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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

PANAMA CANAL CRITICALITY AND SECURITY

by

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ABSTRACT

This campaign of analysis was conducted at the request of Commander, Naval Forces South and 4th Fleet (COMNAVSOUTH/C4F). Its objective was to quantify the Panama Canal's criticality in shifting naval forces from the U.S. East Coast to the Western Pacific, and to provide wargaming support to C4F's "theory of the fight" development to ensure the Panama Canal remains a passable neutral passage between oceans. This research effort included four efforts: a Master of Systems Analysis capstone project to analyze least-cost transit alternatives in time and money that provides C4F staff an optimized routing tool; a Joint Campaign Analysis study in alternative routing worldwide including risk to force analysis; a wargame designed, developed, and executed to support COMNAVSOUTH/C4F's operational plan development; and a master's thesis in Operations Research to further develop the original optimized routing tool for worldwide operations.

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I. INTRODUCTION

A. REQUEST WARGAMING SUPPORT

This campaign of analysis responded to a request by Commander, Naval Forces South (COMNAVSOUTH) to better understand the Panama Canal's criticality and potential responses to a partial or complete loss of its seaway. Over 70% of Panama Canal annual transits originate and end in a U.S. port.(Wolf,2023)

As of 1999, the Panama Canal is owned and operated by the Republic of Panama and administrated by the Panama Canal Authority. China's influence through infrastructure investments and operations contracts has grown since 1999.(Runde 2021) The Treaty Concerning the Permanent Neutrality and Operation of the Panama Canal (Neutrality Treaty), with its stipulation to enable the United States to exert military force in the Canal's defense to any threat to its neutrality, is a deterrent to potential adversary adventurism in the Canal, but even a temporary slowing of traffic flow may have a detrimental impact on U.S. ability to "swing" naval forces and the U.S. economy.

The specific research questions and study objectives asked were as follows:

- 1.) How critical is the Panama Canal to "swing" U.S. naval forces from one theater to another?
- 2.) If the Panama Canal is not available for U.S. force transit, what are the best sea routes to shift forces based on weather patterns, distance, and mission objectives?
- 3.) What are possible U.S. actions and defenses to prevent canal denial to U.S. forces?

B. EXECUTION: A FOUR-PHASE PROCESS

The research effort was conducted in four phases. The first phase involved three Master of Systems Analysis scholars conducting a three-month study to quantify the Panama Canal's criticality by comparing cost and transit schedule differences between a Panama Canal transit and alternative routes, and providing an optimized routing decision

aid to the COMNAVSOUTH staff. The second phase (run concurrently with the Master of Systems Analysis study) included two four-officer teams from the summer 2022 Joint Campaign Analysis class conducting an analysis of worldwide routing alternatives to the Panama Canal as defined by logistics requirements and measured in lost mission days. The third phase of this research involved a four-officer team from the wargaming class designing, developing, and executing a wargame under COMNAVSOUTH sponsorship to advance COMNAVSOUTH's operational planning in late November of 2022. The final phase of this analytical campaign was conducted by operations research scholar LT Katrina Bernal, USN, who developed a worldwide routing tool based on the Phase 1 work for use by United States Fleet Forces Command.

II. CONDUCTING A QUANTITATIVE ASSESSMENT OF THE PANAMA CANAL'S CRITICALITY

A. PANAMA CANAL CRITICALITY FOR WARFIGHTING EFFECTIVENESS

In this analytical campaign's first phase, CDR William Bridges, CDR Fred Hettling and Ms. Jillian Hannah conducted a three-month study to fulfill their Master of Systems Analysis requirement to complete a capstone project. Their study examined the impact on transit times and costs of reduced access to complete denial of the Panama Canal. As part of this restricted distribution study, the team produced an Excel-based decision aid which uses optimization to provide time and cost comparisons for alternative voyage plans (Figure 1). The team briefed the COMNAVSOUTH Deputy Commander and staff on study results and provided a written report, with the decision aid, in September 2022

As an unclassified summary, Bridges, Hettling, and Hannah showed that delays ranging from 2 to 26 days in swinging specific forces from the U.S. East Coast to the Western Pacific without full access to the Panama Canal at excess costs for fuel, port fees, and tolls that ranged from from \$1 million to \$5 million dollars per ship (Bridges, Hannah, and Hettling, 2022).

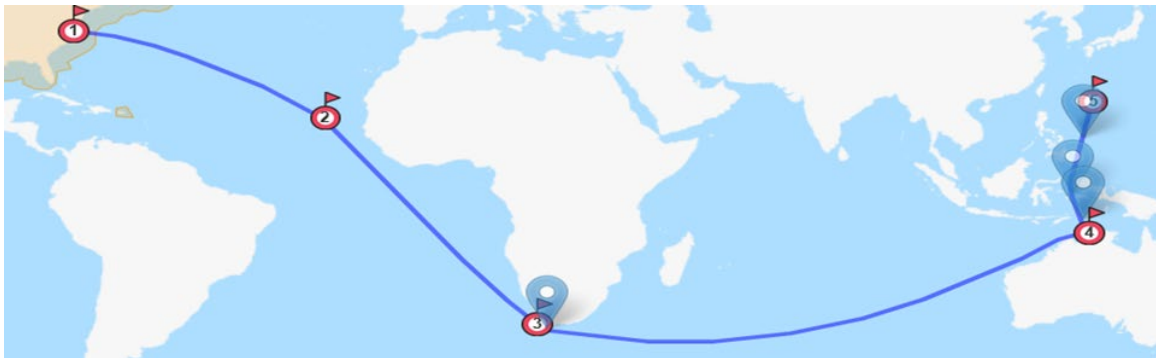


Figure 1. An example of an alternative route examined by the Panama Criticality for Warfighting Effectiveness study.

B. SUMMER 2022 JOINT CAMPAIGN ANALYSIS STUDIES

Concurrent with the Bridges, Hannah, and Hettling study effort, eight officers, divided into two teams, conducted analysis of alternative worldwide routes to the Panama

Canal as part of a Naval Postgraduate School (NPS) summer Joint Campaign Analysis study. One team considered routes that minimized at-sea refueling requirements while the other focused on an adversary's best options to attack or hinder additional sea routes and/or ports to slow force transfer to the Western Pacific. Both teams used network analysis, optimization, and attack-defender modeling to explore these options.

1. Team Blue's Transit Networks and Results

The Joint Campaign Analysis Team Blue included LCDR Jared Deiter, LCDR William Shields, LT Marcus Garcia, and Ensign Connor Rooney. They built a worldwide transit network from the U.S. East Coast to the Western Pacific, then superimposed various levels of threat from adversaries upon each node and transit arc (Figure 2). They constructed an optimized attack-defender model that indicated which areas an adversary could attack or slow to best hinder transit times and costs to U.S. forces moving from one theater to another.

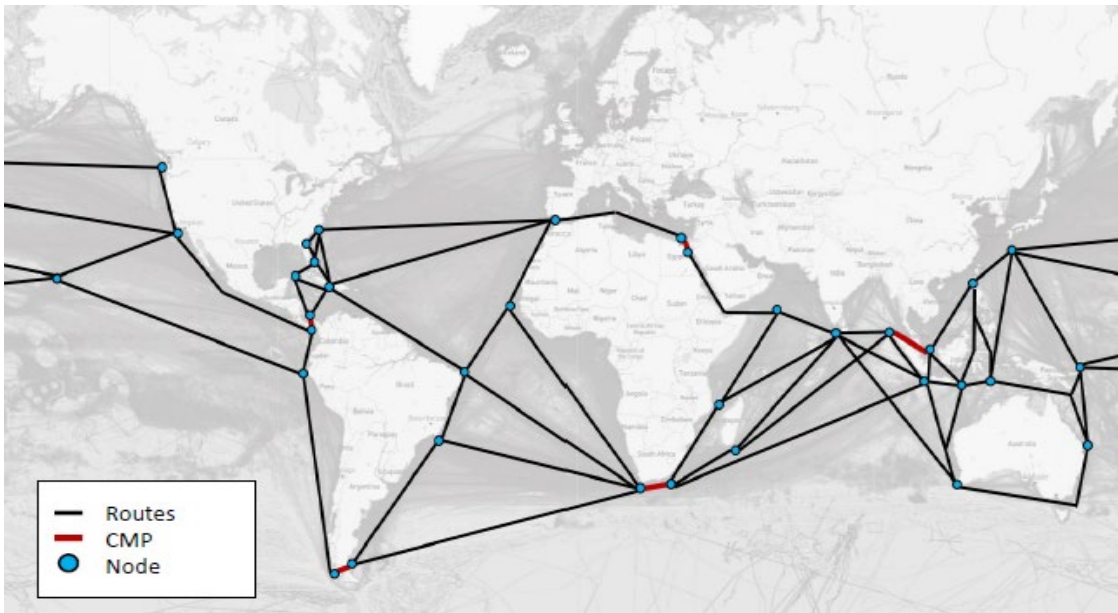


Figure 2. Worldwide transit routes modeled as a network. Through advanced attack-defender optimization, the Joint Campaign Analysis Team Blue can determine where an adversary might best attack this network given limited resources to delay U.S. force transits.

Specific results from the Joint Campaign Analysis Team Blue are restricted, but their model did confirm that the most critical link in the network is the Panama Canal. Put another way, if an adversary has sufficient resources to attack or degrade only one

link to best slow U.S. force transfer, then that link is the Panama Canal. In fact, as attack options grew for an adversary, the Panama Canal remained the top link to degrade. If the Panama Canal is hardened to attack, then this team's model will provide alternative attack options for an adversary. This information may be used to understand where the United States needs resources to ensure minimal disruptions by an adversary to a worldwide force transfer network. This team's briefings, optimization formulation, and select papers were provided to COMNAVSOUTH staff and the Phase Three wargaming design team.

2. Team Gold's Study on Logistics Requirements for Worldwide Transit Routes

The summer 2022 Joint Campaign Analysis Team Gold was composed of LCDR Adam Alleman, LCDR Nathan Marlow, LT Crystal Cornine, and LCDR Rohan Kulkarni, Indian Navy. This team also built a worldwide transit network using attack-defender modeling, but focused primary on minimizing logistics demands for alternative routes and adversary attack scenarios. Like Team Blue, Team Gold's model confirmed that the Panama Canal is attacked in every scenario in which an adversary is allowed at least one attack. At-sea logistics and refueling increased from two events per transit with the Panama Canal open to three events per transit with it closed, while average additional transit mileage was over 5,000 nautical miles. Critical ports and transit areas were also identified as lucrative attack options for adversary consideration and our attention for additional protection. Team Gold's briefing and select papers were delivered to COMNAVSOUTH/C4F staff.

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III. WARGAMING PANAMA CANAL

A. WARGAME DESIGN, DEVELOPMENT, AND EXECUTION

In the NPS fall quarter of fiscal year 2023, an officer team from the NPS Wargaming class was tasked to support C4F in development of their theory of fight development. LT Jacob Shafer, LT Crystal Cornine, LT Kyle Plunkett, and Ensign Connor Rooney worked with C4F staff to understand the sponsor's objectives for the game and desired output. From these discussions, a Data Collection and Management Plan was created; scenario and wargame design completed; wargame developed through multiple practice plays; then conducted from 6-8 December 2022. Players included the Deputy Commander, COMFOURTHFLT, various members of his staff, and NPS officers and the wargame was played at the SECRET level of classification.

B. WARGAME RESULTS

The final wargame report is classified SECRET and provided to the C4F staff. However, an unclassified summary follows:

- Even a marginal loss or reduced operations in the Panama Canal may effect delays in routing forces from the U.S. East Coast to INDOPACOM AOR of up to 11 days.
- Best alternative route in terms of time to reach INDOPACOM from the U.S. East Coast was rounding the Cape of Good Hope.
- Key infrastructure affecting routes are the serviceable ports that have the means, fuel and capacity for U.S. vessels.
- Port security may be required to maintain access to key ports in C4F AOR.
- Potential adversary action against USN routing focused first on Panama Canal, then other ports in the Americas south of the equator identified in the classified report.
- Best deterrence action to prevent interference with Panama Canal shipping is an Information Operations campaign to show the adversary's actions are detrimental to South American economies.

- Adversary actions to close or reduce traffic through the Panama Canal included merchant vessel casualties at critical canal junctions, fouled canal access by fishing vessels, sabotage of bridges spanning the canal, and sabotage of Gatun Lake dams.

IV. OPERATIONAL PLANNING TOOL FOR REROUTING

The final phase of this campaign of analysis was conducted by LT Katrina Bernal, USN, and her advisor, Dr. Jerry Brown of the Operations Research Department. LT Bernal leveraged the work accomplished in the previous three phases to create an enhanced routing decision aid for shipping across contested environments. The output identifies shortest path and least risk voyage plans with feasible logistic plans while also identifying potential locations for adversary action to further delay shipping. The description of the model follows, and the full thesis will be available when published.

LT Bernal's model creates a worldwide routing network model that demonstrates the redistribution of naval forces from the U.S. East Coast to the western Pacific Ocean in the absence of the Panama Canal. The model uses an attacker-defender construct and includes the following: worldwide routes, replenishment options, one- to two-week extended weather forecasts, and adversary action against port nodes. Data such as distances between ports and critical maritime passages was obtained from various navigational documents and from United States Fleet Forces logistic planners. Fuel consumption and fuel capacities were obtained for each surface platform from current Navy publications and documentation. Implementing an attacker-defender model with the parameters stated previously provides further quantitative insight on the vulnerabilities and risks associated with whichever route the model chooses. Such vulnerabilities and risks include but are not limited to the following: replenishment limitations (in port or at-sea), weather conditions, and platform-specific limitations (is it feasible for a destroyer or amphibious ship to transit through uncommon maritime passages?).

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V. SUMMARY

This report has outlined the process used by Naval Postgraduate School faculty and students to conduct an independent qualitative risk assessment on the criticality of the Panama Canal to U.S. naval operational planners who are concerned with sea-borne traffic from the U.S. East Coast to Western Pacific theater areas. The campaign of analysis has produced and delivered several planning tools to U.S. Fleet Forces Command and COMFOURTHFLT staff and advanced COMNAVSOUTH/COMFOURTHFLT's theory of the fight through classified wargaming.

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