centric operations may result in the

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[68] Mitchell, "Small Navies and Network-Centric Warfare," pp. 84.

[69] General James Mattis remarks at the Joint Warfighting Symposium, May 13, 2010, accessed at: www.jfcom.mil/newslink/storyarchive/2010/pa050110.html. As Commander of the U.S. Joint Forces Command, General Mattis was also Commander Allied Force Transformation, an important NATO "hat" that involves seeking solutions to issues of allied and coalition networking challenges.

[70] United States Navy battle formations are most often deployed as Carrier Strike Groups (CSG) or as Expeditionary Strike Groups (ESG). CSGs are built around a large-deck aircraft carrier operating tactical jet aircraft, and ESGs are built around a large-deck amphibious ship operating VSTOL aircraft and helicopters.

exclusion of even close allies. Thus, he notes, while the guiding principle of network-centric warfare (NCW) is to increase the speed and efficiency of operations, coalitions are rarely concerned about combat efficiency. Rather, they are always about scarcity in terms of operational resources, political legitimacy, or both. This led him to conclude that in a dynamic coalition environment, because of the impact of slower networks or non-networked ships, the prospects of the U.S. Navy keeping "in step" with coalition partners, is not high—absent enlightened efforts by all governments concerned.[71]

At a 2002 international C4ISR symposium, Dr. Mitchell put it more directly when he said during the question-and-answer period following his presentation:

> We have been trying to work with the U.S. Navy for a long time. Ten years ago when we basically communicated by the red phone [tactical voice nets] we did all right because it was pretty much a level playing field. Five years ago, with Challenge Athena and the beginnings of networked communications, it started to become more difficult for us as the U.S. Navy sped away from its partners. Today, with IT-21 and the emerging FORCEnet, the U.S. Navy is in danger of leaving behind other navies because all of the background and decision making that goes on over networks like SIPRNET is lost to us, thus, when the order is given to do something we have none of the background for it and we are not in the battle rhythm of the operation.[72]

While some might say this is merely anecdotal information, for us and our colleagues from other navies—especially Commonwealth navies—the situation Dr. Mitchell describes represents the reality of current coalition operations at sea and indicates there important work yet to be done. Additionally, this is consistent with what proponents of network-centric operations have been exposing for some time. In a capstone publication of the Department of Defense Office of Force Transformation, the late Vice Admiral Arthur Cebrowski opined; "The United States wants its partners to be as interoperable as possible. Not being interoperable means you are not on the net, so you are not in a position to derive power from the information age."[73]

If this is such an important issue then why have naval professionals not worked harder and more vigorously to solve it and why have we not found a solution yet? Part of the problem lies in the relative success that navies have had networking at sea. Even in the days of signal flags, ships at sea found a way to communicate to some degree. As technology advanced from flashing lights,

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[71] Mitchell, "Small Navies and Network-Centric Warfare," pp. 88-89. See also Paul T. Mitchell, *Network Centric Warfare and Coalition Operations: The New Military Operating System* (New York: Routledge, 2009) where Dr. Mitchell expands on his argument that coalition partners in U.S. led operations will have to be networked.

[72] Paul Mitchell, "Small Navies and Network-centric Warfare: Is There a Role? Canada and US Carrier Battlegroup Deployments," briefing presented at the 8th International Command and Control Research and Technology Symposium, Washington, D.C., June 17-19 2003. Professor Mitchell's statement did not come from his prepared presentation, but from the question and answer period following his formal presentation.

[73] *Military Transformation: A Strategic Approach* (Washington, DC: Department of Defense, 2003), pp. 1-36, accessed at: oft.osd.mil. This publication is the capstone publication of the Office of Force Transformation, US Department of Defense.

to radio Morse code, to tactical radio voice circuits, to the initial tactical data links, ships at sea often had it better than forces ashore on expanded battlefields. The fact that "we've communicated at sea before and we're doing so today," often obscures how well we could communicate and exchange data if the right technology, doctrine, tactics, techniques, and procedures were in place.

The importance of coalition partners effectively networking was perhaps best articulated by Commander Alberto Soto, Chilean Navy, in his Summer 2010 *U.S. Naval War College Review* article. While he noted; "The availability of a cooperatively created tactical picture has long been a dream of naval commanders who wanted to see what was over the horizon,"[74] he then went to the nexus of the challenge of building and sharing an effective coalition COP. Commander Soto noted that; "[r]egional navies have disparate capabilities, with major differences in C4ISR…allies do not acquire or develop command-and-control systems or surveillance and reconnaissance assets with the main goal of exchanging information with other potential allies."[75]

For the U.S. Navy there is another complicating factor. Almost all officers who attain high rank in the U.S. Navy have served as carrier strike group (CSG) commanders at some time during their career, typically as their first afloat assignment as flag officers. As a CSG commander embarked in a Nimitz-class aircraft carrier, the communications and data exchange capabilities – with robust displays, ample switching and routing capabilities, and high bandwidth – the admiral has experienced the "best of the best" in this area.

Additionally, from the U.S. Navy perspective—with respect to communicating and exchanging data with coalition partners—coalition nets such as CENTRIXS are likely to be installed on the aircraft carrier and that is also where coalition naval officers embark for most exercises.[76] Thus, as carrier strike group commanders mature through policy and acquisition assignments, their collective memory of coalition communications and data exchange capabilities is often quite positive—they rarely have the first-person knowledge of significant problems associated with their operational experience. But their experience is the exception—not the rule—for they have not experienced coalition networking from the position of coalition surface combatants attempting to work with U.S. Navy ships.

There is another, perhaps more important, reason that an effective solution still eludes the operators who want to solve this issue. For a host of reasons, coalition interoperability does not fit neatly into any requirements "bin" for the U.S. Navy or for other likely coalition partner

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[74] Commander Alberto Soto, "Maritime Information Sharing Strategy: A Realistic Approach for the American Continent and the Caribbean," *Naval War College Review* 63, no. 3 (Summer 2010), p.145.

[75] Soto, "Maritime Information Sharing Strategy." See, for example, J. Thomas, *The Military Challenges of Transatlantic Coalitions*, Adelphi Paper 333 (London: IISS, 2000).

[76] CENTRIXS is the U.S. Navy's Combined Enterprise Regional Information Exchange System. See B. Carter and D. Harlor, "Combined Operations Wide Area Network (COWAN)/Combined Enterprise Regional Information Exchange System (CENTRIXS)," *Biennial Review* (San Diego, CA: Space and Naval Warfare Systems Center San Diego, 2003), p. 87, for a detailed technical description of CENTRIXS. See also Mitchell, "Small Navies and Network-centric Warfare," p. 90 for another nation's view of CWAN (COWAN) and CENTRIXS.

navies. It does not fly, float, or operate beneath the seas. It does not strike the enemy from afar like cruise missiles. It does not enhance readiness like spare parts or training. It just does not always have the requisite degree of high-level advocacy.

This is not to imply that those in charge of setting requirements or acquiring weapons systems aren't keen on doing the right thing—clearly they are. However, defining operational needs, the requirements generation process, and acquisition practices have grown up over decades—even generations—and changing these processes to adequately factor in coalition communications takes a great deal of time and attention. As yet, it is a journey that is incomplete.

Part of the reason for this lack of advocacy and difficulty in reorienting requirements and acquisition practice is the inability to quantify the "goodness" derived from coalition networking. With naval establishments and acquisition bureaucracies increasingly driven by the rules of the marketplace—measures of effectiveness, return on investment, best business practices and efficiency—the lack of measures to quantify the benefits derived from effective coalition networking auger against spending scarce research and development, and especially acquisition, dollars to enhance something that has not yet been effectively quantified.

But it is a process that must take place if the U.S. Navy and its likely coalition partners—even so-called "high-end" navies such as those of the British Commonwealth—are to operate at sea effectively for next century. As Dr. Mitchell points out in his *Naval War College Review* article, "In network-centric warfare information is the cornerstone of all action; the existence of separate networks operating at different speeds will have an undeniable impact on battle rhythms."[77] Clearly, overcoming uneven—or more appropriately completely uncoordinated—C4ISR technology infusion efforts on the part of nations that would work together at sea to form a global maritime partnership to maintain the rule of law on the global commons is an essential first step in making the GMP a reality.[78] And while it is a journey that has just begun, there is cause for hope if these nations harness their considerable science and technology assets to address this challenge.

[77] Mitchell, "Small Navies and Network-Centric Warfare," p. 91.

[78] See, for example, DC Gompert, RL Kugler, and MC Libicki, *Mind the Gap: Promoting a Transatlantic Revolution in Military Affairs* (Washington, DC: National Defense University Press, 1999) for one of the earliest works that explored the challenges involved in ensuring that network-centric warfare investments and technology lead to more effective networking between and among allies and coalition partners. See also J Thomas, *The Military Challenges of Transatlantic Coalitions*, Adelphi Paper 333, (London, IISS, 2000) for a European point of view on this issue.

Harnessing the Science and Technology Community – the AUSCANNZUKUS Way

"We will win – or lose – the next series of wars in our nation's laboratories."[79]

Admiral James Stavridis
SOUTHCOM Commander
"Deconstructing War"
U.S. Naval Institute Proceedings December 2005

For the U.S. Navy, the technical challenges to effectively network with its likely coalition partners are not trivial. Specifically, when working with a 21st Century FORCEnet-centric U.S. Navy and attempting to leverage the enormous capital investment the U.S. Navy is making in FORCEnet, the challenge for partners is twofold: quantifying the operational effectiveness of a coalition force networked via U.S. Navy infrastructure provided by FORCEnet, versus the operational effectiveness of a coalition force less-robustly networked; and finding a way for likely coalition partners to co-evolve maritime networking systems in a way that enables maximum networking among partner ships and other platforms.[80]

The issue of co-evolution is an important one because for navies determined to work together with other—often smaller—navies as global maritime *partners*, a cooperative arrangement regarding technology development is crucial.[81] This implies early and frequent cooperation and collaboration at the grass-roots level by scientists and engineers working in laboratories of these navies, as well as those of other prospective global maritime partners, to come up with technical solutions for challenging networking problems.

One vehicle for this cooperation among the five AUSCANNZUKUS nations is The Technical Cooperation Program (TTCP). Although it has been around in various forms for over half a century, TTCP is not universally well known, even among AUSCANNZUKUS naval personnel, and some background is in order to explain how this program facilitates efforts to address coalition interoperability. Importantly, while conducting an analysis of coalition interoperability in another forum is certainly *possible*, the extant TTCP organization and infrastructure provided a ready-made medium that made success in this endeavor *probable*.

TTCP is a forum for defense science and technology (S&T) collaboration between Australia, Canada, New Zealand, the United Kingdom and United States. Established as a joint effort

[79] Vice Admiral James Stavridis, "Deconstructing War," U.S. Naval Institute *Proceedings* (December 2005), p. 42-45.

[80] For more on FORCEnet see the following: *FORCEnet: A Functional Concept for Command and Control in the 21st Century* (Norfolk, VA: Naval Network Warfare Command, 2006) and *FORCEnet: A Functional Concept for Command and Control in the 21st Century: Annex Version 20 June 2006* (Norfolk, VA: Naval Network Warfare Command, 2006), both available at www.enterprise.spawar.navy.mil/getfile.cfm?contentId=816&type=R.

[81] Gordan Van Hook, "How to Kill a Good Idea," U.S. Naval Institute *Proceedings* (October 2007), p. 33. Captain Van Hook, drawing on his experience as a destroyer squadron commander where he worked with coalition partners, emphasized the importance of a cooperative approach to instantiating the global maritime partnership, noting that the U.S. should; "Encourage regional maritime security arrangements to form at the grassroots level, without overt U.S. leadership."

between the U.S. Defense Department and the respective agencies of the other four nations, TTCP is one of the largest collaborative defense S&T activities in the world. The statistics alone give some indication of the scope of this effort: five nations; 11 technology and systems groups formed; 80 technical panels and action groups; 170 organizations; and 1,200 scientists and engineers. The purpose is to enhance national defense and reduce costs. To do this, TTCP provides a formal framework that scientists and technologists can use to share information among members.

Collaboration within TTCP provides a means of acquainting participating nations with each other's defense research and development programs so that each national program may be adjusted and planned in concert with the efforts of the other nations. TTCP has its center of gravity in the applied research domain, but it also encompasses basic research and technology development activities. The scope includes the exploration of alternative concepts prior to development of specific weapon systems, collaborative research, sharing of data, equipment, material and facilities, joint trials and exercises, and advanced technology demonstrations. Cooperation within TTCP often acts as the catalyst for project-specific collaborations further along the acquisition path.

Enhancing Coalition Interoperability: MAR AG-1 and AG-6

In response to a mutually perceived need to assess the quantitative value of network-centric naval forces, the five allied countries of TTCP established the Maritime Systems Group (MAR) Action Group One (AG-1) in 2002 to conduct a three-year "Network-Centric Maritime Warfare" (NCMW) collaborative study. The work of AG-1 provided robust quantitative assessments of the benefits of coalition naval forces adopting a networked force structure. The report of the AG-1 prompted leaders of TTCP's MAR to charter a second investigative team. Action Group Six (AG-6) was chartered in 2005 to examine the U.S. Navy's FORCEnet[82] concept on coalition interoperability.

In seeking to establish the basic requirement for the technologies to be included in these options, AG-6 began with a common understanding of the operational environment facing a coalition naval force. The group developed a scenario for a coalition naval force that evolved from a disaster assistance/humanitarian relief effort, to a counterterrorism operation, and finally a high-tempo conflict at sea. Four principal measures of effectiveness were devised to measure the success of a robustly networked coalition force that fully-leveraged the U.S. Navy's FORCEnet capability compared to one that was not networked.

[82] In straightforward terms, FORCEnet refers to the systems and processes for providing fully networked naval command and control in 2015 to 2020. The objective of FORCEnet is to provide commanders the means to make better, timelier decisions than they currently can and to allow the effective execution of those decisions. For more on FORCEnet see: *FORCENet: A Functional Concept for Command and Control in the 21st Century* (Norfolk, VA: Naval Network Warfare Command, 2006); available at: www.enterprise.spawar.navy.mil/getfile.cfm?contentId=816&type=R; and *FORCENet: A Functional Concept for Command and Control in the 21st Century: Annex Version 20 June 2006* (Norfolk, VA: Naval Network Warfare Command, 2006).

In addition to the analysis of networked forces versus non-networked forces, AG-6 members shared the "technology on-ramps" of their respective national acquisition communities in order to find the windows where complementary technological capabilities could be inserted into their naval C4ISR systems. By modeling the planned capabilities of these on ramps against the scenario, the impacts and value of alternative coalition network structures were assessed. This also allowed AG-6 members to develop a set of quantitative tools that could be adopted by the acquisition branches of the respective nations to maintain coalition interoperability among the networked forces.

In a similar progression, the concept of maritime net-centricity and early manifestations, such as the U.S. Navy FORCEnet, have become regarded as stepping stones on the evolutionary path of becoming Fully Net-Enabled with each step building on the one before. The next step on the Maritime Net Centric roadmap for TTCP nations is the implementation of an information architecture to deliver the military capabilities and benefits aspired to in nations' perceptions of network-centric warfare.

The U.S. Navy has committed to evolving its current afloat network capability and global C2 infrastructure to the Consolidated Afloat Networks and Enterprise Services (CANES) within the next several years. The development of CANES will move the Navy to a Service Oriented Architecture (SOA) where applications, services, and data are provided to Communities of Interest. A SOA is one built primarily with network-available services, such as web services, and uses publish and subscribe techniques. Information is published and potential users subscribe to services which access and provide the information. The roadmap for CANES incorporates IT and network services currently provided to U.S. coalition partners under the CENTRIXS[83] umbrella, making the development of CANES a critical concern to the Five-Eyes community as the pathway to the Maritime Net Centric Roadmap's goal of "Fully Net Enabled," and ultimately convergence with the Global Information Grid.

The AG-6 study quantified how disparities in C4I capability within a U.S.-led coalition force undermine its effectiveness in a range of missions, ultimately disenfranchising less-capable units. The migration of U.S. Navy networking capabilities to new architectures such as CANES could increase that disparity, and may introduce invasive and disruptive effects not well-understood by the United States and its allies. With the rapid progress of U.S. maritime networking capabilities to CANES, and conclusions from prior AG-1/6 studies, as well as ongoing TTCP studies can help allied nations stay aligned with USN developments. Previous AG-1/6 studies have given MAR an excellent appreciation of U.S. and allied maritime capabilities, along with modeling frameworks and tools to provide recommendations to national leadership. Ultimately, a new MAR AG-X study will provide an analytical assessment of requirements, funding and execution of national programs to sustain U.S.-Allied interoperability in a CANES SOA environment. It will inform national decision-makers on the impact of such technologies in the future network architecture in order to improve future coalition operations.

[83] CENTRIXS (Combined Enterprise Regional Information Exchange System) is the premier network for U.S.-coalition interoperability in support of military operations. Information flow to coalition partners via the multiple versions of CENTRIXS networks achieved unprecedented volume and continues to expand.

As it relates to the planned integration of coalition network services (e.g. CENTRIXS), this study will inform the U.S. Navy's CANES development process by leveraging a multinational effort to raise the awareness of the USN and allied navies on the value and impact of potential C4I technologies that are to be incorporated into CANES.[84] As with previous studies, it will inform national acquisition processes of coalition SOA requirements to enable TTCP navies participation in the GMP, and provide validated analytical tools and techniques that are capable of re-use by nations when exploring national versions of SOA for their joint operations. In that regard, it will identify the minimum entry qualifications for equipment that nations should aim for so as to participate in future GMP net-enabled maritime operations.

Leveraging TTCP Efforts Across Global and Regional Maritime Partnerships

Importantly, while TTCP represents the work of only five nations, and the MAR AG-1/AG-6 effort represents only a small fraction of the entire TTCP body of work, it must be noted that the issue of coalition networking is sufficiently compelling and the TTCP process sufficiently worthy of emulation, that those outside the TTCP network have identified this as a best-practices example and argued for similar efforts to be conducted by other national groups. Commander Soto put it this way in his *Naval War College Review* article:

> Since 2002, the Technical Cooperation Program … has focused the efforts of its Maritime Systems Group (MSG) on "Networking Maritime Coalitions' and 'FORCEnet and Coalitions Implications." The MSG has become an important link among national naval C4ISR acquisition programs … For that very reason these [Latin American and Caribbean nations] should tenaciously strive to become involved in initiatives like MSG.[85]

As Commander Soto suggested, other nations and navies can leverage the policies and processes that TTCP has instituted among the five AUSCANNZUKUS nations to other groups of nations and navies in natural clusters so they can begin to replicate the TTCP model where it makes the most sense. As he suggests, the navies of South America offer one such grouping. The ASEAN nations offer another potential grouping and one that already has several collaborative forums. NATO offers another, and given the wide range of similar efforts already underway such as the NATO Network Enabled Capability (NEC) C^2 Maturity Model, this may be easier than some think.

It is important and necessary to use work such as TTCP as a means to harmonize national C4ISR acquisition programs because the challenge is so great. This challenge has persisted for quite some time, as pointed out over a decade ago in an analysis of Operation JOINT ENDEAVOR in Bosnia where it was noted:

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[84] Such an inclusive effort is often more useful for informing important constituencies, than in providing prescient new information.

[85] Soto, "Maritime Information Sharing Strategy," pp. 139-152.

> Coalition operations such as Joint Endeavor present a complex set of challenges for the military C4ISR systems planners, implementers, and operators. The most difficult challenge is the provision of integrated C4ISR services and capabilities to support the needs of ad hoc multinational military force structures and politically driven command arrangements. Although integrated C4ISR services are the desired objective, the realities tend to drive the solution to stove-piped implementations. In spite of technology advances, this will likely be the case for some time to come. There will continue to be uneven C4ISR capabilities among coalition members who will continue to rely on systems with which they are most familiar—their own.[86]

Lest anyone think this challenge is already solved in 2011 (or will solve itself shortly) the ability of navies to effectively network remains a 'wicked problem' among navies attempting to work together to deal with even basic challenges such as combating piracy—let alone dealing with more 'high-end' challenges such as AAW, ASW or ASuW. In their *Newport Paper* publication titled *Piracy and Maritime Crime: Historical and Modern Case Studies*, Bruce Elleman, Andrew Forbes, and David Rosenberg highlight the importance of effective maritime surveillance to counter piracy this way; "Clearly, maritime surveillance is the key to gaining a better understanding of what is happening on the oceans, but currently, systems are not integrated within each country, let alone at regional or global levels."[87]

It is beyond debate that the U.S. Navy will continue to partner with other navies to secure the rule of law on the global commons and that the effectiveness of this combined global force for good will rise or fall on the ability of these naval coalitions to network at sea. TTCP represents an outstanding best-practices model for the way the U.S. Navy is moving forward to ensure that its C4ISR systems are compatible with the systems of the navies of partner nations. It is a model that must be extrapolated—and quickly—to other navies the U.S. Navy will partner with at sea.

[86] A Krygiel, *Beyond the Wizard's Curtain: An Integration Environment for a Systems of Systems* (Washington, DC: DoD Command and Control Research Program, 1999).

[87] Bruce Elleman, Andrew Forbes, and David Rosenberg, *Piracy and Maritime Crime: Historical and Modern Case Studies*, Newport Paper 35 (Newport, RI: Naval War College Press, 2010), p. 235. The *Newport Papers* is a series of monographs published by the Naval War College Press that "are extended research projects that the Dean of Naval Warfare Studies and the president of the Naval War College consider of particular interest to policy makers, scholars, and analysts." This monograph is the 35th in the series.

16th ICCRTS: Collective C2 in Multinational Civil-Military Operations

Networking the Global Maritime Partnership

Track 9: Networks and Networking

Ms. Mary Chrysler
Mr. George Galdorisi
Dr. Stephanie Hszieh

June 22, 2011

Outline

- Background
- Perspective
- The Challenge of Naval Coalition Networking
- Tell It To The Labs: Achieving Coalition Networking
- A Way Forward

Background

“Partnerships are an integral part of our Maritime Strategy today. From the highest level of warfare to the humanitarian assistance missions, Global Maritime Partnerships are playing a decisive role in keeping the peace.”

Admiral Gary Roughead
Chief of Naval Operations
Rhumb Lines
September 3, 2008

“In this age, I don’t care how tactically or operationally brilliant you are, if you cannot create harmony – even vicious harmony – on the battlefield based on trust across service lines, across coalition and national lines, and across civilian/military lines, you really need to go home, because your leadership in today’s age is obsolete.”

General James M. Mattis
Then Commander, Joint Forces Command
Remarks at the Joint Warfighting Symposium
May 13, 2010

Networking the Global Maritime Partnership

- Globalization has brought nations closer together and increased world-wide prosperity
- Navies under-gird the ability of nations to trade across the global commons
- Globalization has facilitated all forms of international terrorism
- No one navy can police the global commons – a Global Maritime Partnership is needed

Networking the Global Maritime Partnership

- Navies working together to police the global commons must be effectively networked
- This networking is crucial to develop a common operational picture and to self-synchronize
- Emerging C4ISR technologies are critical to networking navies
- The fact that navies have led networking at sea often obscures technological challenges

Perspective

"When John Fisher became First Sea Lord in 1904, his main pledge was to solve this intractable problem … Fisher in effect invented picture-based warfare. He created a pair of war rooms in the Admiralty, one built around a world (trade) map, the other around a North Sea map."

Dr. Norman Friedman

"Netting and Navies: Achieving a Balance"

Sea Power: Challenges Old and New


H.M.A.S SYDNEY

“Most think that bigger, faster, and more is best when talking about providing technology to naval forces. But this is not always the case. What matters in not how *much* you communicate, but rather getting the right information to the right people at the right time.”

Professor Nicholas Rodger
Exeter University
Keynote Address
2007 King Hall Conference

Perspective

- Maritime coalitions have existed for at least two and a half millennia and navies have communicated at sea for at least that long
- Over time, the need to *communicate* at sea has morphed to the need to *network* at sea – and this networking has a rich, century-long history
- Understanding this history is important in our efforts to successfully network coalitions at sea in the future
- The globalization of commerce has made the need for a global maritime partnership (GMP) an *urgent* requirement to support worldwide prosperity
- Networking navies is a *necessary condition* for a GMP but technological advances among navies have often been uneven – impeding effective networking
- We have “beta-tested” and will share one methodology for networking navies more effectively

The Challenge of Naval Coalition Networking

“In today’s world, nothing significant can get done outside of a coalition context, but we have been *humbled* by the challenges of devising effective coalition communications.”

Dr. David Alberts
Director of Research
Assistant Secretary of Defense for Networks Information Integration
U.S. Department of Defense
7th International Command and Control Research and Technology Symposium
September 2002

“Information sharing is a fundamental requirement for meeting most of the current challenges to international maritime security. The notion of a regional maritime partnership in the American continent and the Caribbean demands effective information-sharing capabilities in order to become a reality.”

Commander Alberto Soto, Chilean Navy
“Maritime Information-Sharing Strategy”
Naval War College Review
Summer 2010

Technological Advances and Networking

- Coalition partners working with the U.S. Navy often want to know the “price of *admission*”
- From the U.S. perspective it is more about the “price of *omission*” if we can not work together
- It is not ship hulls or aircraft airframes that enable this – but C4ISR technologies
- If each coalition partner develops these technologies independently, chaos can ensue

Technological Advances and Networking

- The "need for speed" often drives each navy to push technology forward independently
- Coordinated technological development in parallel offers one promising solution to this
- This must then translate to parallel acquisition of systems that are mutually compatible
- This sounds great in theory, but is there a "best-practice" model that we can examine?

Systems Center PACIFIC

Tell It To The Labs: Achieving Coalition Networking

Systems Center PACIFIC

"What we build and what we subsequently sell to foreign navies used to be low priority for the Naval Sea Systems Command. Today, with the Thousand Ship Navy and the Global Maritime Partnership, this is now a huge part of what we do."

Vice Admiral Paul Sullivan
Commander, Naval Sea Systems Command
NLUS Sea-Air-Space Symposium
Washington, D.C.
March 20, 2008

SPAWAR Systems Center PACIFIC

"The Technical Cooperation Program (TTCP), a longstanding forum for defence science and technology cooperation between Australia, Canada, New Zealand, the United Kingdom and the United States, has, for example, established an initiative to consider the 'FORCEnet Implications for Coalition Partners.'"

Dr. Chris Rahman

The Global Maritime Partnership Initiative: Implications for the Royal Australian Navy

Tell it to the Labs: Achieving Coalition Networking

- Effective nation-to-nation defense laboratory cooperation has been going on for over a half-century under the auspices of The Technical Cooperation Program (TTCP) and other entities
- TTCP leadership has recognized the challenges to effective coalition networking at sea
- In 2001, the TTCP Maritime Systems Group commissioned a team to address this issue
- This five-nation cooperative effort has completed two three-year efforts and future work is planned
- We are sharing our results as one best-practices model for all nations represented here

Our "Beta-Test" Under the Auspices of The Technical Cooperation Program: One Path to "Building the Networks"

One Model for International Defense and Networking Cooperation: MAR AG-1/AG-6

MAR Action Group 1:
“Maritime Network Centric Warfare”

MAR AG-1

- Maritime Network Centric Warfare
  - Open ended
- Focus on “bounding the problem”
  - Good product
- Proof of concept through multilateral analysis
- Warfighting scenarios with traction for all
- Two Studies
  - Broad Issues: First Principles of NCW
  - Tactical Level Analysis: MIO/ASW/ASuW

SPAWAR Systems Center PACIFIC

AG-1 Membership

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- Ms. S. Andrijich (M)
- Ms. M. Hue (M)
- Dr. I. Grivell (M)
- Dr. D. Sutton (M)
- Dr. M. Fewell (M)

Canada

- Mr. P. Sutherland (NL)
- Mr. R. Burton (M)
- Mr. M. Hazen (M)
- Mr. B. Richards (M)

New Zealand

- Dr. D. Galligan (NL)
- Mr. C. Phelps (M)

United Kingdom

- Mr. A. Sutherland (NL)
- Mr. P. Marland (M)
- Mr. R. Lord (M)

United States

- Mr. J. Shannon (NL)
- Dr. R. Klingbeil (M)
- Dr. S. Dickinson (M)
- Mr. G. Galdorisi (M)*

Notes: NL = National Leader
M = Member

MAR AG-1 Study B
Tactical Level Analysis

ASW TACSIT Analysis

Improving ASW Effectiveness – NCASW Concepts and Hypotheses

1 Shared Situational Awareness (SSA)

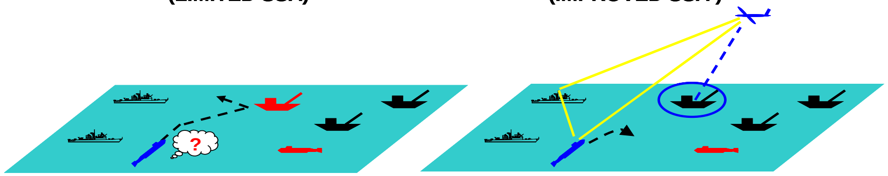
Network- enabled Shared Situational Awareness (SSA) can <u>reduce false contact loading</u> thereby increasing ASW effectiveness.

2 Collaborative Information Environment (CIE)

Sensor operators in a network-enabled collaborative environment can <u>reach-back to ASW experts</u> to improve target and non-target classification performance.

Queueing Theory can provide an intuitive mathematical and physical framework for the analysis of any military system or operation that can be characterized as a “waiting line” or a “demand-for-service.”

False Target Reduction Concept



Submarine’s search track plan is interrupted due to false contact investigation

Submarine avoids unnecessary false contact investigation due to SSA

- Congestion of sonar, high workload
- Time to investigate false contacts
- Reduction of effective search rate
- Missed detections of targets

- Information is essential
- System to remove specified sensor contacts
- Can possibly lower detection threshold
- Increased probability of target detection

- Use sensor correlation across all appropriate platforms in a task group to reduce the number of non-target contacts presented to sensor operators.
- Reduce non-object false contacts, such as reverberation spikes and wrecks, by using acoustic models, in situ data, and local data bases.

Metric for SSA Concept Analysis

Reduce false contact loading on the ASW system by improving Shared Situational Awareness (SSA)

$P_{ASW} = P_{DET} * \underline{P_{CLASS}} * P_{LOC} * P_{ATK}$

$P_{CLASS} = P_{ACQ\ CLASS} * P(T|t)$

$P_{ACQ\ CLASS}$ = probability that the target acquires classification service

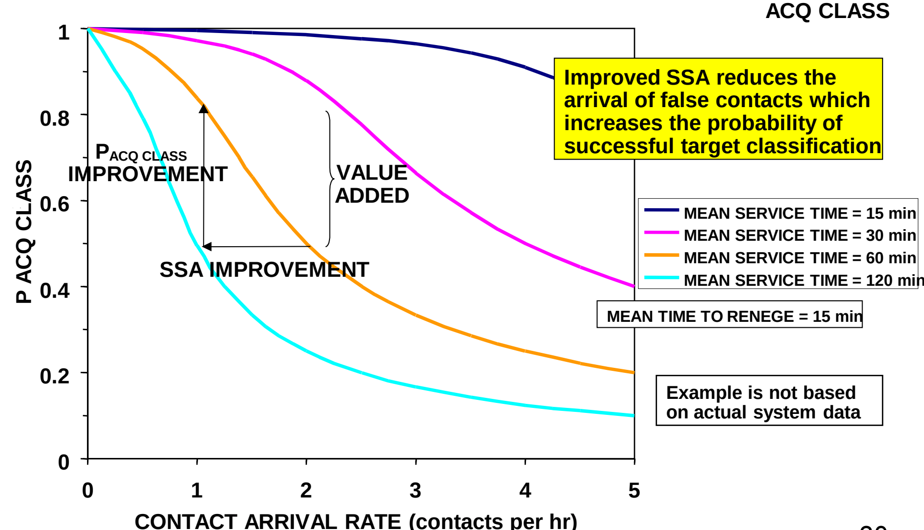
$P(T|t)$ = probability of recognizing the target contact as the actual target of interest (experimental data required)

T = THREAT DECISION

t = true target

There are queueing aspects (waiting line/demand for service) in each of the terms in P_{ASW}

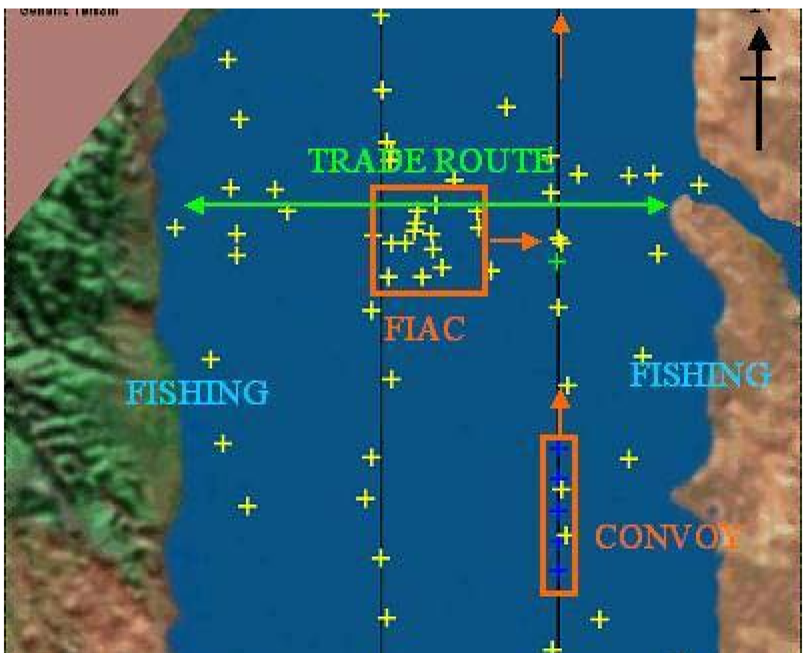
Effect Of Improved SSA and Service Time on $P_{ACQ\ CLASS}$



ASuW/Swarm TACSIT Analysis

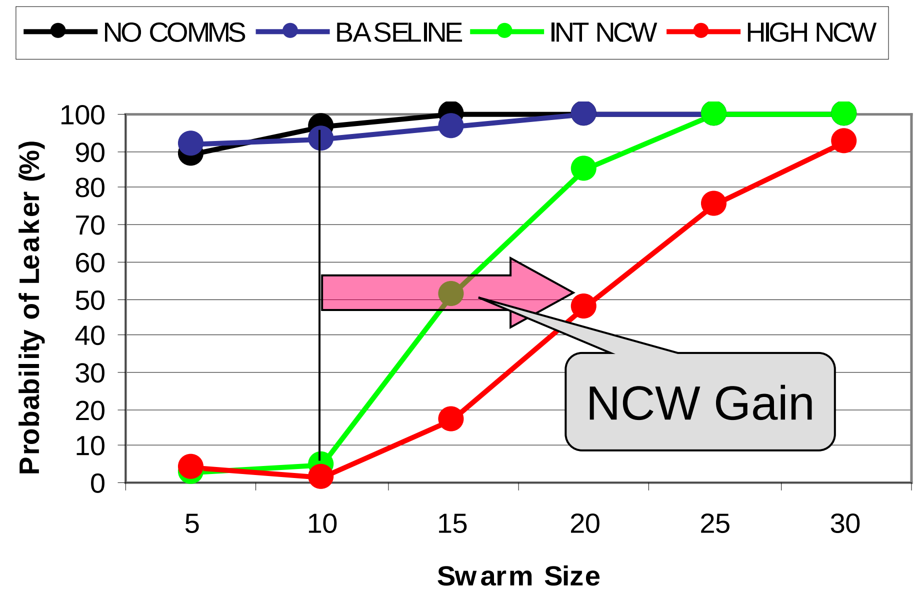
Tacsit: Blue force in restricted sea room is attacked by a swarm of FIAC. Network enabled Blue shared situational awareness and distributed targeting reduces the number of 'leakers.'

Metrics: Probability of one or more FIAC reaching firing position against HVU. Fractions of FIAC leaking, and of Blue escorts damaged. Collateral damage.



Study has used MANA agent based model to represent the Swarm's dynamic tactics, with four levels of Blue networking capability.

Sample Results: (30 knot FIAC)



- Intermediate and High levels of networking increase Force survivability versus Type 1 FIAC by factor of ≈9.
- Full results include dependencies on Red speed (leakers increase at 40 knots).

AG-1 Study “Takeaways”

- Any analysis must begin with the recognition that there will likely be a significant networking capability gap between U.S. and coalition partners
- This analysis must evaluate the impact of technology insertion on a networked coalition naval force
- Networking would most benefit coalition naval forces in planning and re-planning, training, and reach-back to better intelligence
- More study is needed….

MAR Action Group 6: "FORCEnet Implications for Coalitions"

MAR AG-6

- Leverage AG-1 work
- Build on AG-1 work but added:
  - More specificity regarding ops and force structure
  - More granularity to analysis and modeling
- Work within a realistic operational scenario that all member nations would participate in
- Produce a product that informs national leadership and acquisition officials

SPAWAR Systems Center PACIFIC

AG-6 Membership

Chairman

Mr. Don Endicott

Australia	Canada	New Zealand	United Kingdom	United States
Dr. A. Knight (NL)	Mr. R. Mitchell (NL)	Dr. D. Galligan (NL)*	Mr. A. Sutherland (NL) *	Mr. D. Endicott (NL)
Ms. R. Kuster (M)	Mr. M. Maxwell (M)	LCDR W. Andrew (M)	Mr. P. Marland (M) *	Mr. G. Galdorisi (M)*
Ms. A. Quill (M)	Dr. M. Lefrancois (M)		Mr. M. Lanchbury (M)	Mr. P. Shigley (M)
Mr. M. Coombs (M)				Ms. M. Gmitruk (M)
				Mr. T. McKearney (M)
				Ms. M. Elliott (M)

Notes: NL = National Leader
M = Member
* = Former AG-1 member

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What is FORCEnet?

FORCEnet is an "…operational construct and architectural framework for naval warfare in the information age, integrating warriors, sensors, command and control, platforms, and weapons into a networked, distributed combat force."

Admiral Vern Clark
Then Chief of Naval Operations
U.S. Naval Institute Proceedings
October 2002

Premises

- FORCEnet will empower warfighters at all levels to execute more effective decision-making at an increased tempo, which will result in improved combat effectiveness and mission accomplishment.
- The warfighting benefits of FORCEnet in a coalition context can be assessed through analysis and quantified to provide input to national balance of investment studies of the five member nations.
- It is necessary that FORCEnet address current and near term information system requirements that support operations in the joint and coalition environments. **Coalition Communications was the clear number one priority** of all numbered fleet commanders and is a critical enabler in leveraging coalition partners in the GWOT.

Hypothesis

- Conducting modeling and simulation and detailed analysis to demonstrate the enhanced warfighting effectiveness of coalition partners (in this case – the AUSCANNZUKUS nations) netted in a FORCEnet environment can help inform national naval C4ISR acquisition programs.

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Notional Coalition Order of Battle

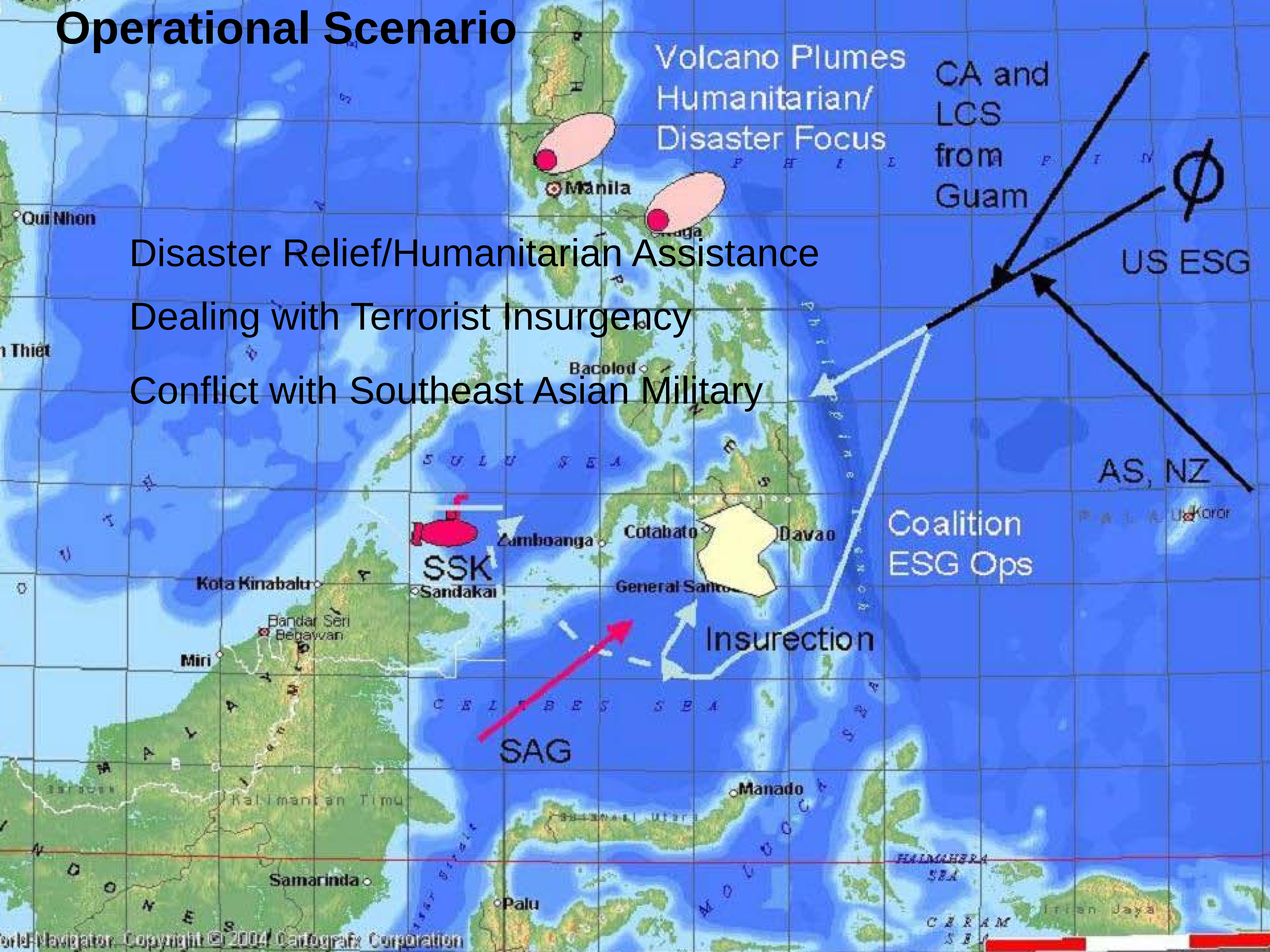
Australia	United Kingdom
▼2 ANZAC Frigates ▼2 FFG ▼1 AWD	▼ 1 LPH/LPD ▼ 2 LSD ▼ 1 Replenishment Ship
Canada	**United States**
▼ 1 Destroyers ▼ 2 Frigates ▼ Replenishment Ship ▼ Submarine	▼ 3 Amphibious Assault Ships ▼ 1 Cruiser ▼ 2 Destroyers ▼ 3 Littoral Combat Ships ▼ 1 Attack Submarine
New Zealand	
▼ 2 ANZAC Frigates ▼ 1 Replenishment Ship ▼ 1 Multi-role Vessel	

Operational Scenario

Disaster Relief/Humanitarian Assistance

Dealing with Terrorist Insurgency

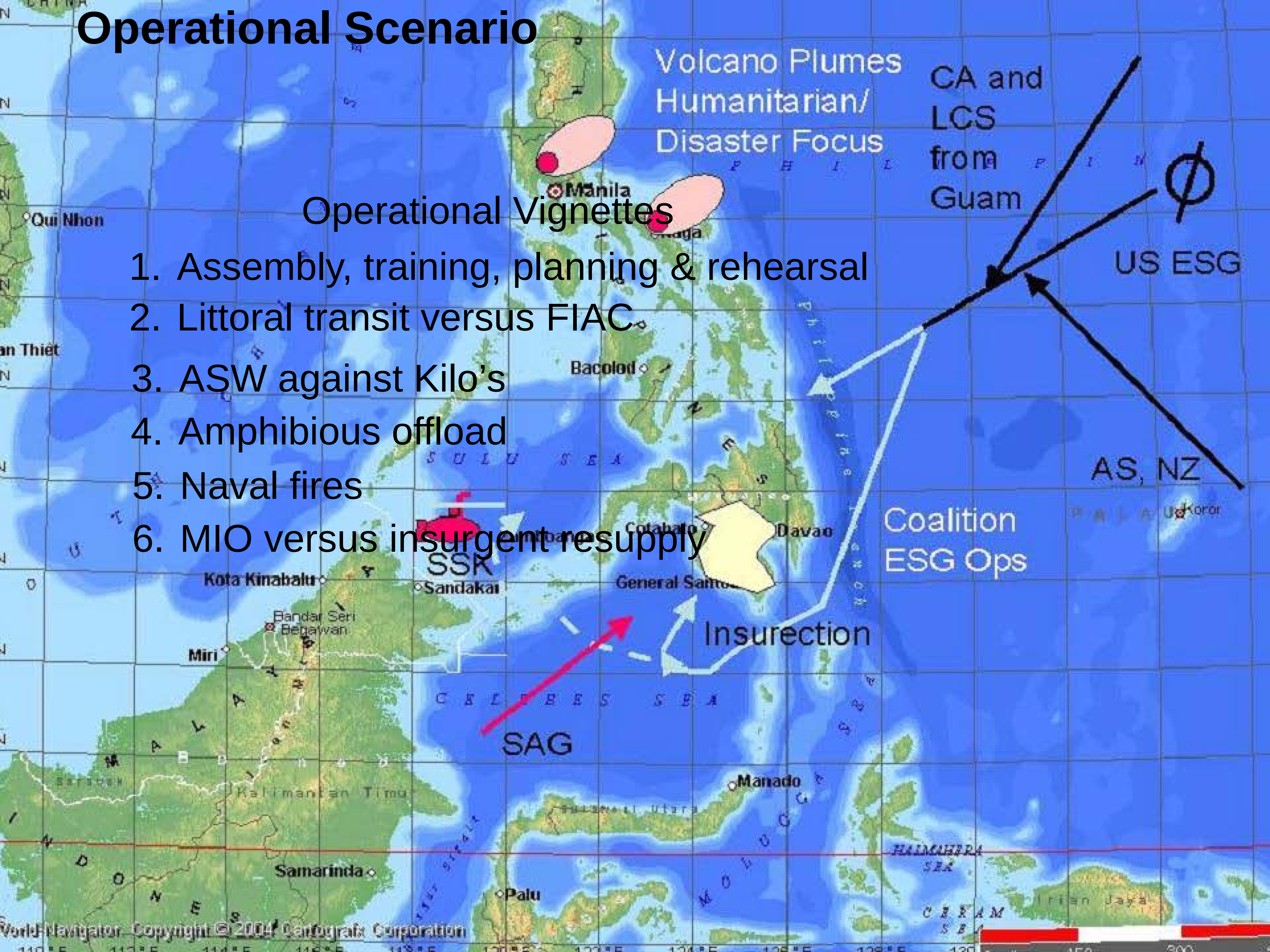
Conflict with Southeast Asian Military



Operational Scenario

Operational Vignettes

1. Assembly, training, planning & rehearsal
2. Littoral transit versus FIAC
3. ASW against Kilo's
4. Amphibious offload
5. Naval fires
6. MIO versus insurgent resupply



Summary of Key Findings

- FORCEnet improves military performance in every vignette assessed
- Improvements primarily in process time, decision making, information availability and planning
- Force effectiveness higher when all coalition units operate at same FORCEnet level

A Way Forward

"We will win – or lose – the next series of wars in our nation's laboratories."

Admiral James Stavridis
SOUTHCOM Commander
"Deconstructing War"
U.S. Naval Institute Proceedings
December 2005

“Haiti showed us once again that we must be interoperable to be effective.”

Vice Admiral Adam Robinson

Chief, Bureau of Medicine and Surgery

Remarks at the Navy League of the

United States Sea-Air-Space Symposium

May 4, 2010

Summary and Conclusions

- Over time, especially in the past several decades, the need to *communicate* at sea has morphed into the need to *network* at sea
- Today no navy stands alone & networking navies effectively is a necessary condition for a global maritime partnership
- Technological advances among navies have been uneven – impeding effective networking between navies
- We have “beta-tested” one methodology for networking navies more effectively and this model can be extrapolated to other nations and navies

A Way Forward

- The rich history of naval cooperation to secure the global commons offers good examples of how our navies can cooperate today while raising the bar for how these navies work together in the future
- Today, globalization and a wide range of challenges mean that no navy stands alone and all navies must work together even more closely in peace and in war
- Networking navies effectively via C4ISR technologies *concurrently developed* is a *necessary* condition for mutual security and prosperity via an effective global maritime partnership
- The AUSCANNZUKUS example of naval cooperation under the auspices of The Technical Cooperation Program offers one example of how to begin to tackle C4ISR interoperability challenges at the lab level

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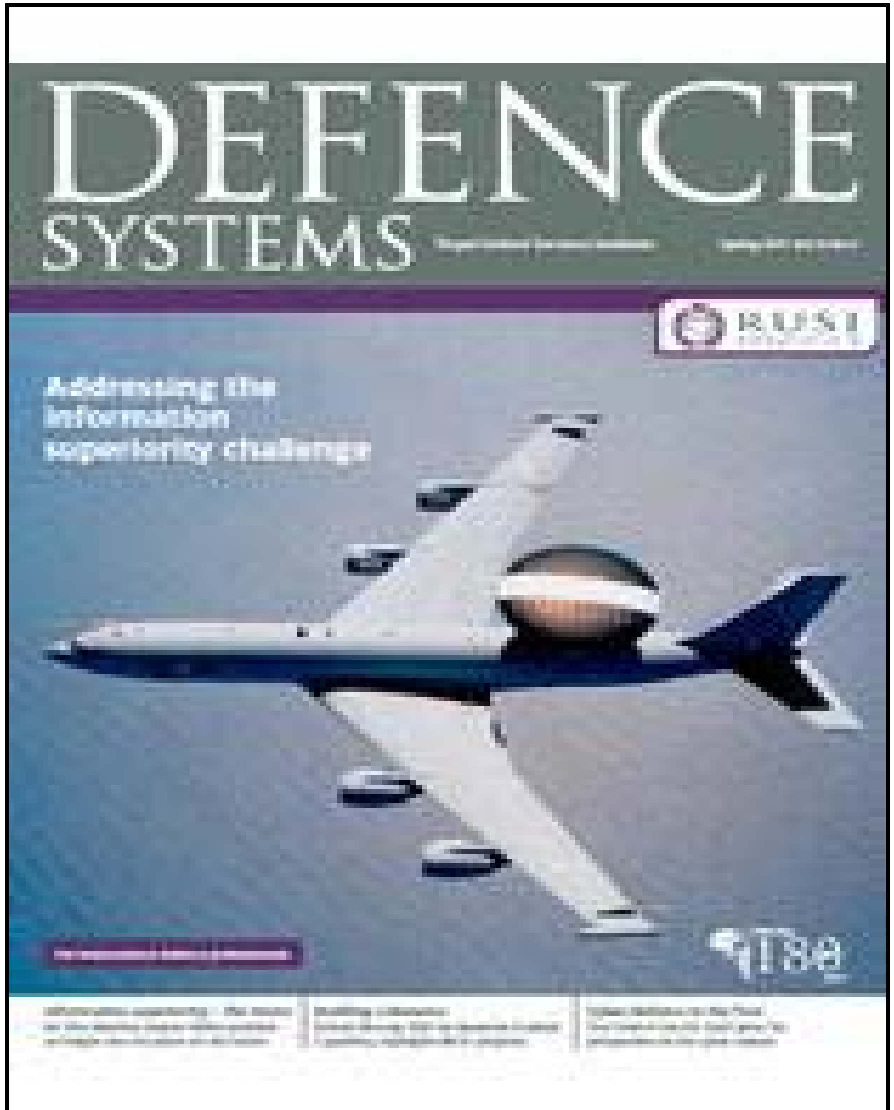
"Since 2002, the Technical Cooperation Program has focused the efforts of its Maritime Systems Group (MSG) on "Networking Maritime Coalitions" and "FORCEnet and Coalitions Implications." The MSG has become an important link among national naval C4ISR acquisition programs … For that very reason these [Latin American and Caribbean nations] should tenaciously strive to become involved in initiatives like MSG."

Commander Alberto Soto, Chilean Navy
"Maritime Information-Sharing Strategy"
Naval War College Review
Summer 2010


DEFENCE
SYSTEMS
Addressing the
information
superiority challenge

Questions?

Backup

Initial Modeling Results - Summary

	Summary	Operational Impact	MoE Analysis
Assembly	Network capability limits time required to build force	Force can plan in advance of rendezvous, training time reduced	Total force at Fn Level1 reduced time required “in company” from 3 to 1 day
FIAC	Networking with increased ISR, flexible ROE enhances ability to counter	Gain in reducing probability of FIAC “leaker” attacking HVU	Fn level 0 or 1 little impact, Level 2 doubles size of swarm that can be countered
ASW	Increased networking impacts in both planning and common operational picture	Gains realizes in better networking of sensors and ISR assets (MPA, helo)	Fn Level 1 allowed OTH sensor monitoring and increase in predicted HVU survivability from .55 to .85.
Offload	Networking shared landing craft resources speeds delivery of on-cal relief supplies	Flexibility in delivering supplies to beach as HA mission unfolds	Fn Level 3 produced impact as all landing craft assets were able to service any supplying ship
Fires	Call-For- Fire process evolves from voice to digital data exchange	Reduced time allows for improved initial accuracy, less chance of targets escaping	Time to engage reduced from 55 min (Fn Level 0) to 2 min (Fn Level 3)
MIO	Range of networked capabilities for detection, tracking, and search of CCOIs have potential for improved performance	Better CCOI tracking through enhanced planning, asset management. Boarding party tools for personal safety and reachback into HQ databases	Probability of acquiring CCOI increased from .1 to .7 with Fn Level 1. Fn Level 2 needed for enhanced database tool and ISR integration

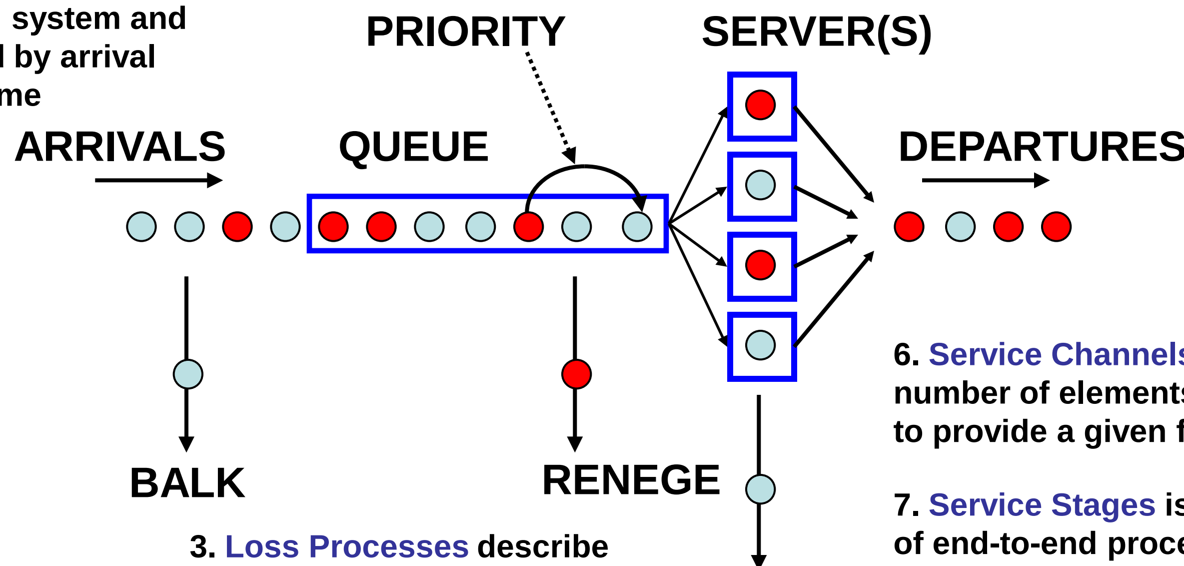
Queuing System for MIO

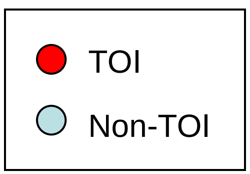
4. **Queue Discipline** describes how a customer is selected for service once in queue (FIFO, priorities, etc.)

5. **System Capacity** is the maximum size of a queue; finite or infinite

2. **Service Pattern** is described by service rate or service time

1. **Arrival Pattern** describes the input to the queuing system and is typically specified by arrival rate or interarrival time





6. **Service Channels** are the number of elements available to provide a given function

7. **Service Stages** is the set of end-to-end processes for completion of service

3. **Loss Processes** describe how customers can be lost (balking and reneging)

KEY QUEUEING METRICS:
- Probability of a customer acquiring service
- Waiting time in queue until service begins
- Loss rate due to either balking or reneging

Queueing Theory interrelates key system characteristics and can be used to identify where investment should be made to improve performance and effectiveness

TTCP Groups

- Aerospace Systems (AER)
- Command, Control, Communications, & Information Systems (C3I)
- Chemical, Biological, and Radiological Defense (CBD)
- Electronic Warfare Systems (EWS)
- Human Resources and Performance (HUM)
- Joint Systems and Analysis (JSA)
- Land Systems (LAN)
- **Maritime Systems (MAR)**
- Materials and Processes Technology (MAT)
- Sensors (SEN)
- Conventional Weapons Technology (WPN)

MAR Construct

- **Technical Panels:**
  - TP-1: C2 and Information Management
  - TP-9: Sonar Technology
  - TP-10: Maritime ISR & Air Systems
  - TP-13: Mine Warfare and HF Acoustics
- **Action Groups:**
  - AG-1: Net Centric Warfare Study*
  - AG-2: Novel Maritime Platform Systems
  - AG-3: Torpedo Defense
  - AG-4: Surface Ship Air Defence Systems
  - AG-5: Force Protection
  - AG-6: FORCEnet Implications for Coalitions*