VALUE FOCUSED THINKING ANALYSIS OF THE PACIFIC THEATER'S FUTURE AIR MOBILITY EN ROUTE SYSTEM

GRADUATE RESEARCH PAPER

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AFIT/IMO/ENS/11-01

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Abstract

Proper optimization in number, location, and function of supply chain nodes to reduce costs with simultaneous improvements in distribution effectiveness is a key goal for United States Transportation Command (USTC) in its execution of the National Defense Strategy. As the distribution process owner (DPO) for all things transportation, USTC ensures America's ability to project power rapidly and sustain operations globally. Studies such as the Mobility Capabilities and Requirements Study (MCRS) as well as the Global Access and Infrastructure Assessment (GAIA) have been conducted to assist USTC in identifying key infrastructure locations and capabilities to increase accessibility and improve effectiveness. This research utilizes a Value Focused Thinking (VFT) methodology and decision analysis tool to analyze the proposed en route system in the Pacific Theater, as identified by Air Mobility Command, for coverage gaps or additional capability opportunities and provide leadership with a decision tool to optimally and effectively meet America's future security challenges.

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"Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do. So throw off the bowlines. Sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream. Discover." — Mark Twain

Acknowledgements

I would like to thank my faculty advisor, Lt Col Joseph B. Skipper for his patience and counsel. His direction, insight and encouragement helped me properly scope the project and were integral to its successful completion. I would also like to thank the many individuals I spoke with at United States Transportation Command, Air Mobility Command and commercial industry partners for their direction and passionate discussions to work towards a better system.

Thanks to all of you who have stood by me over the years. Your friendship, love and admiration are the reasons why I do what I do (:p).

Finally, I would like to thank the men and women who operate our en route squadrons day in and day out. Their "never say, can't" attitudes and unparalleled work ethic has taught me a great deal about leadership, organizational pride and values. I was humbled and honored to be a part of that world, even if it was for just a short while. Thanks!

Pete "Axe" Axtell

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Introduction

> "If international politics is 'the art of the possible,' and war is its instrument, logistics is the art of defining and extending the possible. It provides the substance that physically permits an army to live and move and have its being."
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> -- James A. Huston, *The Sinews of War: Army Logistics, 1775-1953* (2004)

The quote above highlights the broader truth regarding the value of logistics in today's military environment, particularly due to the current length our nation has been at war. It does a fairly good job of illustrating that logistics is, and should be, considered to be at the tip of the spear of every military effort and serves as the primary enabler of a nation to wage war against its enemies. Understanding the intrinsic importance of logistics remains vital to carrying out the United States Air Force's (USAF) core competencies around the globe.

In recent years, however, a shift from the traditional thinking in terms of efficiency vs. effectiveness of operations has turned to that of capacity vs. capability (Gorenc, 2011), meaning efficiencies and effectiveness can be met given the appropriate level of capacity and capability. The *2010 Quadrennial Defense Review's* (QDR) priorities shape the capabilities of the Armed Forces while aggregating the capacity required to accomplish their missions not only now but well into the future (QDR, 2010).

A major key to accomplishing this is maintaining a capability to rapidly respond anywhere in the globe at a moment's notice. Access is the key to ensuring this capability exists as capacity is increasingly dwindling in the area of en route availability due to a reduced logistical footprint overseas. Along with this, Secretary of Defense Robert M. Gates, has announced budget cuts to the tune of $90 Billion over the next five years in attempts to streamline defense spending to match current economic times. He stated, "As a matter of principle and political reality, the Department of Defense (DoD) cannot expect America's elected representatives to approve budget increases each year unless we are doing a good job, indeed everything possible, to make every dollar count" (Gates, 2010).

With that in mind, the Pacific Theater Area of Responsibility (AOR) is the largest geographical theater in the world and encompasses approximately one-half of the earth's surface. Logistical challenges in moving throughout the theater are vast and continually evolving. The art of defining and extending force deployment, sustainment, and redeployment continues to challenge the greatest strategic minds we have today. The appropriate identification and selection of strategically important en route locations throughout the AOR is more important today than ever before , and will ensure the DoD's priorities can be met with the appropriate level of capability while remaining conscious of increasing budgetary restrictions.

Background

The United States Air Force's global en route system (ERS) dates back to the days of World War II and was initially developed to meet the specific demands of those times. A massive ERS had been established in the Pacific AOR largely in part due to the bases and islands occupied by US forces at the end of the war and had been left to decay since heavy uses following Vietnam (515 AMOW, 2010). The Pacific En Route Infrastructure Steering Committee (PERISC) was formed in 1999 to define the en route requirements and shortfalls associated with many of these decaying locations. They were able to identify several shortfalls and established a “two-lose one” route structure that ensured 100% throughput capability to Northeast Asia (McVickar, 2002). This Northern Route through Japan and Southern Route through Guam were created based primarily on good, predictive weather and currently favor the less efficient Southern Route (AMC Global En Route Strategy White Paper, 2009). The current en route system is steeply rooted in outdated strategy such as the 1995 Mobility Requirements Study – Bottom Up Review, and utilizes a “lens” approach. This approach identifies the sweet spot to overcome the strategic airlift fleet’s physical and technical limitations with an overlapping location of capability on a geographical map (AMC Global En Route Strategy White Paper, 2009). The lens theory doesn’t work in the Pacific AOR due to the expansive nature of accessible locations and distance from the Continental U.S. (CONUS).

Today, approximately 32% of arrivals and departures supporting the war efforts in both Iraq and Afghanistan transit through the Pacific AOR, moving roughly 26% of the cargo and 39% of the passengers (AMMP, 2010). The Air Force’s en route system used in supporting these efforts has seen almost no change in the way aircraft flow through that system (AMC Global En Route Strategy White Paper, 2009*)*. Continued missions supporting the current conflict areas, coupled with the number of humanitarian missions conducted in the region, the potential for restricted access due to political tensions or natural disasters (as seen by the recent earthquake in Japan and flooding in Pakistan), as well as geo-political instability of small states in an increasingly diverse and expansive region all highlight the criticality of reevaluating the en route structure and making important changes to meet current and future requirements.

Problem Statement

In order to accomplish the full spectrum of passenger and cargo movement, global mobility must overcome the constraints of time, distance and environment within the Pacific AOR in order to optimize its en route structure. This system has not adapted to the post-9/11 National Military Strategy (NMS) and its shift to the 1-4-2-1+ strategy, nor has it adapted to greater technological advances in both the organic and commercial fleets. The 1-4-2-1+ strategy calls for the Armed Forces to defend the homeland, operate in and from four forward regions, win two overlapping campaigns, win decisively a single campaign and conduct a limited number of lesser contingencies (AMC Global En Route Strategy White Paper, 2009*)*. The Armed Forces continue to move towards an expeditionary, joint force (NMS, 2011) and vast improvements in fuel efficiency and range / payload characteristics of strategic aircraft continue to increase capability.

The Pacific AOR is the only Geographical Combatant Command (COCOM) to have strategic airlift assets assigned to them at Hickam Air Force Base (AFB), HI and Elmendorf AFB, AK. Both locations are considered to be part of the en route system as it stands today and not Aerial Ports of Embarkation (APOE). This placement of capability at a location that has no validated cargo or passenger mission (these do have validated aeromedical evacuation missions using KC-135 aircraft) creates inefficiencies and highlights the need for a globally interconnected system of en route capability and capacity. The purpose of this research is to analyze AMC’s proposed en route structure for 2015 and beyond and determine if an optimal and appropriate level of access will exist to meet our national strategies well into the future.

Research Focus and Questions

Several research projects similar in nature to this research effort have been conducted in the past. The first focused on goal programming to evaluate factors associated with 25 locations to establish a "top ten" list of eligible en route locations (Sere, 2005). These factors included en route distance, Maximum on Ground (MOG), fuel availability and diplomatic relations of each location and were scored using a weighted distribution to compare and contrast the "best" location.

The next research effort focused on those same factors but added throughput capability into the formula (Voight, 2005) highlighting those locations with a greater potential for throughput. The third area of research was conducted using a value focused thinking (VFT) methodology (Tharaldson, 2006) to obtain detailed analysis of each location within the en route structure and its characteristics. From this research effort, a decision analysis tool (Mirivate & Schlegel, 2006) was created to quickly determine and analyze which factors are most important for a given location or region and how important that location is within the en route system to the individuals making the decisions.

These efforts identified a lack of capability in the current system, and established the means to import political and security concerns into the decision process. However, since that time, nothing of significance has been accomplished in this area of study while requirements for a valid study continue to grow. This research will utilize the model (updated to match future requirements) and VFT methodology to analyze those locations identified by AMC to serve as the future en route structure from 2015 and beyond.

In order to properly evaluate the various en route locations, several questions will require explanation. These questions are:

1. What were the assumptions and requirements for a specific location to be included in proposed future en route system?

2. What factors are important characteristics to measure an en route location of the future?

3. Does the proposed system of en route locations offer global access in the Pacific Theater given the assumptions and requirements provided by AMC?

4. What new locations could extend and/or strengthen the proposed en route system?

Implications

This research will provide decision-makers at Headquarters AMC with a value-focused thinking assessment of the future system of en route locations to minimize costs and/or time in the execution of AMC's strategic airlift missions. It hopes to feed into ongoing and future studies within AMC, such as future Mobility Capabilities and Requirements Studies (MCRS) as well as USTRANSCOM's ongoing Global Access and Infrastructure Assessment (GAIA). These studies provide the analytical underpinnings in which the proposed en route posture and required infrastructure will be based on for future years.

Paper Format

Section I was a simple introduction to the research study to provide the reader with a basic level of understanding of what the research entails and hopes to uncover. To preclude redundancy in the following chapters, the background, methodology and model explanations were not discussed in any detail in Section 1 but will be covered in Section II. The format for the remainder of this document will be as follows: Section II presents the study as a whole, in a publishable, article format. Section III will provide conclusions of the study and recommendations for further study based on the findings and will hold minor redundancy from what is discussed in detail in Section II. Appendices can be found at the end of the paper containing appropriate data from the research.

Draft Article

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> "If international politics is 'the art of the possible,' and war is its instrument, logistics is the art of defining and extending the possible. It provides the substance that physically permits an army to live and move and have its being."
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Abstract

Proper optimization in number, location, and function of supply chain nodes to reduce costs with simultaneous improvements in distribution effectiveness is a key goal for United States Transportation Command (USTC) in its execution of the National Defense Strategy. As the distribution process owner (DPO) for all things transportation, USTC ensures America's ability to project power rapidly and sustain operations globally. Studies such as the Mobility Capabilities and Requirements Study (MCRS) as well as the Global Access and Infrastructure Assessment (GAIA) have been conducted to assist USTC in identifying key infrastructure locations and capabilities to increase accessibility and improve effectiveness. This research utilizes a Value Focused Thinking (VFT) methodology and decision analysis tool to analyze the proposed en route system in the Pacific Theater, as identified by Air Mobility Command, and provides leadership with a decision tool to optimally and effectively meet America's future security challenges.

Background

Strategic Landscape

The United States' most recent National Defense Policy and overarching strategies to carry out that policy highlight a globally dispersed, requirements-based capability to sustain major campaigns in distant locations and the need for an agile and rapidly deployable capability. This underlying expectation relies on the United States Armed Force's ability to plan and operate under the premise that forces will remain expeditionary by nature. Achieving this in an uncertain and expansive operational environment like that found in the Pacific Theater (AOR from this point forward) requires robust sealift, airlift, aerial refueling, and pre-positioned assets (USTC Strategy Plan, 2011).

These assets must become an increasingly agile force able to rapidly achieve objectives in simultaneous, overlapping military operations to support a 1-4-2-1+ strategy; calling for the Armed Forces to defend the homeland, operate in and from four forward regions, win two overlapping campaigns, win decisively a single campaign and conduct a limited number of lesser contingencies (AMC Global En Route Strategy White Paper, 2009*)*. This may seem an impossible task given the state of the current economic environment and ongoing defense budget cuts. Defense Secretary Robert Gates stated, "If the Department of Defense can't figure out a way to defend the United States on a budget of more than a half a trillion dollars a year, then our problems are much bigger than anything that can be cured by buying a few more ships and planes… (Joint Operating Environment, 2010:69)."

As the United States' overseas military presence reduces due to global defense posture realignments, we will need to develop and leverage a more agile, expeditionary force and be capable of moving and sustaining that force over greater distances to protect our national interests (National Military Strategy, 2011). USTC has identified key areas in the globe that remain hot spots of hostility and instability, or are areas prone to natural disasters and will require the preponderance of airlift support. These areas are Southwest Asia, Southeast Asia, Korea, Indonesia, Africa and Eurasia (AMC Global En Route Strategy White Paper, 2009).

Efficiency and effectiveness will become increasingly difficult to maintain a balance with capacity and capability to meet the needs of both the war fighter and those on Capitol Hill. The AOR's tyranny of distance will always influence the conduct of America's wars. The challenge ahead, lies in the ability to overcome these challenges associated with moving forces over great distances and maintaining the capacity and capability to supply them with fuel, munitions and sustenance (Joint Operating Environment, 2010). General Hap Arnold once said, "Air power is not made up of airplanes alone. Air power is a composite of airplanes, aircrews, maintenance crews, air bases, air supply, and sufficient replacements in both planes and crews to maintain a constant fighting strength . . ." (Arnold, 1989). Pacific en route bases are the key enablers of the agility, versatility and flexibility that the United States needs to achieve its strategic objectives and rapidly employ and sustain its expeditionary combat forces.

History of the En Route System

Having the capability to resupply at an en route location is nothing new and its strategic importance can be determined simply by looking at any conflict throughout the world's history. For the United States, the preponderance of the AOR's en route locations (Figure 1) came from what bases were held at the end of World War II. En route bases totaled approximately 141 locations within the Pacific alone (Haulman, 1997). Those staggering numbers have since shrunk considerably in comparison to what you see in the AOR today particularly due to organizational realignments and budgetary reductions associated with the number of required forward deployed locations following the Cold War (515 AMOW, 2010). Many of the remaining bases were left in a state of decay and have required tremendous efforts to "right-size" the force. This decay, among other things, led to the creation of the European En Route Infrastructure Steering Committee (EERISC) in 1996, and 1999 for the Pacific En Route Infrastructure Steering

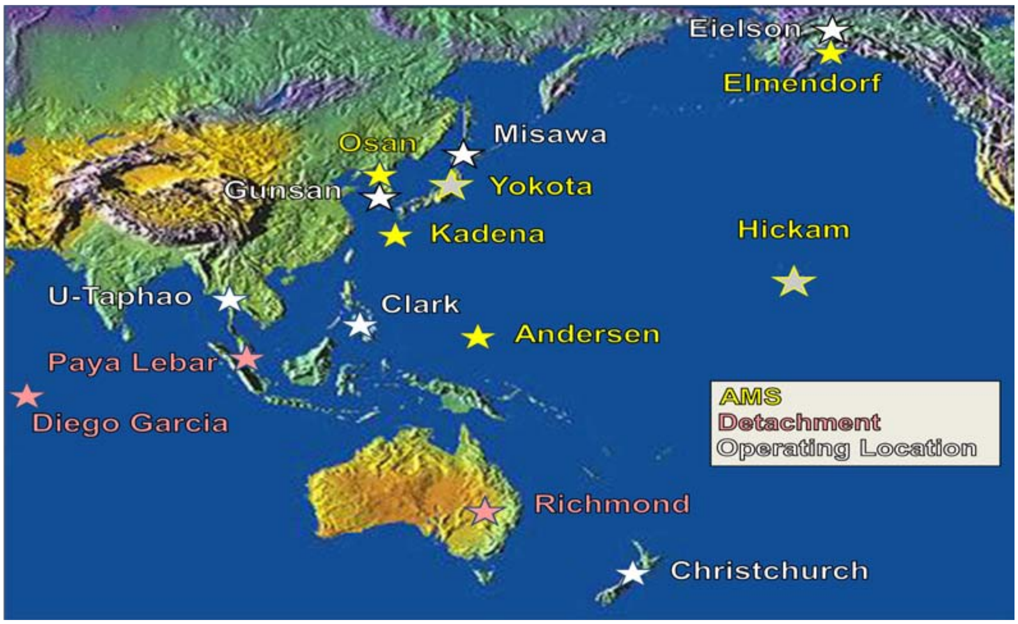


Figure 1. The Current Pacific En Route System (515 AMOW)

Committee (PERISC). These two committees were developed to advocate for the respective en routes and to develop and guide an appropriate strategy. Both committees proved valuable in correcting many of the deficiencies associated with individual airfields, but tended to be AOR-centric when it came to strategy. A Global En Route Infrastructure Steering Committee (GERISC) was established to balance both AORs strategic requirements with those assets available and has led to a global view, rather than just a theater view (Naylor, 2009).

In order to understand the current system, it's important to understand some of the basic concepts that USTC and AMC use in the planning process associated with its en route network. The current en route system is primarily based on an outdated "lens methodology" that utilizes a 3,500 Nautical Mile (NM) ring from the Aerial Port of Embarkation (APOE) (McVickar, 2002). The APOE is a CONUS base in which cargo or passengers originate from. The location that the cargo or passengers are scheduled to be dropped off at is called the Aerial Port of Debarkation (APOD). Creating city-pairs (APOE-APOD) has become the primary method of validating and assigning the airlift requirement for all services, regardless of cargo or mission type. The 3,500NM ring is drawn from the APOE and APOD to identify suitable locations for en route support in the overlapping rings. This methodology worked fairly well in the European theater due to the proximity of available bases, but it does not work well in the Pacific.

Rather than focusing on potential supporting locations between an APOE and APOD in the Pacific, straight-line routes were developed. A strategy of two-lose one routing enabled a single route to support 100% of the throughput requirements to Northeast Asia from the West Coast should the other route not be available due to weather or other factors (McVickar, 2002). This strategy is evolving into a "two route plus" strategy (Figure 2) which continues to follow the two-lose one strategy with the "plus" eluding to the ability to use both routes while mitigating chokepoints (AMC Global En Route Strategy White Paper, 2009). The Northern Pacific route routed aircraft through bases in Japan but was subject to harsh winter weather and required a robust all-weather capability at the en route locations. While this was a shorter, fuel efficient route, it was not heavily used. The Mid-Pacific route through Guam, albeit longer and less fuel efficient, has predictable weather patterns that remain good for flying in the majority of the year and has become the predominant route used for aircraft flow in the Pacific (AMC Global En Route Strategy White Paper, 2009).

Figure 2. The Proposed Two Route-Plus Strategy (AMC, 2009)

Another fundamental flaw in the lens methodology is the continued utilization of 3,500NM as the planning range for today's aircraft. The strategic airlift lens was based on the range of a C-17A carrying 90,000 pounds of cargo (McVickar, 2002) and has become the standard strategic airlift planning factor utilized out of *Air Force Pamphlet 10-1403, Air Mobility Planning Factors,* since its release in March, 1998. This is non-representative of the strategic airlift fleet we have today and was due to the initial C-17's not having a centerline fuel tank. The Air Force fixed this limitation by installing a centerline fuel tank on every aircraft (called extended range aircraft) beginning with the 71st airplane and is retrofitting the initial 70 airplanes that did not have them installed (Congressional Research Service, 2008). If we look at the primary strategic aircraft carrying cargo for the USAF today, we'd see the range of the C-17A (extended range aircraft) carrying 90,000 pounds of cargo actually sits at 5,000NM, the C-5M carrying 270,000 pounds of cargo sits at 6,300NM (Congressional Research Service, 2008), and the 747-400 carrying 265,000 pounds is approximately 8,500NM, depending on aircraft configuration and engine type (Boeing, 2011). Using this outdated, non-regulatory guidance as gospel works well where land mass is abundant but not in many areas of the Pacific.

One final aspect of the en route locations worth discussing here is just how the airfields are categorized for the support they can provide and how subjective that categorization can be. This system is called the Tier system and classifies airfields based on the Air Mobility Squadron's (AMS) capability at that airfield. The Tier system looks at capabilities of the categories as seen in Figure 3 and combines maintenance capability

Capability	Tier I	Tier II	Tier III	Expeditionary
Operations	24/7 w/ AMCC	24/7 w/ AMCC	Less Than 24/7, AMC Permanent Presence	No Enduring AMC Presence
Maintenance	WMOG = 3 Or More, R&R, Predictive Mx, Limited Backshop, 2 Or More MDSs, => 15 Acft/Day Throughput	WMOG = 1 Or More, Skill Sets For 2 MDSs, 5-14 Acft/Day Throughput	WMOG = 0 – 1, 0-4 Acft/Day Throughput	As Mission Dictates Rotational Forces
Refuel	20 WB W/in 24 Hrs, Demand = 600K Sustained, 1M Surge 3M Gal Store	10 WB W/in 24 Hrs, Demand = 300K Sustained, 500K Surge 1.5M Gal Store	5 WB W/in 12 Hrs, Demand = 150K Sustained, 200K Surge 750K Gal Store	As Mission Dictates
Aerial Port	WMOG = 3 Or More Wide-Body Acft Full hub/spoke services and passenger handling, provides full-spectrum to limited distribution services (multi-modal) in support of DPO mission, may include full break-bulk and cross-dock operations	WMOG = 1 Or More Wide-Body Acft Provides in-transit aerial port support and passenger handling, to include: trans-load, moderate break-bulk, flightline-to-truck dock "customer receipt" aerial port services	WMOG = 0 – 1 Provides limited aerial port services and passenger handling, to include: import/export capability only--can expand services as required with manpower/equipment augmentation	As mission dictates rotational forces initially established with Air Mobility Contingency Response (port opening) capability. Can be sized as necessary to meet full distribution capability or limited "customer "receipt" capability.
C2	24/7 ops, 2 or more controllers	24/7 ops, single controller	less than 24/7 ops	As required

Figure 3. AMC/A4 En Route Tier Classification

with aerial port capability to scope that location's throughput capability. Each location is then reviewed each year by AMC/A4 to ensure the current Tier-level assigned is still valid. The problem with this is that the weight for each capability may be different by region and could paint an entirely different picture depending on which weight is assigned by AMC/A4 (AMC Global En Route Strategy White Paper, 2009). This also leads to an individualistic approach in that a geographical area is only as capable as its highest tier level, rather than a system of en routes that create a network of capabilities for an entire area.

Mobility Studies for the Future

Air Mobility Command began regular studies of the en route system following concerns associated with movement of cargo in support of Operations Desert Shield and Desert Storm. Questions were raised by senior military officials as to the length it took to deploy equipment (Naylor, 2009). These questions resulted in study being conducted by USTC called the Mobility Requirements Study (MRS) and intended to identify and quantify the mobility capabilities needed to support strategic objectives for the future. This study identified several limitations in the capabilities of USTC, but due to the shift of the NMS to be able to fight two simultaneous major theater wars (MTW) shortly after it was released, a significant shift in strategy occurred. This resulted in a new study called the Mobility Requirements Study Bottom-Up Review Update (MRS-BURU) in 1995 and remains the predominant strategy for which the current en route system falls under.

Follow-on studies have been conducted by AMC since then, MRS 2005 and Mobility Capabilities Study 2005, but no changes to the strategy or en route structure has been done since the MRS-BURU. The MCS concluded that the overseas infrastructure, not aircraft available, was the key to reducing delivery timelines of large scale deployments (AMC Global En Route Strategy White Paper, 2009). The Government Accounting Office conducted a two-year review of the most recent MCS and questioned the validity of the report. They stated, "Until DoD conducts an adequate and complete future MCS and clearly discloses all limitations and their effects on the study results, decision makers likely will not have full information concerning DoD's mobility capabilities (GAO-06-938, 2006:13)."

To assess mobility requirements in the post-9/11 strategic arena, two comprehensive studies are underway within the DoD. USTC began its Global Access and Infrastructure Assessment (GAIA) in 2007 (ongoing) to examine global access and infrastructure needed to support the Joint Deployment Distribution Enterprise (JDDE), develop strategy to ensure that access and to shape the Mobility Capabilities and Requirements Study (MCRS) being conducted by DoD (AMC Global En Route Strategy White Paper, 2009). The MCRS-16 study was a joint, collaborative interagency study to assess the JDDE as executed in the 2016 timeframe using 2009 programmed forces under the ability to fight 2 MTWs and was completed in 2009.   The study assessed the mobility system's performance by examining how force closures supported the achievement of U.S. objectives (Lude, 2009) and was designed to coincide with and shape the 2010 QDR. The GAO has once again weighed in on the validity and accuracy of the study by stating,

> It [MCRS-16] may not fully provide the level and type of information that would allow DoD and congressional decision makers to clearly understand what mobility systems are needed, how many are needed, and what the risks are of

> having too many or not enough of each asset to meet the defense strategy (GAO-11-82R, 2010).

The report did state that current en route infrastructure was sufficient in all theaters to support fuel requirements for deploying and sustaining forces; however, as seen by the Tier system above, other factors may significantly affect the en route capability to support the forces. This is also highlighted in the GAO's analysis of the 2010 QDR by noting, "DoD also defines sustainment as providing logistics - delivering materiel such as ammunition, spare parts, and fuel to military forces - to maintain operations. According to DoD officials, the QDR analyses did not include a detailed analysis of supplying forces with food, fuel, and spare parts (GAO-10-575R, 2010)."

These en route historical challenges and reportedly incomplete analytical studies make the future study of en route bases that much more important. A comprehensive, capabilities-based approach balancing near-term capabilities with long-term requirements, while incorporating a global perspective on military and strategic risk is essential for decision makers to program forces of the future. Integrating these concepts ensures military forces possess the capability to rapidly conduct globally dispersed, simultaneous operations in support of the ever-evolving National Defense Strategy.

Research Problem Statement and Questions

In order to accomplish the full spectrum of passenger and cargo movement, global mobility must overcome the constraints of time, distance and environment within the Pacific AOR in order to optimize its en route structure. This system has not adapted to the post-9/11 National Military Strategy (NMS), nor has it adapted to greater technological advances in both the organic and commercial fleets. The purpose of this research is to analyze AMC's proposed en route structure for 2016 and beyond and determine if an optimal and appropriate level of access will exist to meet our national security strategies well into the future. This study utilizes a Value Focused Thinking (VFT) methodology and decision analysis tool to analyze the proposed en route system in the Pacific Theater, as identified by Air Mobility Command, and provide leadership with a decision tool to optimally and effectively meet America's future security challenges. The decision analysis tool, Global En Route Base Infrastructure Location (GERBIL) model, looks at 27 different measures at a location to provide a comprehensive analysis of command values.

In order to properly evaluate the various en route locations using command values, several questions will require explanation. These questions are:

1. What were the assumptions and requirements for a specific location to be included in proposed future en route system?
2. Which factors are important characteristics to measure an en route location of the future?
3. Does the proposed system of en route locations offer global access in the Pacific theater given the assumptions and requirements provided by AMC?
4. What new locations could extend and/or strengthen the proposed en route system?

Methodology

To tackle this expansive problem associated with the en route selection criteria, the researcher used a value focused thinking methodology and incorporated those values, as defined by AMC and USTC, into a decision tool model. The research looks at the 20 proposed en route airfields, as well as 8 additional airfields not identified by AMC, for potential value. The methodology and process is discussed in further detail below.

Value Focused Thinking

Value Focused Thinking (VFT) is simply a decision analysis approach to aid decision makers in making optimal decisions via a systematic process. It's a structured method for incorporating the information, opinions, and preferences of the various relevant people into the decision making process and of which the main premise is based on a value system (Kirkwood, 1997). Values are fundamental to the way we live our daily lives and should be included in the way we make decisions. "They [values] are principles for evaluating the desirability of any possible alternatives or consequences (Keeney, 1994:33)." This style of decision making is ideal for our national strategies as "our Nation's security and prosperity are inseparable. They are sustained by our values and leadership in the international order (NMS, 2011:1)."

The future studies identified above continue to focus on the current way of doing business and utilize the lens methodology for en route location selection. Keeney identifies this type of thinking as Alternate Focused Thinking (AFT), in that decision makers continue to focus on alternatives, or a heuristic approach, rather than on the values associated with the problem (Keeney, 1992). This essentially leads to choosing the "best of the worst" and evidence of this methodology can be seen throughout our military's acquisition history (Kirkland, 1997). VFT overcomes this by identifying and structuring values pertinent to the decision required and provides the decision maker with an evaluation of objective criteria and value tradeoffs to make optimal decisions. This structure is known as a value hierarchy which specifies the important evaluation considerations and providing the structure in which to identify and measure alternatives (Falcone, 2007).

Value hierarchies have been used in several research efforts in the past to look at potential en route locations for the future. Sere (2005) and Voight (2005) started the analysis of the en route structure using goal programming methodology to establish weighted scores based on several factors for each en route. Tharaldson (2006) expands on their research by using a ten-step VFT process and creation of an En Route Location Selection (ERLS) model based on a 6-tiered value-focused hierarchy that measures the score of an en route location given an origin and destination pairing. This hierarchy was further expanded upon by Miravite and Schlegel (2006), as seen in Figure 4, to adequately cover all concerns necessary to evaluate a given objective. This study utilizes

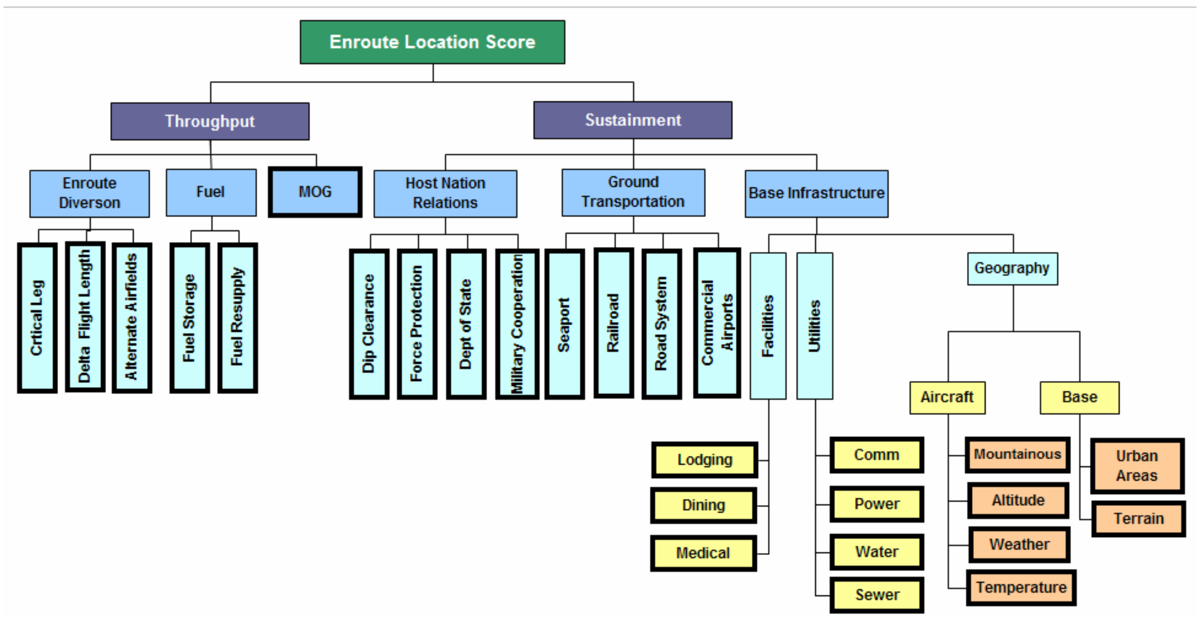


Figure 4. En Route Base Selection Tactical Sub-Model (Miravite, 2006)

this value hierarchy to comprehensively calculate values for twenty seven different measures of an alternate for each en route location proposed by AMC in its *Global En Route Strategy White Paper* (2009). This hierarchy is termed as the tactical sub-model which is then embedded into a higher level model, termed the operational value hierarchy (Miravite, 2006). The operational value hierarchy and tactical submodel are discussed at length further on.

Global En Route Basing Infrastructure Location Model (GERBIL)

Description

GERBIL is an Excel-based computer program developed in 2006 to evaluate en route alternatives given a set of value measures input by a user. It provides a simple and user-friendly interface to examine different scenarios through data inputs for an origin, alternative en route and destination. These scenarios then assess the value of en route possibilities which will best support operations from the given APOE.

One of the key features of the model is the capability to change the weights of both the tactical sub-model and operational hierarchy to adjust for changing geo-political conditions. "The weights of each objective can be changed locally for each branch, and the program includes an application of Clemen and Reilly's (2001) swing weighting technique to make the solicitation of weights from the decision maker easier (Miravite, 2006)." This highlight's the model's validity in assuring the appropriate values are represented given the different values of each location and enables the decision maker to create optimal decisions. In the Pacific AOR this will prove extremely important given the expansiveness of area and differing values associated in each region. For greater detail on GERBIL, see Miravite and Schlegel (2006).

Tactical Sub-Model

As previously mentioned, the tactical sub-model is a 6-tiered value hierarchy that, given a specific APOE and APOD, will measure those attributes that are valuable at a given en route. The main tiers are divided into two main planning factors: throughput and sustainment. Throughput in simple terms is how much air traffic flow a given airfield can handle during a 24-hour period and is identified by the tier designation for the en routes. For example, a Tier one en route can handle a throughput requirement of 15 or more aircraft per day (as seen in Figure 3).

Measure	**Type of Value Function**	**Original Global Weight**
Critical Leg	Continuously Decreasing	0.111
Δ Flight Length	Continuously Decreasing	0.099
Alternate Airfields	Continuously Increasing	0.037
Fuel Storage	Continuously Increasing	0.099
Fuel Resupply	Continuously Increasing	0.066
MOG	Continuously Increasing	0.138
Diplomatic Clearance	Categorical	0.068
Force Protection	Categorical	0.068
Dept. of State	Categorical	0.045
Military Cooperation	Categorical	0.045
Seaport	Continuously Decreasing	0.067
Railroad	Continuously Decreasing	0.015
Road System	Continuously Decreasing	0.037
Commercial Airport	Continuously Decreasing	0.030
Lodging	Categorical	0.011
Dining	Categorical	0.011
Medical	Binary	0.009
Communications	Categorical	0.007
Power	Categorical	0.006
Potable Water	Categorical	0.005
Sewer	Categorical	0.005
Mountainous	Binary	0.004
Altitude	Binary	0.005
Weather	Categorical	0.004
Temperature	Binary	0.002
Urban Areas	Binary	0.004
Terrain	Binary	0.004

Table 1. Tactical Sub-model Measures, SDVF and Global Weights

Throughput gets further broken down in the model by looking at alternate diversion, fuel capability, and Maximum on Ground (MOG). These three sub-categories measure the effectiveness of the throughput capability. Sustainment looks at an ability to support operations on a more permanent basis and to adequately determine if a long-term operation at the en route is possible. Sub-categories include host nation relations, ground transportation and base infrastructure (Miravite, 2006). These twenty seven measures each have a user designated single dimensional value function (SDVF) assigned to them. Table 1 shows the original measure, value function type and original global weightings of the tactical sub-model.

Changes to the model for purposes of this research include a greater emphasis on throughput and multi-modal capabilities at the en routes. While these are not new, both factors are viewed with greater importance in recent years. There have been several operational unit movements conducted at reduced costs and deployment timelines due to the ability of USTC and AMC to exploit the benefits of throughput and multi-modal capabilities. For the purposes of GERBIL, the SDVF's for MOG, Critical leg and Seaport were adjusted to meet current assumptions and expectations. The MOG SDVF upper bound was changed from 30 to a more realistic expectation of 15 aircraft given a surge. The target value was also reduced to a steady state value of 6 aircraft rather than the previous 20. The Critical Leg SDVF upper and lower bounds were changed to 2,000NM and 4,225NM, respectively to match AMC assumptions and AFPAM 10-1403 planning guidelines as used by USTC. The target value is still set at 3,500NM but incorporates the capability of newer aircraft ranges. The Seaport SDVF has a reduced upper bound set at 200 miles with a greater value placed at 30 miles from the airfield. This reduced mileage makes the increasingly utilized and evolving capability of the Joint Task Force – Port Opening (JTF-PO) mission for USTC more viable and adds greater value for the selection of future en route locations. SDVF charts can be seen in Appendix B.

For those areas of uncertainty in the model, both triangular and empirical probability distributions are built in to compensate for the uncertainty. For example, if the user is not sure of the fuel storage capability at a field, they can enter a lower bound amount (most likely) and an upper bound amount to get a triangular distribution. This then incorporates the expected value into the model. Similarly, for those measures that are categorical and unknown, a discrete empirical distribution is incorporated specifying the probability of the unknown measure (Miravite, 2006).

Mathematically, the tactical sub-model is computed by taking the value for each of the 27 measures, $v_i^T(\alpha_i^T)$, for an alternative, A, is weighted by w_i^T and summed to calculate the value of the alternative, $v_T(A_d)$, given a specific APOE and APOD (Miravite, 2006:10).

A mathematical representation of the tactical sub-model scoring equation (1) and definitions is depicted below:

D	set of all possible destinations
A	an en route alternative
D_A	$D_A \subset D$. The set of destinations feasible to A and whose great circle distance between the origin and destination is greater than the maximum critical leg value (i.e. an en route airfield is required)
d	specific destination
a_i^T	measurement level of attribute *i* of the tactical sub-model
$v_i^T(a_i^T)$	SDVF of attribute *i* of the tactical sub-model
w_i^T	global weighting factor for attribute *i* of the tactical sub-model

$$V^T(A_d) = \begin{cases} \sum_i w_i^T \, v_i^T(a_{id}^T) & where \quad \sum_i w_i^T = 1, \;\; if \; d \in D_A, \\ 0 & otherwise \end{cases} \tag{1}$$

This formula will enable the identification of en route candidate airfields within the model; however, the tactical sub-model does not have the capability to calculate operational scenarios that incorporate national security objectives and the probability that a specific airfield will be used. Therefore, the resulting tactical sub-model score is then incorporated into the operational value hierarchy as a weighted input, as seen in Figure 6 and as discussed below.

Operational Value Hierarchy

In order to better evaluate regional security values and the probability that airfields will be utilized in a given scenario, the tactical sub-model is incorporated into an operational value hierarchy which calculates all three considerations. The branches, as seen in Figure 5, are weighted values assigned and are equal to one. The tactical sub-model score was previously discussed. The probability of utilization is a weighted score based on the probability that a regional event will occur requiring the use of that en route airfield. The third branch, National Security, measures the value of the region as it pertains to national objectives. These additional factors are extremely important in the Pacific not only due to the expansive nature and volatility of the region, but also in maintaining the ability to reach those key areas defined by USTC.

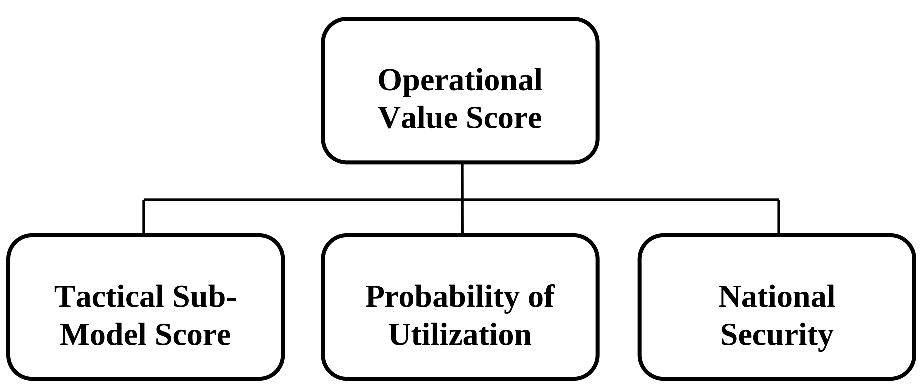


Figure 5. Operational Value Hierarchy

Probability of Utilization

As previously mentioned, the probability of alternative utilization scores the probability that a regional event will occur requiring the use of that en route location within the region. In order to accomplish this, the Prospect Theory is used, which takes into account the tendency of individuals to under or overestimate the probability weight (Miravite, 2006). This estimation occurs for several reasons; an individual's risk bias, experience level or consequences of the decision, etc. can all affect the probability assigned. Therefore, the prospect function enables the model to arrive at a value, weighting the individual decision maker's risk acceptance (y-axis) with the corresponding probability (x-axis). This relationship can be seen in Figure 6.

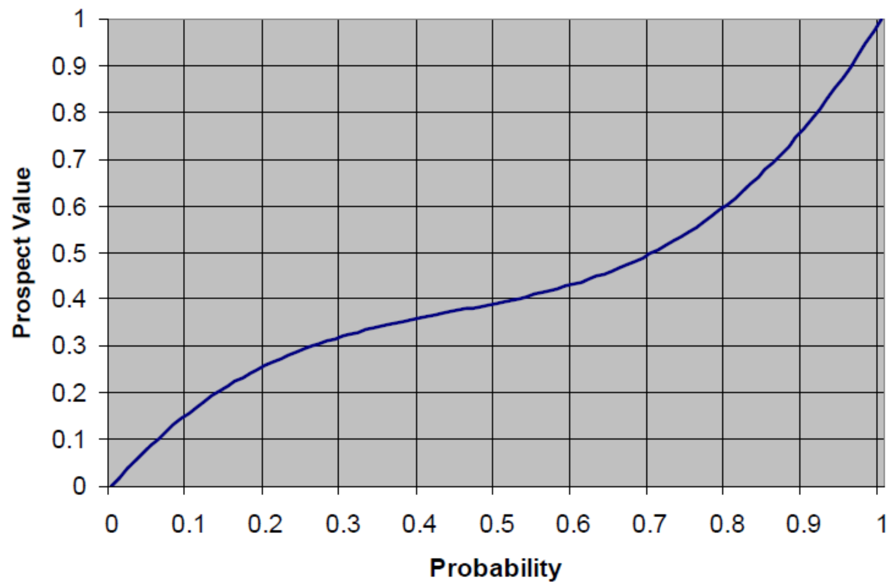


Figure 6. Prospect Function

The SDVF for the probability of utilization of the destination airfield, P_d, is given a value, $V^P(A_d)$, by using the Prospect Function, $\pi\ (P)$, shown in equation (2) and incorporated into the value function for the probability of utilization as shown in equation (3).

P_d subjective probability as determined by the decision maker

$\pi\ (P_d)$ value of the subjective probability from the Prospect Function

$$\pi\ (P_d) = 1.89799P_d - 3.55955P_d^2 + 2.662549P_d^3 \tag{2}$$

$$V^P(A_d) = \begin{cases} \pi\ (P_d) & d \in D_A, \\ 0 & otherwise \end{cases} \tag{3}$$

This formula allows the model to account for some of the behavioral aspects of over-assigning or under-assigning a probability to an unknown event and assigns value weightings of probability for the model.

National Security

The third and final branch is the National Security import of the destination region, as defined by the decision maker. The model utilizes a VFT decision tool matrix to assist the decision maker in assessing the overall value to be assigned. The tool (Table 2) utilizes a sliding scale from one to ten to assess the impact of the en route's regional value to National Security interests. These interests tend to change regionally and can be instantly updated depending on the guidance provided or decision required. The decision maker can either input the value deterministically or stochastically. If the value is stochastic, it is evaluated utilizing the triangular distribution method as previously discussed in the tactical sub-model (Miravite, 2006).

The SDVF for the National Security import of a destination, $v\ (N_d)$, given the regional determination by the decision maker, N_d, is represented in the value function for the National Security Import found in equation (4). This formula simply assigns a weighted value to the model based on the decision maker's assessment of the region based on the import decision tool.

N_d National Security import for destination d. $N_d = [1, 10]$

$v\,(N_d)$ National Security import SDVF of destination d

$$V^N(A_d) = \begin{cases} v\,(N_d) & d \in D_A, \\ 0 & otherwise \end{cases} \quad (4)$$

NATIONAL SECURITY IMPORT		Minor Allies	Major Allies	US
1	None. Region has no impact in any area for US or allies.	GREEN	GREEN	GREEN
2	Slight. Instability/crisis in region has minimal impact on some US minor allies, but not the US or its major allies.	YELLOW	GREEN	GREEN
3	Minimal. Instability/crisis in region has major impact on some minor allies or minimal impact on some major allies. No impact on the US.	ORANGE	YELLOW	GREEN
4	Low. Instability/crisis in region has significant impact on some minor allies and minimal impact on some major allies. No impact on the US.	RED	YELLOW	GREEN
5	Low/Moderate. Instability/crisis in region has significant impact on some minor allies. Minimal impact on major allies and the US.	RED	YELLOW	YELLOW
6	Moderate. Instability/Crisis has minimal impact on major allies and minimal impact on US.	RED	ORANGE	YELLOW
7	Moderate/High. Instability/Crisis has major impact on major allies and minimal impact on US.	RED	ORANGE	YELLOW
8	High. Instability/Crisis has major impact on major allies and major impact on US.	RED	ORANGE	ORANGE
9	Very High. Instability/Crisis has significant impact on major allies and major impact on US.	RED	RED	ORANGE
10	Extremely High. Instability/Crisis definitely has significant impact on US and major allies.	RED	RED	RED

GREEN – no impact; YELLOW – minimal impact; ORANGE – major impact; RED – significant impact

Table 2. National Security Import Decision Tool (Miravite, 2006)

Once the values are computed for all three branches of the Operational Hierarchy, a composite value is provided as seen in equation (5) to arrive at the en route's overall value for a specific APOE/APOD. This process is then repeated for a given en route alternative for an entire set of APODs and gives a total value, $V_{OP}(A)$, equation (6), for a specific en route location given the APOE. This allows destinations that may not be used given a specific APOE, to receive additional value to the decision maker for its capability to serve more than one APOE/APOD, thus receiving a higher overall score.

The equations are as follows:

$$V_{OP}(A_D) \;=\; \begin{cases} w_{OP}^{T}V^{T}(A_d) + w_{OP}^{P}V^{P}(A_d) + \; w_{OP}^{N}V^{N}(A_d) & d \;\in\; D_A, \\ 0 & otherwise \end{cases} \qquad (5)$$

$$\text{Where,} \quad \textstyle\sum_{i \,\in\, \{T,P,N\}} w_{OP}^{i} = 1$$

$$V_{OP}(A) \;=\; \textstyle\sum_{d \,\in\, D} V_{OP}(A_D) \;=\; \sum_{d \,\in\, D_A} V_{OP}(A_D) \qquad (6)$$

Case Study Set-Up

In order to properly analyze the proposed en route structure for the future, as desired by AMC, the first two research questions need to be answered. Both of these research questions are answered by the *AMC Global En Route Strategy White Paper*, 2009 and from discussions with AMC/A9A, AMC/A8X and USTC's Joint Distribution Process Analysis Center (JDPAC). AMC's assumptions (Appendix A) were created to support the overall goal of global access. Global access seeks to enhance seam coverage for current and anticipated areas of interest, preserve prior infrastructure while identifying new requirements that are fiscally optimized, minimize operational risk and maximize operational capabilities of current airframes (AMC Global En Route Strategy White Paper, 2009). GERBIL incorporates the assumptions identified by AMC.

Requirements for inclusion of an en route location are primarily based on throughput capability, force protection and infrastructure availability. The current en routes, as well as locations designated as potential future en route locations, are found in Table 3 and were the focus of the model simulations. GERBIL incorporates the requirements listed by AMC and USTC in the 27 measures of the tactical sub-model.

Tier I	Tier II	Tier III	Expeditionary	
Hickam AFB	Anderson AB	Eielson AFB	Richmond	!Saipan
	Elmendorf AFB	Misawa AB	Christchurch	!Cam Ranh
	*Iwakuni MCAS	*U-Tapao	Bahrain	#Clark AB
	Kadena AB	Diego Garcia	Wake	#Singapore
	Yokota AB	Osan AB	Subic Bay	

*** Increased Capability**	
# Decreased Capability	
! New Location	

Table 3. 2025 Pacific En Route System (AMC GERS White Paper, 2009)

Additionally, the researcher cross-referenced two independent organizations to adequately identify a national security import reference for the model. These organizations, Foreign Policy and Fund for Peace, collaborate to create a *Failed States Index*, 2010. This listing, considers twelve social, economic, political, and military indicators to generate a relative score within each area and an overall total score that ranks the 177 countries annually. Utilizing their Conflict Assessment System Tool (CAST), as well as over 90,000 open-source articles and reports (Foreign Policy, 2010), the Failed States Index provides a macro-level view of relative geo-political stability for particular regions and countries that can then be translated into the national security index required for GERBIL.

The CAST methodology has been peer-reviewed and is constantly refined and updated. Governments use it, among other things, for early warning and to design economic assistance strategies that can reduce the potential for conflict and promote development in fragile states. Militaries use it to strengthen situational awareness, enhance readiness, and apply strategic metrics to evaluate success in peace and stability operations and for training (Foreign Policy, 2010). It served as a research baseline to score the geo-political landscape in 2025 for which AMC states as a primary assumption in the selection of future en routes.

The model was run utilizing the primary Pacific APOE (Travis AFB), Tier 1 en route (Hickam AFB), offshore Tier 2 en routes (Yokota AB, Kadena AB, Iwakuni MCAS, Anderson AFB & Elmendorf AFB) as departure locations to both Diego Garcia and Djibouti-Ambouli International airports to ensure appropriate coverage exists. Tier 3 and expeditionary locations were not run in the model as APOE/APOD locations for en route analysis, but they were included in the model as appropriate en route alternatives for inclusion in the analysis. Operational assessments were conducted using notional movements from Travis AFB, Elmendorf AFB, Hickam AFB and Iwakuni MCAS. All 20 Pacific airfields identified by AMC as current or proposed en route locations were utilized in the model, as well as 8 additional airfields not identified by AMC that may prove useful as alternatives for consideration; as they have been used in the past by C-17 aircraft. These additional locations are Sultan Abdul Aziz Shah International (WMSA), Malaysia; Royal Australian Air Force (RAAF) Amberley (YAMB) and RAAF Darwin (YPDN), Australia; Kwajalein Atoll (PKWA), Marshall Islands; Nimoy Aquino International (RPLL) and Zamboanga (RPMZ), Philippines; Pago Pago (NSTU), American Samoa; and finally, Tan Son Nhat (VVTS), Vietnam.

Data Analysis

The analysis of the model sought to answer the final two research questions. The first of those two questions required the model to identify if gaps in coverage existed in the proposed system of en route locations or if the system would offer global access given the assumptions and requirements provided by AMC. The tactical sub-model allows the decision maker to identify select APOE and APOD locations to determine the adequacy of coverage. Both the southern route and northern route had an abundant number of en routes available. Figure 7 shows the results of a typical channel mission run from Elmendorf AFB (PAED) to Diego Garcia (FJDG). This shows Kadena AB is the best alternate to utilize in order to reach Diego Garcia based on the 27 inputs. While this example may not be realistic in current business rules due to the use of city pairs in channel validation[1], this analysis can be useful to leadership for identifying chokepoint workarounds and potentially identify more efficient ways to support the customer.

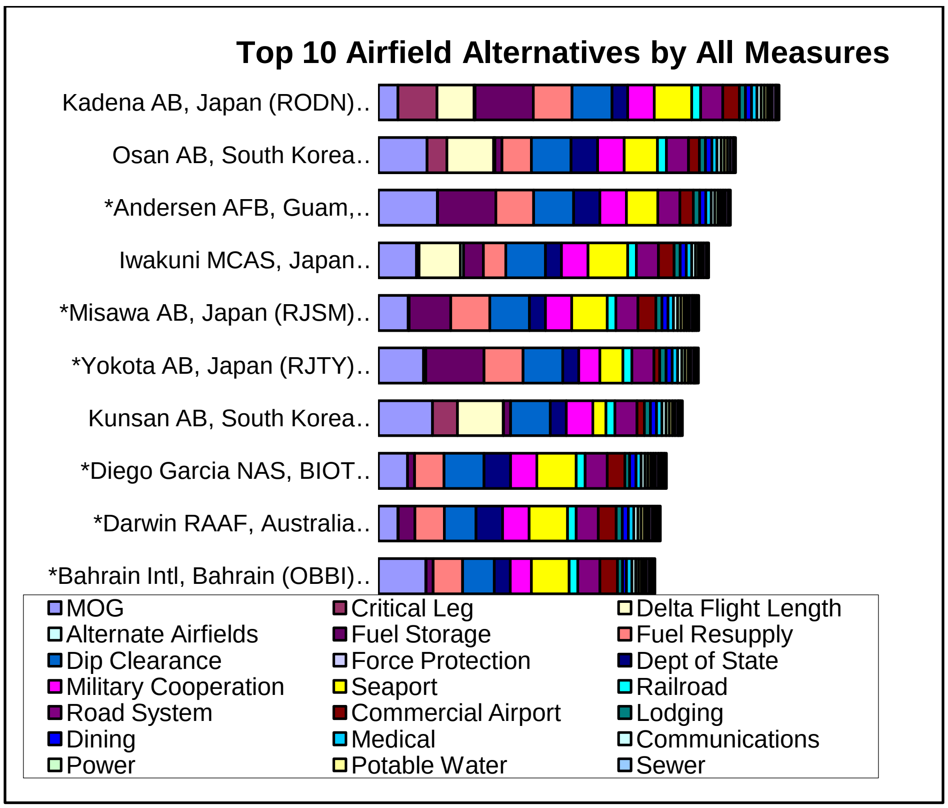


Figure 7. GERBIL Tactical Sub-Model Results (PAED-FJDG)

For example, a weekly channel mission supporting the US Navy runs from Yokota to Diego Garcia moving cargo (fresh fruits & vegetables - FFV) and personnel

[1] The Validated Channel is from Yokota AB to Diego and back via Paya Lebar AB, Singapore (AMC Air Channel Sequence Listing, 2011)

via Paya Lebar, Singapore. This mission has historically had marginal on-time performance due to weather, diplomatic clearances or field closure issues. Diego Garcia's naval leadership states,

> "The Diego to Singapore leg and vice versa is the critical leg for us. We only use on average 17% of the cargo capacity and 20% of the pax capacity from Bahrain to Diego, versus 76% of cargo capacity and 60% of pax capacity from Paya Lebar to Diego. From my perspective, there's nothing magical about Japan. I think the channel could come from somewhere else to support the relatively high transfer of personnel supporting the USS Emory S. Land and SSGN voyage repair period. Guam to Singapore or Guam to Bahrain might be a suitable alternative coming from the West (515 AMOG, 2011)."

From a simple analysis of the field commander's requirements, efficiencies to the system can be identified. Both Kadena AB and Anderson AB scored high in all models run and may be ideal for the movement of personnel, and possibly FFV, with little to no impact to the mission support to Diego Garcia and ultimately the channel customer. This "out-of-the-box" thinking breaks away from city-pair mentality and promotes an integrated system of en routes rather than the linear system that currently exists.

Regional identification of en routes is possible in the Tactical Sub-model; however, the operational model results show the decision maker a broader strategic view of the theater as a system and aids in determining appropriate routes for a given movement. The operational model shows a range of APODs that Hickam AFB can serve as an APOE (Figure 8 and Table 4).

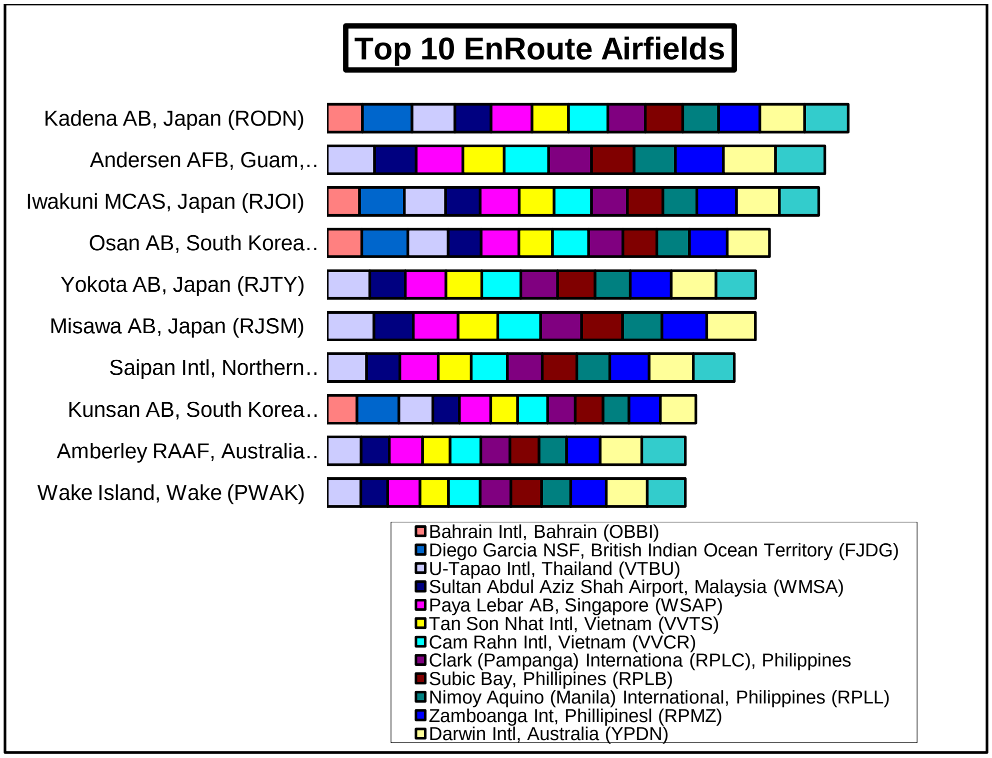


Figure 8. GERBIL Operational Scenario Model Results (Hickam AFB)

Rank	Alternatives	TOTAL	Bahrain Intl, Bahrain (OBBI)	Diego Garcia NSF, British Indian Ocean Territory (FJDG)	U-Tapao Intl, Thailand (VTBU)	Sultan Abdul Aziz Shah Airport, Malaysia (WMSA)	Paya Lebar AB, Singapore (WSAP)	Tan Son Nhat Intl, Vietnam (VVTS)	Cam Ranh Intl, Vietnam (VVCR)	Clark (Pampanga) International (RPLC), Philippines	Subic Bay, Philippines (RPLB)	Nimoy Aquino (Manila) International, Philippines (RPLL)	Zamboanga Int, Philippines (RPMZ)	Darwin Intl, Australia (YPDN)	Richmond RAAFB, Australia (YSRI)
1	Kadena AB, Japan (RODN)	6.797	0.461	0.645	0.561	0.470	0.536	0.474	0.514	0.489	0.489	0.468	0.537	0.582	0.571
2	Andersen AFB, Guam, (PGUA)	6.491	0	0	0.621	0.541	0.610	0.539	0.579	0.558	0.558	0.538	0.623	0.684	0.640
3	Iwakuni MCAS, Japan (RJOI)	6.413	0.424	0.583	0.540	0.448	0.513	0.451	0.491	0.465	0.465	0.443	0.514	0.563	0.513
4	Osan AB, South Korea (RKSO)	5.768	0.450	0.601	0.525	0.431	0.495	0.435	0.474	0.445	0.445	0.423	0.494	0.550	0
5	Yokota AB, Japan (RJTY)	5.588	0	0	0.557	0.463	0.531	0.466	0.509	0.482	0.485	0.460	0.535	0.585	0.516
6	Misawa AB, Japan (RJSM)	5.586	0	0	0.609	0.516	0.581	0.520	0.560	0.534	0.534	0.512	0.584	0.636	0
7	Saipan Intl, Northern Marianas (PGSN)	5.308	0	0	0.514	0.433	0.502	0.431	0.472	0.451	0.451	0.431	0.515	0.575	0.532
8	Kunsan AB, South Korea (RKJK)	4.809	0.388	0.549	0.441	0.347	0.411	0.350	0.390	0.361	0.360	0.339	0.410	0.464	0
9	Amberley RAAF, Australia (YAMB)	4.671	0	0	0.443	0.366	0.436	0.359	0.400	0.379	0.379	0.359	0.440	0.542	0.568
10	Wake Island, Wake (PWAK)	4.669	0	0	0.440	0.348	0.424	0.369	0.414	0.401	0.401	0.381	0.463	0.532	0.496
11	Bucholtz AAF, Kwajalein Atoll, Marshall Islands (PKWA)	4.553	0	0	0.429	0.338	0.413	0.359	0.403	0.391	0.391	0.371	0.453	0.521	0.485
12	Pago Pago, American Samoa (NSTU)	3.723	0	0	0	0	0.396	0.315	0.366	0.369	0.369	0.350	0.445	0.550	0.564
13	Christchurch Intl, New Zealand (NZCH)	1.387	0	0	0	0	0	0	0	0	0	0	0.405	0.482	0.500

Table 4. GERBIL Operational Scenario Model Results (Hickam AFB)

The results show that missions originating from Hickam AFB can reach 11-13 different APODs by utilizing the en route identified by the model considering all the factors, current national security situation and utilization probability. The model also enables sensitivity analysis to be conducted on the weighting of any of the three branches of the operational value hierarchy to assess the consistency of the measures. Figure 9 shows the sensitivity analysis run for Hickam AFB, with a value between 0 and 1 and at a weight of 0.60. You can see in the analysis that Anderson AFB falls in ranking to Iwakuni MCAS at a weight of approximately 0.50.

While GERBIL was designed to be risk neutral in the criteria selection, running sensitivity analysis on a given APOD also provides an avenue for the decision maker to assign a given risk to the utilization of the specified en route given the entered criteria.

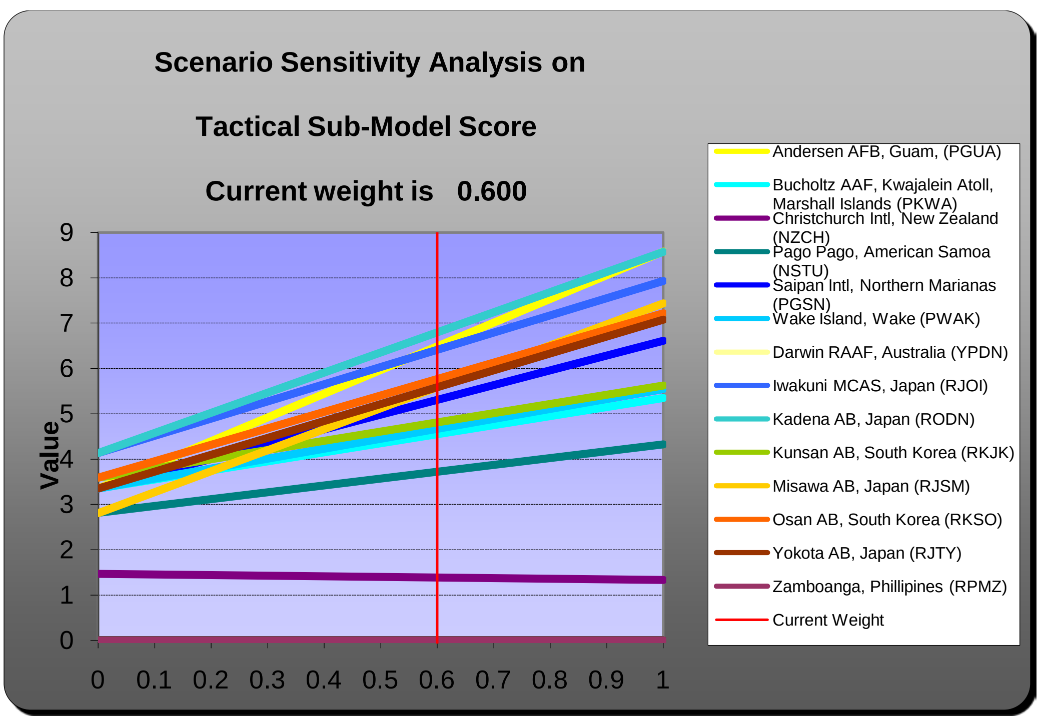


Figure 9. GERBIL Sensitivity Analysis (Hickam AFB)

For example, it’s clear to see that three en routes provide little risk (Anderson AFB, Iwakuni MCAS and Kadena AB), but beyond those, an appropriate risk assessment will be required for each remaining location to assess the utilization criteria. Sensitivity analysis can be further broken down by location and run on the 27 factors to determine which factors provide the least amount of risk for the airfield. This analysis adds to the strategic assessment required by AMC’s given assumptions.

Additional analysis of the results highlights a few locations of interest, Saipan and Cam Ranh and lead to the answer to the final research question; which airfields would extend or strengthen the system? Both airfields were designated by AMC as potential expeditionary en routes for regional pairing and are not necessarily strategic locations. Saipan was identified as an alternate pair for Anderson AB should there be a need to divert for weather or mitigate a chokepoint and Cam Ranh as an en route to access Indonesia/South China Sea (AMC Global En Route Strategy White Paper, 2009). This requires infrastructure investment, diplomatic agreements and potentially more deployed personnel and equipment from Air Mobility Squadrons within the AOR. Adding these locations would essentially be similar to identifying Kona Airport, Hawaii as a suitable airfield for Hickam AFB. U-Tapao is just over an hour away (480 NM) by C-17, Paya Lebar AB, Singapore is an hour-and-a-half away (590NM) to the West and Clark AB and Subic Bay, Philippines are just under 2 hours away (690NM) to the East (618 AOC, 2011). All three of these locations are already identified as expeditionary or Tier 3 locations for AMC with Singapore being the most robust in capability.

When utilizing the tactical sub-model to run analysis of 14 different Tier I/II departure and arrival locations (Table 5), Saipan’s average value score was 0.398 with it consistently falling in the low-mid 20's (out of 28 En Route airfields). Cam Ranh fared better when utilized with the northern route, with an average score of 0.477, but when compared to airfields such as

Tier I/II Airfields	Score	Tier I/II Airfields	Score
Kadena AB, Japan	0.641	Iwakuni MCAS, Japan	0.522
Anderson AB, Guam	0.598	Elmendorf AFB, AK	0.456
Yokota AB, Japan	0.543	Hickam AFB, HI	0.439
Tier III/Exp Airfields	**Score**	**Tier III/Exp Airfields**	**Score**
Misawa AB, Japan	0.544	Subic Bay, Philippines	0.474
Osan AB, Korea	0.537	Christchurch, N.Z.	0.408
U-Tapao	0.525	Saipan, N. Marianas	0.398
Paya Lebar, Singapore	0.514	Clark AB, Philippines	0.387
Diego Garcia, BIOT	0.513	Richmond RAAFB, Aus.	0.382
Bahrain, Bahrain	0.489	Eilson AFB, AK	0.342
Cam Ranh, Vietnam	0.477	Wake Island	0.289
Additional Airfields	**Score**	**Additional Airfields**	**Score**
Darwin RAAFB, Aus	0.511	Tan Son Nhat, Vietnam	0.446
Zamboanga, Philippines	0.48	Amberly RAAFB, Aus.	0.43
Nimoy Aquino, Philippines	0.471	Pago Pago, Am. Samoa	0.371
Sultan Aziz, Malaysia	0.456	Bucholtz AAF, Kwaj.	0.303

Table 5. GERBIL Model Results (Averaged Values of 14 Model Runs)

Subic Bay (.474), U-Tapao (.525) and Paya Lebar AB (.514), it's clear to see they do not offer tremendous value on a strategic level when existing capacity exists in the region already.

The airfield with the greatest potential to add benefit to a strategic system of en routes in the Pacific was RAAF Darwin, Australia. It scored an average value of .511 and was consistently in the top 10 airfields listed in the tactical sub-model results. This airfield provides tremendous access to the areas identified by AMC and would provide greater strategic benefits than that of Vietnam or Saipan and is comparable in scores to Iwakuni, Diego Garcia and Paya Lebar. Other than an expeditionary en route at RAAF

Richmond to support operations at Alice Springs, no additional partner airfields have AMC presence. Yet our military strategy states, “Bilaterally, Australia's leadership in regional security affairs, and our shared values and longstanding historical ties provide the basis for an increasingly important relationship. We will make our alliance a model for interoperability, transparency, and meaningful combined full spectrum activities (NMS, 2011).” Figure 10 shows the “lens coverage” utilizing RAAF Darwin as an en route for both out-and-back coverage (2,000NM) and point-to-point capability (3,500NM). Additional airfields which scored high in the model were Sultan Abdul Aziz Shah International, Malaysia (0.456), Zamboanga, Philippines (0.48), Tan Son Nhat, Vietnam (0.446) and RAAF Amberley, Australia (0.43).

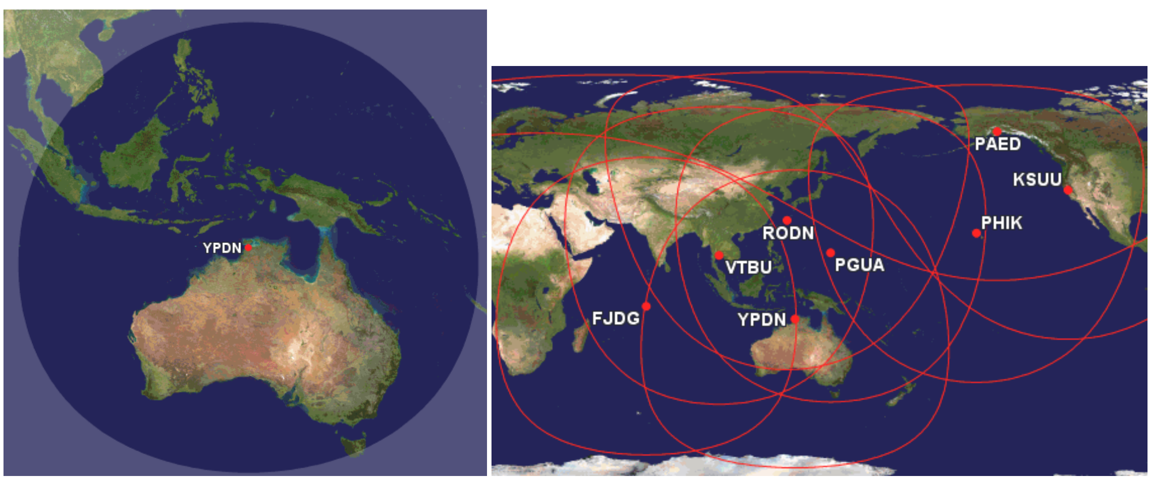


Figure 10. RAAF Darwin Coverage Capability (Great Circle Mapper, 2011)

Conclusions and Recommendations

Analysis of AMC’s proposed en route system for the future reveal a system that enables sufficient access given AMC’s assumptions; albeit not necessarily efficient given existing capability and capacity elsewhere. Utilizing a valued focused thinking methodology and applying those values mathematically (via GERBIL), results show that AMC may be limiting its capability to execute strategically in part due to limited assumptions of aircraft capabilities and heavily regionalized capacity and capability, particularly when only looking at Tier I/II/III en routes (Figure 11).

In today's constricted budgetary environment, we can no longer afford to build a strategy of "nice to have's," while maintaining a capability to mitigate chokepoints should a primary en route become unusable for any given reason. Today's military must focus on a fine balance of capacity and capability which will open access to the globe without holding resources in reserve for those just in case scenarios. This concept has been the theoretical underpinning of this research in which the following discussion of the author's views of the proposed en route structure will provide alternative examples as supported by the model and the emerging JTF-PO doctrine.

Strategic Overview

Selection of en route locations for AMC and USTC is no different than any other transportation industry in selecting appropriate hub-and-spoke locations or route optimization. By simply conducting a scholarly search of route optimization, one can see the plethora of research conducted in identifying ways to optimize and improve efficiency of an organization's operations. Whether you are Wal-Mart, United Airlines or the United States Military, each corporation is constantly seeking better ways of doing business that will continue to save resources in the future. However, geographic location (regional pairing) alone does not establish a comparative advantage of an en route and should not be a sole basis for selection. Factors such as runway capacity, airspace delays, airfield charges, and growth capacity need to be considered for selection of a suitable en route worthy of investment. The current Tier classification system is not robust enough to adequately consider these additional factors and the differing views on airfield capabilities were not considered significant enough to address in the strategy (AMC Global En Route Strategy White Paper, 2009).

AMC states, "90 percent of the world's landmass is north of the equator. Not surprisingly, 90 percent of the world's population lives north of the equator. These two facts drive the east-west orientation of the strategy. While not ignoring the existence of the 10 percent in the southern hemisphere, the proposed strategy is heavily weighted toward the northern hemisphere (AMC Global En Route Strategy White Paper, 2009:10)." This alludes to the notion that a geographic alignment of en routes remains the preferred selection criteria when designing the network. With that in mind, AMC and USTC also identify several regions (Figure 11) (Southwest Asia, Southeast Asia, Korea, Africa, Eurasia and Indonesia) as "continuing zones of hostility or instability or areas prone to natural disasters and have the greatest need for airlift support. Accordingly, the en route lay-down and infrastructure [is] needed to be able to support a heavier flow to these regions (AMC Global En Route Strategy White Paper, 2009:8)."

It's easy to see these two views of the system conflict with one another and a viable strategy cannot be accomplished until a holistic view of the system is adopted that considers more than geographical pairings of en routes. Expeditionary en routes are not designed to sustain operations without significant increases in manning and equipment. These are airfields that are designed "where all maintenance and port capability is provided as the mission dictates and by deployed personnel (AMC Global En Route Strategy White Paper, 2009:11)." Yet AMC identifies Bahrain, Richmond and Paya

Lebar AB as expeditionary locations when all three airfields have permanent personnel and equipment on location (either AMC or US Navy).

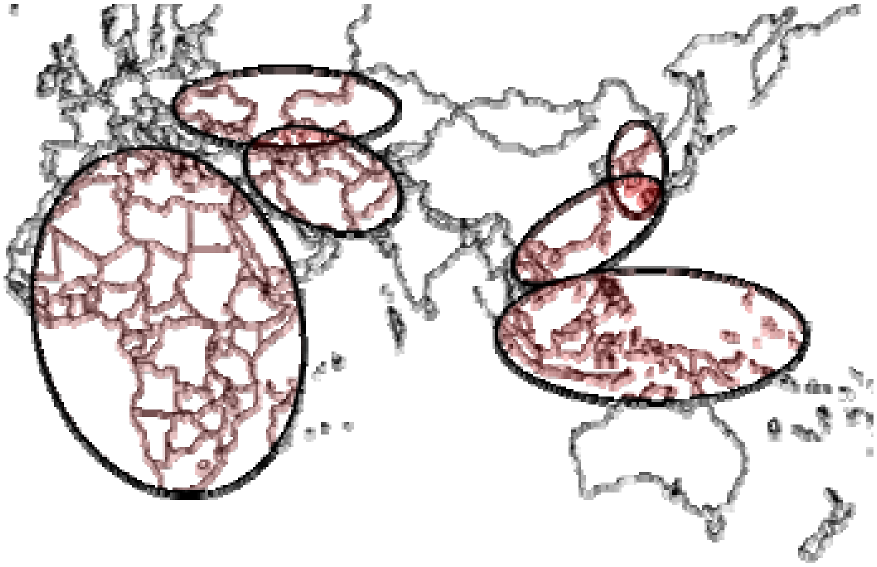


Figure 11. Zones of Hostility (AMC GERS White Paper, 2009)

When viewing the en route lay down without these expeditionary airfields, coverage gaps can be identified (using AFPAM 10-1403 planning factors) and a greater emphasis on increased range becomes evident (Figure 12).

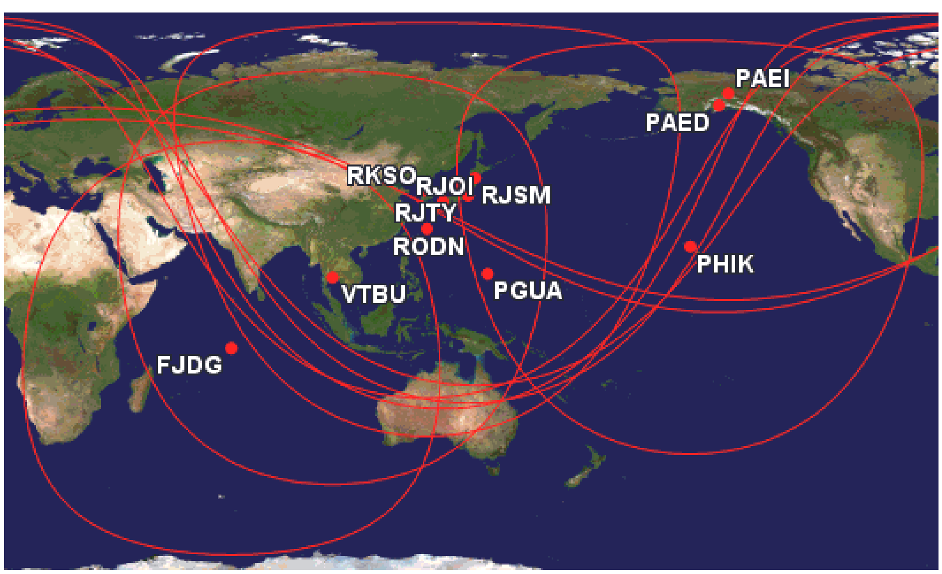


Figure 12. 2025 Tier 1-3 En Routes, 3,500NM (Great Circle Mapper, 2011)

Additionally, the JTF-PO doctrine continues to evolve and become a viable alternative to expeditionary en routes without the cost of additional manpower, equipment or airfield infrastructure. This concept will be discussed in the future research later in this chapter.

Strategic Assumptions

As previously stated, AMC's assumptions of the future en route strategy are restrictive and will require adjustment if AMC intends on meeting its strategic goals. Potential en route locations beyond those identified by AMC would not only open operations in the southern hemisphere (and potentially another route into Africa from the East), but also provide for rapid and optimal airlift to a large number of these identified locations. This additional capability will require modification of several assumptions provided by AMC to create a comprehensive list of alternative locations not previously identified. Assumptions 1, 4, 5 require modification and assumptions 7 and 10 (Appendix A) should be the number one and two assumptions and serve as the basis for the future strategy in order to meet the challenges ahead.

The political landscape has already drastically changed, particularly in Africa and Southeast Asia, and AFRICOM accessibility continues to become increasingly challenging given the lack of assigned assets and widespread conflicts. Several examples of AMC's proposed changes to the en route system neither utilizes and expands existing capacity and capability, but it also does not focus on the areas of concern as identified above. Expansion of Iwakuni MCAS from an expeditionary en route to a Tier 2 multi-modal en route will require significant military construction (MILCON) for a capability that can be found commercially and will duplicate regional capabilities already found at

Kadena AB, Yokota AB (both Tier 2) and Misawa AB (Tier 3). The recent earthquake and tsunami in Japan should also raise a few eyebrows in the strategic planning community as to how to handle an en route system should access to Japan be shut down. As witnessed by the Icelandic volcano eruption in 2010 and subsequent adjustment of airbridge access to Europe, natural disasters need to be accounted for and heavy reliance on a specific region may hinder access at any given moment.

Also, the assumption of 2,000 NM out-and-back distance and max point-to-point range of 3,500 NM must be modified to meet current day capabilities. Improvements to aircraft range are always increasing, particularly in the civilian sector. Our CRAF partners have the ability to reach destinations in the AOR with ease compared to organic lift (Figure 13). Atlas Air's Senior Manager for Defense and Government Programs states, "the legs of the 747-400F really surprise TACC. We flew from Travis AFB to Kadena AB and back to Travis AFB in 24 hours. TACC said they figured it would have taken an organic plane several days to accomplish (Bricker, 2011)." Additional benefits

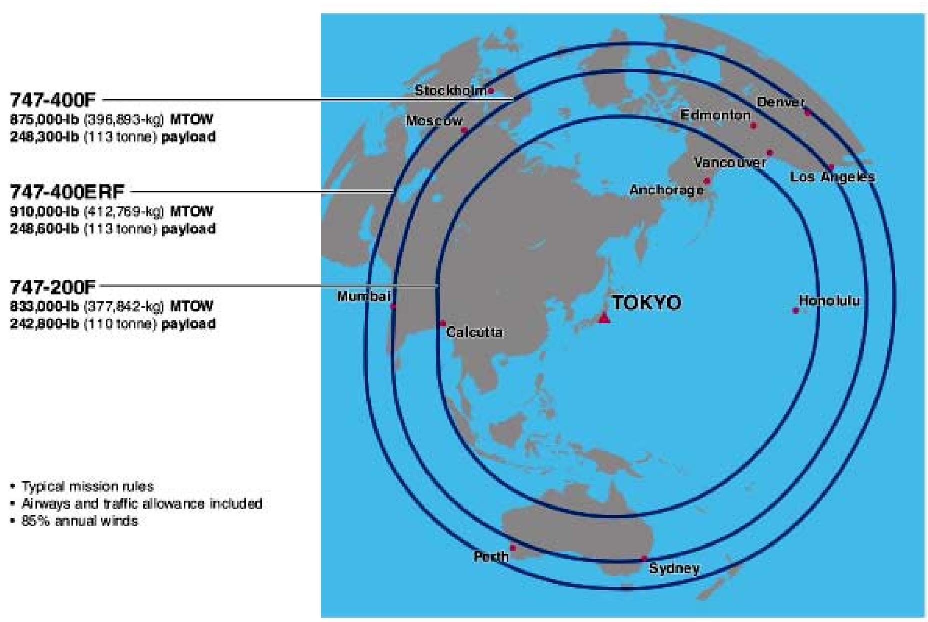


Figure 13. Boeing 747 Range (Boeing, 2011)

of the 747-400 is the cargo carrying capacity (48 pallets) in comparison to the C-17 (18 pallets). With modifications to the C-5M capability, as well as continued purchase of extended range C-17s, "the operational goal is to make next-generation airlift procurement more flexible and beneficial without relying on centralized mechanisms that ensure convergence but reduce efficiency (Godfrey, 2004:886)." Figure 14 illustrates the potential benefits of effective range planning of military aircraft. If the C-17 will be the primary airlifter in 2025 (as assumed by AMC), as a taxpayer, why are we continuing to invest in the C-5M RERP if it will not be around long enough to get a return from that investment? I believe it will and that the assumption is simply flawed and along with the other assumptions identified, hinder a strategy that will enable global access.

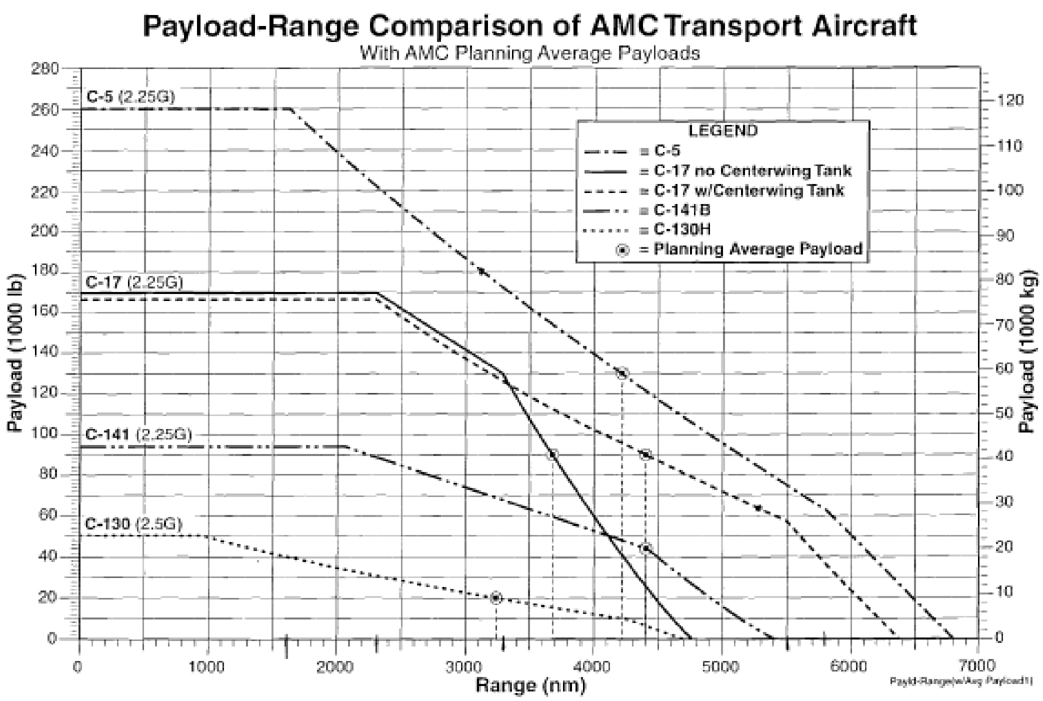


Figure 14. Payload-Range Comparison of AMC Transport Aircraft (Merrill, 2010)

Future Research

One specific area of future research should focus on an analysis of the expanding mission set of the contingency response groups (CRG) and particularly that of the Joint Task Force-Port Opening (JTF-PO) and how it fits into an overarching en route strategy. While this is a fairly new capability for USTC, it has been used successfully numerous times in recent years to rapidly move units in support of OEF, at reduced costs to the American tax-payer and increased velocity to the user. JTF-PO's mission is to "provide a joint expeditionary capability to rapidly establish and initially operate a port of debarkation and conduct cargo handling and movement operations to a forward node, facilitating port throughput in support of combatant commander executed contingencies (Ackerson, 2010)." JTF-PO will integrate the efforts of the Army and Air Force so that reception and onward movement of forces and equipment is seamless and immediate to the customer, and they are designed to operate for 45-60 days in duration. Figures 15 and 16 show the design capabilities and required manpower to conduct organic JTF-PO operations.

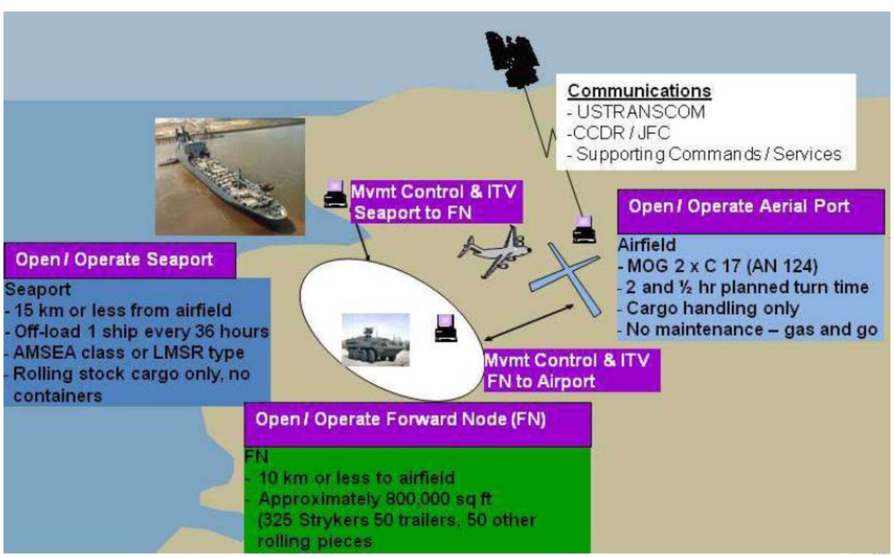


Figure 15. JTF-PO Sea-to-Air Transload Design Capability (Ackerson, 2010)

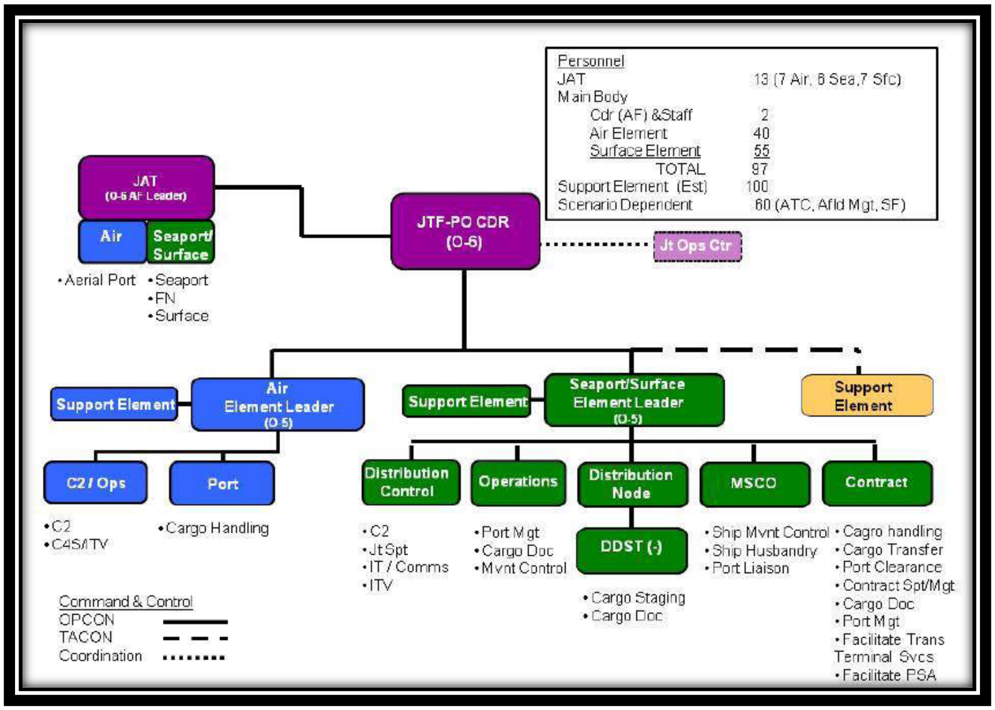


Figure 16. JTF-PO Sea-to-Air Transload Organization (Ackerson, 2010).

The JTF-PO consists of an air element for airfield operations and the surface element for cargo movement control and cargo handling operations (Congrove, 2010). To illustrate the capability of a JTF-PO, an element was incorporated into an existing Tier III en route airfield to conduct Operation ISLAND STRYKER. This was located at Diego Garcia and was conducted in 2009 to move Army equipment from Tacoma, WA to Afghanistan using multi-modes of transportation. The operation utilized command elements of the JTF-PO and the existing units assigned to Diego Garcia (515 AMOW personnel) to perform aerial port, command and control and aircraft maintenance functions throughout the operation, reducing the design manning levels of the JTF-PO from 100 to just 36 utilized. This not only reduced the demand on scarce island resources (such as billeting, sundry supplies - AKA Sustainment), but also highlighted the ability of AMC's en route system to surge when required without having to rely on expeditionary airfields. It was because of these consolidated capabilities that the operation was completed three weeks early, well under budget, and with record-breaking statistics. Follow-on research should address if the need exists today and in the future for expeditionary en routes when USTC continues to build an existing capability that is more robust than expeditionary airfields in the form of a JTF-PO and better fits the military's expeditionary mindset. Is it feasible to assume an expeditionary location that has been bare-bones operated, at minimal cost and for a lengthy period of time could be better utilized for these operations? Does USTC need to invest in both capabilities given there may be other cases in which uncontested access to bases is not available for the projection of military forces. "This may be because the neighborhood is hostile, smaller friendly states have been intimidated, negative perceptions of America exist, or states fear giving up a measure of sovereignty. Furthermore, the use of bases by the Joint Force might involve the host nation in conflict. Hence, the ability to seize bases in enemy territory by force from the sea and air could prove the critical opening move of a campaign (Joint Operating Environment, 2010)."

The Pacific theater is a perfect AOR to experiment with this capability to assess its potential value. The 36th CRG is located at Anderson AB, Guam (centrally located and within a 4,000NM lens of all Pacific en routes). Anderson AB has a Tier II AMC presence located on the field and can provide excess capacity should additional equipment or manpower (via 515 AMOW) be required to augment the JTF-PO, as was the case at Diego Garcia. There are additional combat mobility flights stationed at Yokota AB, Japan, Hickam AFB, Hawaii and Elmendorf AFB, Alaska who perform a similar role to that as the JTF-PO, however on a much smaller scale. Approximately 79, 2T2X1's (air transportation specialists) remain AEF postured and are OPLAN tasked to execute airfield openings (PACAF/A4, 2011). With these capabilities already in the AOR, it may be possible to tap into these resources rather than utilize expensive expeditionary en route airfields.

Bottom-line: what are AMC and USTC willing to invest for the future to ensure rapid access moving and sustaining a fighting force over great distances to protect our national interests given budgetary constraints? I would argue the JTF-PO is worth the investment more than expeditionary en routes and would save not only manpower, but significant costs covering the spectrum from infrastructure to flying hours. This concept of reduction in capacity to increase capability was seen in the Air Force's decision to retire the C-9A Nightingale, the primary aero medical (AE) evacuation aircraft, in 2005 (Gorenc, 2011). While many in the AE community scoffed at the decision thinking it would inhibit any possibility to adequately evacuate a combat casualty, Air Force officials saw the potential cost savings and efficiencies of a new, robust system. As a result, today's AE system is far more efficient and combat effective than first envisioned and is a tribute to the foresight of those men that decided to reduce capacity to increase strategic capability.

Final Thoughts

This research was presented to AMC to provide decision-makers at Headquarters AMC with a value-focused thinking assessment of the future system of en route locations to minimize costs and/or time in the execution of AMC's strategic airlift missions. It hopes to feed into ongoing and future studies within AMC, such as future Mobility Capabilities and Requirements Studies (MCRS) as well as USTRANSCOM's ongoing

Global Access and Infrastructure Assessment (GAIA). Through utilization of the model and analysis of the resulting airfields, a decision maker can make financially and strategically viable choices to secure access for America's future. While it does not specifically identify cost savings or manpower reductions from the model results alone, it does identify potential benefits that a comprehensive Pacific en route strategy will bring. Not only will it enhance operations within the AOR, but it can be viewed as beneficial for access to other combatant command AORs as well, particularly AFRICOM and CENTCOM. The model results conclusively show, however, that AMC's proposed "new" en route locations may not be the most effective and efficient locations to invest in, albeit sufficient coverage, and alternative locations as identified by GERBIL should be considered for use. Maintaining excess capacity no longer remains a viable alternative to improved capability in a fiscally constrained environment.

The results of this research are validated by similar results found in the most recent GAIA signed by the USTC/CC and presented to the Joint Chiefs and SECDEF in December, 2010. Independent of this research, USTC utilized a commercial of-the-shelf model (Supply Chain Guru) to identify 27 primary, 15 secondary and 19 multi-modal strategic locations which will aid in building resiliency and redundancy in the global distribution network (USTC/JDPAC, 2011). Those results, while not identical, provide additional locations, such as Darwin, to be considered for use by AMC.

Additionally, studies conducted by Sere (2005), Voight (2005), Thareldson (2006) and Naylor (2009) all conclude similar results while utilizing different methodologies in analyzing the global en route structure. These studies, in addition to this, identify numerous strategic locations of potential value to AMC and USTC and discussion must be conducted to determine their usefulness for future studies.

Extended Conclusion and Recommendations

This section presents an extended narrative of conclusions and recommendations to expand on those found in Chapter 2.

Introduction

As stated in the previous section, several assumptions by AMC require additional clarification in order to adequately answer the final research question and create a substantial en route strategy for the future. The first three research questions looked at the adequacy of the system as defined by AMC, whereas the final research question required a look at new potential locations which could extend and/or strengthen the proposed en route system for AMC. "AMC's desire is to create efficient routes while maximizing use of commercial partners by 2016 to reduce effects on the organic fleet and crews and to also meet a potential reduction in maximum flight duty periods for aircrews as imposed by new Federal Aviation Administration (FAA) regulations (AMC, 2010)." In order to attack this goal while maintaining the assumptions of the research, the researcher drew from knowledge and techniques of C-17 Evaluator Pilot's across the community; many with extensive flying experience throughout the Pacific AOR. He also conducted personal interviews with AMC and USTC to determine what factors may be additionally important in qualifying an en route for the future.

Data Analysis

These new locations were incorporated into GERBIL to identify their potential value to meet the requirements provided by AMC. The difference in this research as compared to other similar research efforts conducted in the past are the additions of aircraft range capacity, and multi-modal potential, as well as MOG revisions that accurately match the vision of today for USTC as the DPO. These realistic modifications to the model address several additional capabilities that previous research did not account for or place an appropriate level of value to due to inflated values assumed for AMC's throughput capability. These changes enable the model to take into consideration the simple, but often overlooked, fact that AMC and USTC are not the only organizations seeking to expand capacity and capability at a given en route location and it's not as simple as identifying a location to claim for AMC/USTC use. However, as the DPO, USTC has a tremendous amount of leeway with other components in the Pacific AOR in identifying efficient means of supporting the combatant commanders (PACOM, CENTCOM & AFRICOM). That leeway will prove useful in supporting customers throughout the AORs through sustainment or operational support missions, particularly as the force posture changes to support growing concerns in the Pacific well into the future.

Through the adjustment of the model SDVF's to capture this potential for limited real estate and increased support, the results more closely match expected throughput capacity and airfield capabilities enabling AMC's assumptions to remain validated throughout the model without penalizing the potential to optimize those factors identified above.

With that said, the tactical sub-model was run for each of the Tier 1 & 2 en routes, as well as the CONUS APOD, Travis AFB. Results incorporated new airfields not considered by AMC as en routes for the future with the top two new fields consistently showing RAAF Darwin (YPDN) and Zamboanga (RPMZ) as being the greatest value (0.511 and 0.48, respectively). While Zamboanga is currently a combat zone tax exclusion and hazardous duty pay airfield, it should not be ruled out as having value for the future should the geo-political situation in Southern Philippines change for the positive. An increased value of the current Tier 3 locations of Misawa AB (RJSM), U-Tapao (VTBU) and Diego Garcia (FJDG) en route alternates were also observed with a value score averaging 0.544, 0.525 and 0.513, respectively. These results identify potentially existing infrastructure with tremendous capacity and capability that could be better utilized for future access rather than the recommended locations of Saipan (.398) and Cam Rhan (.477). Additionally, the Tier II airfield with the greatest value was Kadena AB (0.641), highlighting possible investment potential rather than Iwakuni MCAS (.522).

This addition of new key locations such as RAAF Darwin and increased utilization of existing capacity at Diego Garcia and U-Tapao (Figure 17), not only provide for a comprehensive system for a northern or southern Pacific flow to aid the

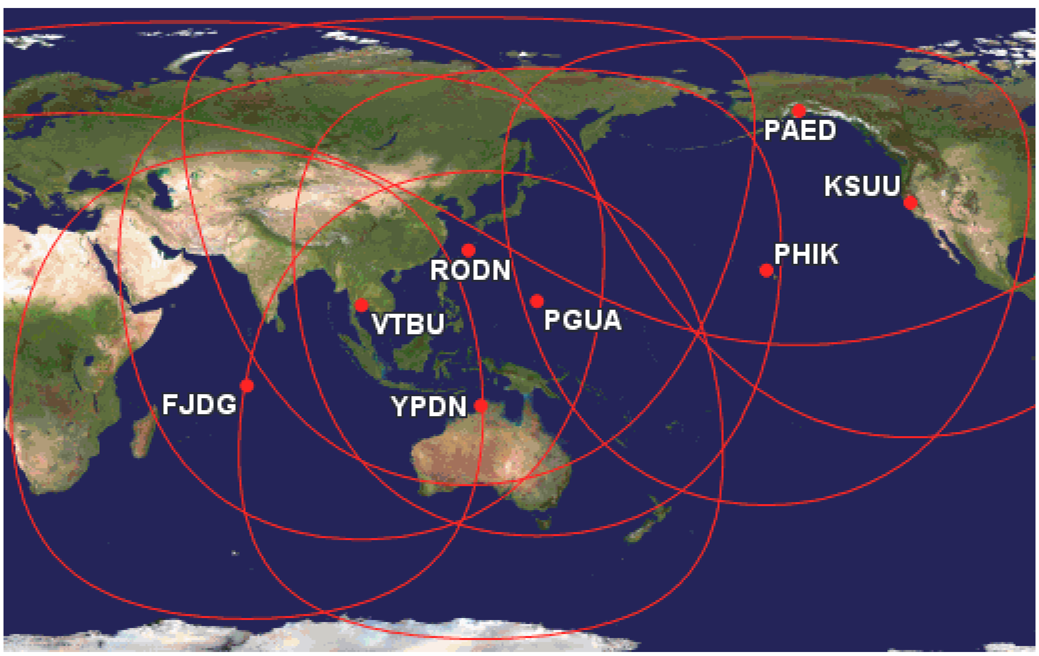


Figure 17. Additional En Routes, 3,500NM Coverage (Great Circle Mapper, 2011)

current East-West flow, but also reduces any potential chokepoints; thus meeting the strategy requirements set forth by AMC, USTC and ultimately the NMS. Investment would not be significant to achieve this system as capacity exists at all of these locations and could easily be incorporated to provide access to PACOM, AFRICOM or CENTCOM locations. For example, Diego Garcia has a tremendous capacity which has been used several times for multi-modal movements to CENTCOM and may provide additional capability to the Eastern half of Africa with minimal to no investment required to move from tier three to tier two (pending an additional evaluation of the Tier criteria in regards to maintenance capability).

Strategic Assumptions

In addition to the data findings above, this research also uncovered significant differences in the assumptions (values) which AMC and USTC used in analyzing the proposed en route strategy. In the independent model ran by USTC for the GAIA, they utilized AFPAM 10-1403 to establish average planning standards for a C-17A carrying 90,000 pounds of cargo. They used an average block speed of 406 NM/Hr burning 19,643 pounds of fuel/hr. Block speed is equal to the leg distance divided by the total elapsed time, from aircraft brake release on takeoff to parking after landing (Brigantic, 2004).

Running through some basic computations, an operational empty weight of a C-17 is 285,000 lbs added to the 90,000 lbs of cargo, it makes the total weight before fuel to be 375,000 lbs. The maximum takeoff weight is 586,000 lbs, leaving approximately 210,000 lbs left for fuel. The maximum fuel capacity of an extended range C-17 is 245,000 lbs so the planning factor in AFPAM 10-1403 does not even allow for a full fuel load at takeoff, leading to the question of capacity vs. range and which has greater value to AMC? Using the average block speed and fuel burn to determine how far 210,000 lbs of fuel can take you, we come up with a flight time of 10.7 hours and 4,345 NM. Using the "rules of 16" technique widely utilized by C-17 crewmembers (16,000 lbs of fuel * total flight time + 30,000 lbs of reserve fuel = required fuel), the flight time is 11.3 hours and 4,587 NM. To account for this in the model and to provide accurate results, the lower bound was set at 2,000 NM and upper bound set at 4,225 NM for the critical leg SDVF. The target value was still set at 3,500 NM to meet the intent of AMC's assumptions while not discounting the capability of the aircraft today. The results were significantly different and identified the airfields discussed above as being the best value potential given the other assumptions provided by AMC.

From these simple calculations above and techniques typically "operationally" utilized, the question must be asked if 45 STONS is still the standard to plan from or is there a historical average that better represents what is moving throughout the system on any given day? USTC and AMC rely on AFPAM 10-1403 heavily and while the formulas are not universally applicable, they are treated as gospel amongst transportation professionals. It can be seen that operational gains can be made and a greater en route strategy formulated by simply applying good business rules in the assumptions made to incorporate aircraft performance that is up to date with the times.

Additional Research Areas

Finally, in addition to the recommended further research topic provided in Chapter 2, an analysis of en routes should include pairing the en route strategy to current channel airlift strategy. The traditional strategic view of en route selection has typically evolved by analyzing a unit's time-phased force deployment database (TPFDD). The TPFDD will show how much equipment and personnel to move from an APOE to an APOD and drives the size of airlift required. The size of lift determines the required throughput of an airfield and so on. While this analysis is valuable in its own right, it should not serve as the standard for all flow through an AOR.

The channel system is validated by AMC for a given APOD and APOE for each channel pairing (city-pair). For example, the Yokota AB (APOE) to Diego Garcia (APOE) channel is validated for cargo movement one-way. This system is part of a larger association plan supporting numerous APODs from Travis AFB (originating APOE). The only stipulation to the movement of the cargo/pax is when it is "destined for one of the theater supported APODs [it] will be routed using the applicable AMC channel (AMC Air Channel Sequence Listing, 2011:A1-3)" and optimization of aircraft flow or aircraft utilization is not considered. Currently, 144 validated channel pairs exist in the world with the majority flowing through the Pacific AOR. An analysis of the validity of the city pairs with the customers could be conducted to see if an optimal solution can be met to better utilize en route locations to enhance aircraft flow and aircraft utilization.

The comment by Diego Garcia NSF's Commander in section two illustrates an opportunity for TACC/XOC and the customer to further analyze the true requirements of a validated channel and create a balance of efficiency and effectiveness to match capacity and capability. For example, between Jan, 2009 and Jan, 2010, there were 9,118 seats made available to passengers traveling to/from Diego Garcia. Of those 9,118 seats, 5,469 went unused for a utilization rate of 40.1% (515 AMOG, 2011). To put those numbers into perspective, that's 170 DC-8s (32 passenger carrying capacity), 54 C-17s (101 passenger carrying capacity) or 22 767-400s (245 passenger carrying capacity) that did not have to fly to Diego Garcia based on customer utilization. Most of those fell on the Diego Garcia to Bahrain portion but it highlights the opportunity to be more efficient and effective by utilizing the appropriate capability to meet the capacity requirements.

Final Thoughts

The overarching en route strategy to carry out globally dispersed, requirements-based capabilities to sustain major campaigns in distant locations and the need for an agile and rapidly deployable capability is essential in future conflict. This underlying expectation relies on the United States Armed Force's ability to plan and operate under the premise that forces will remain expeditionary by nature. Incorporating our expeditionary capabilities, such as JTF-PO, not only makes AMC and USTC more viable in the eyes of the Army, but it enables us to balance capacity and capability without holding too much in reserve. Achieving this in an uncertain and expansive operational environment, like that found in the Pacific theater, requires a change in current thinking and doctrine to meet fiscal constraints without hindering effectiveness. The potential efficiencies gained and resources saved from this shift in thinking have yet to be realized; however, with a comprehensive and realistic analytical approach to creating a synergistic en route structure, AMC and USTC can begin to ensure access now and well into the future.

APPENDIX A

AMC's En Route Strategy Assumptions

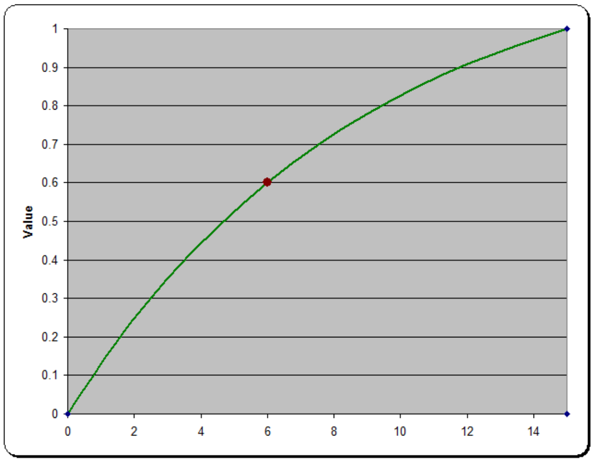
1. The global political landscape in 2025 is similar to the landscape today
2. There will be no significant change in over flight restrictions
3. In 2025, the strategic airlift fleet will consist primarily of C-17s
4. A C-17's unrefueled out-and-back radius is 2,000NM
5. A C-17's point-to-point distance is 3,500NM
6. Since the airlift capability of the new air refueling design has not been fully vetted, its capability was not considered
7. Every attempt will be made to maximize existing infrastructure within the strategy. In other words, as long as existing infrastructure can fit into the new strategy, the strategy should take best advantage of it
8. Where possible, attempt to maximize transportation opportunities with intermodal capability
9. CONUS locations and end of the strategic airlift routes were not considered part of the en route system. Some locations serve dual roles as APOEs and APODs. In these cases, we will treat them as en routes
10. The strategy should maximize global coverage while concentrating on areas of concern

Sourced from *AMC Global En Route Strategy White Paper*, 2009

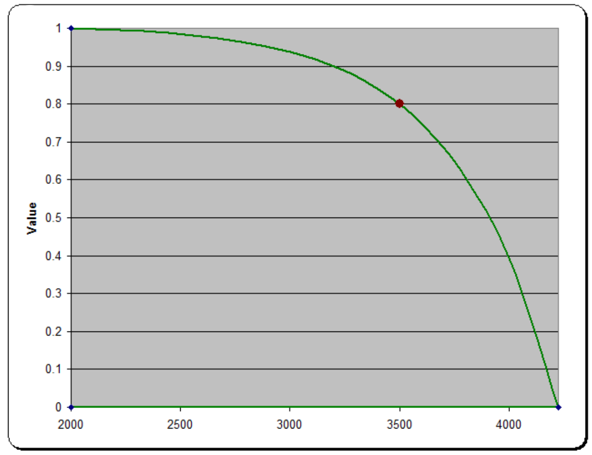
APPENDIX B

Tactical Sub-Model Value Functions

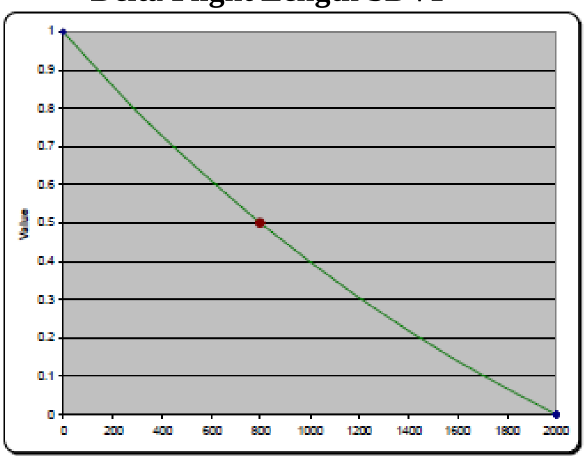
MOG SDVF



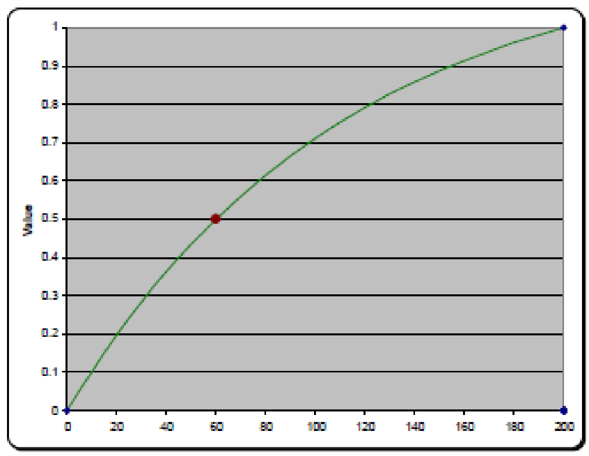
Critical Leg SDVF



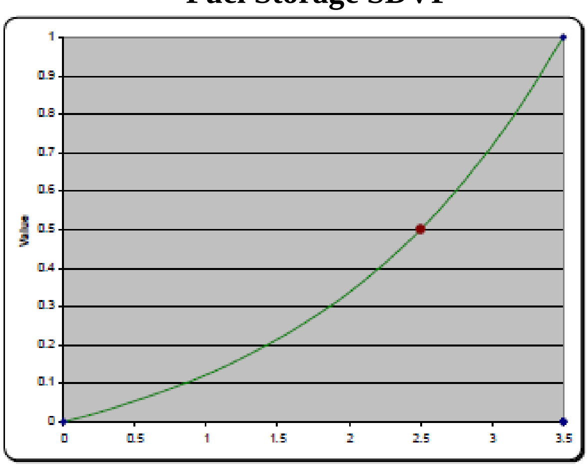
Delta Flight Length SDVF



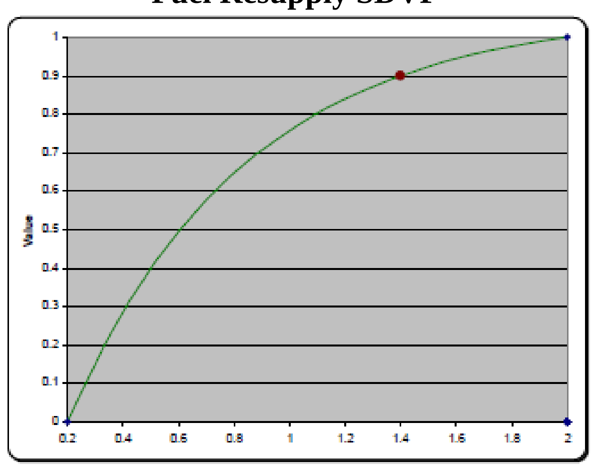
Alternate Airfields SDVF



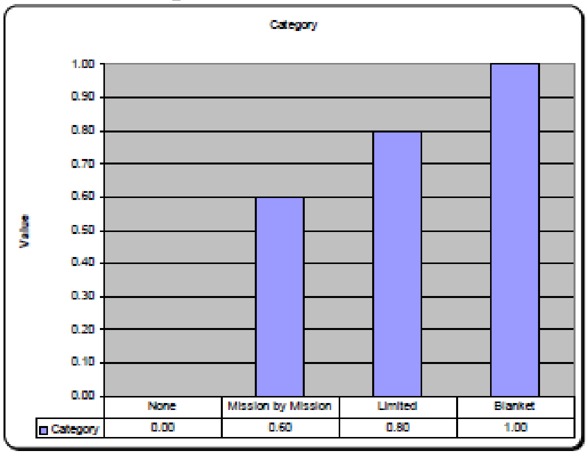
Fuel Storage SDVF



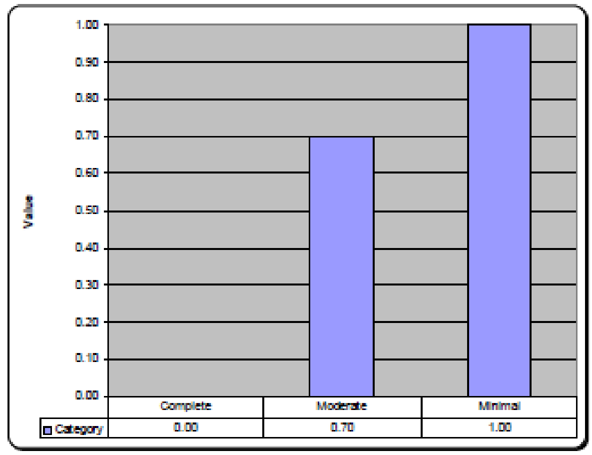
Fuel Resupply SDVF



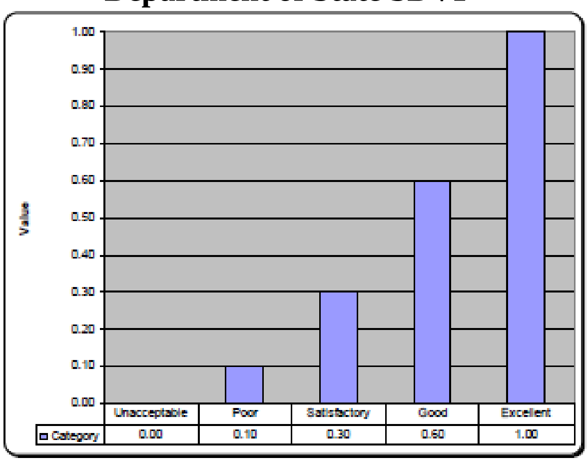
Dip Clearance SDVF



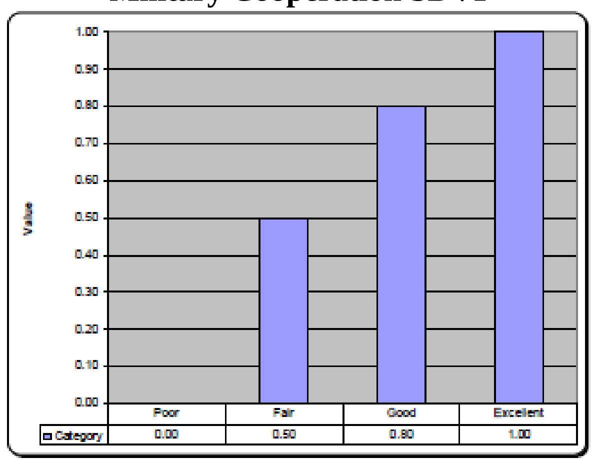
Force Protection SDVF



Department of State SDVF



Military Cooperation SDVF



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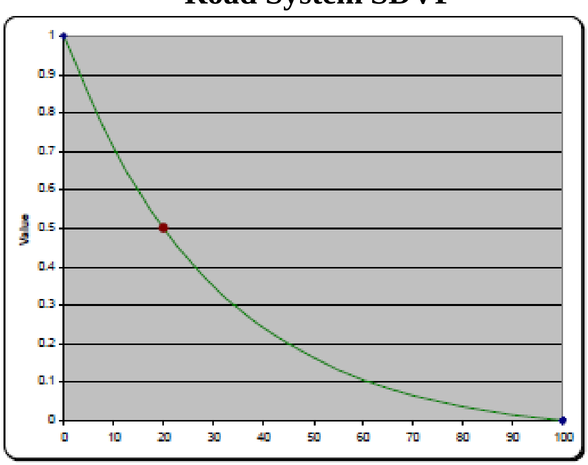

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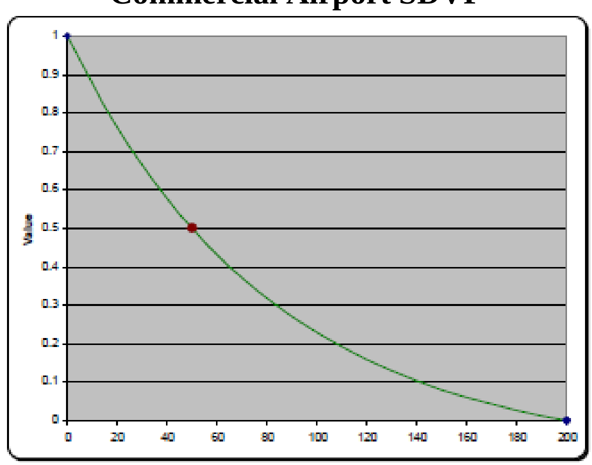

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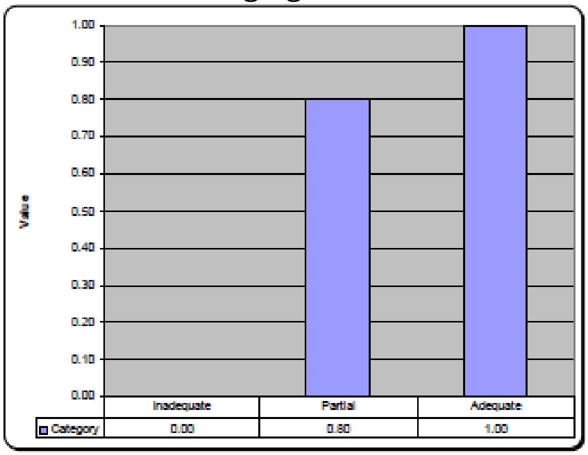

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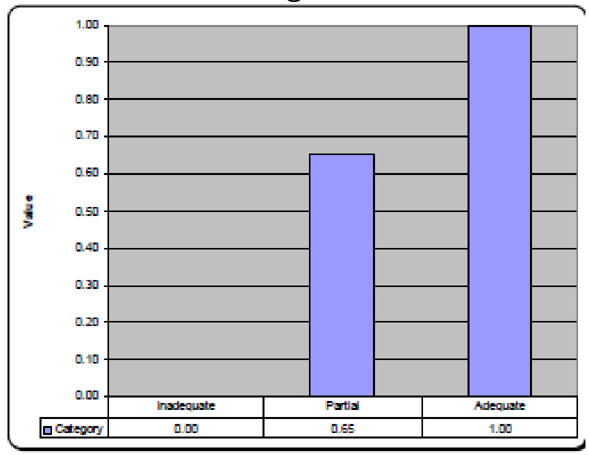

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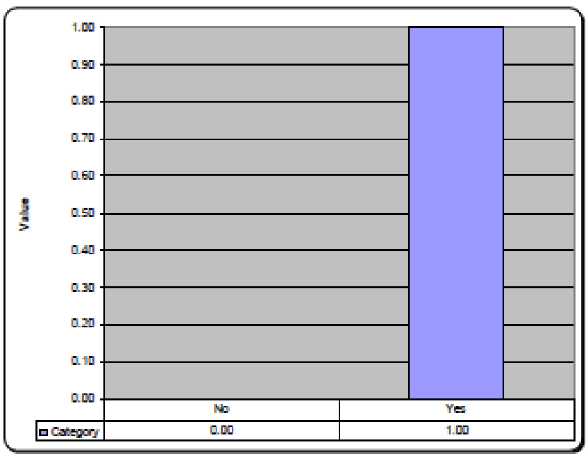

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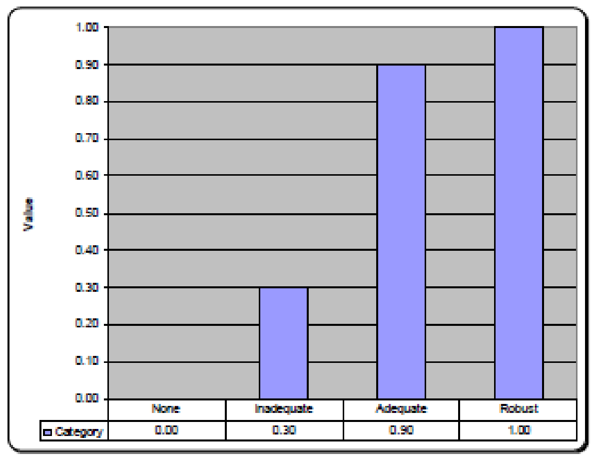

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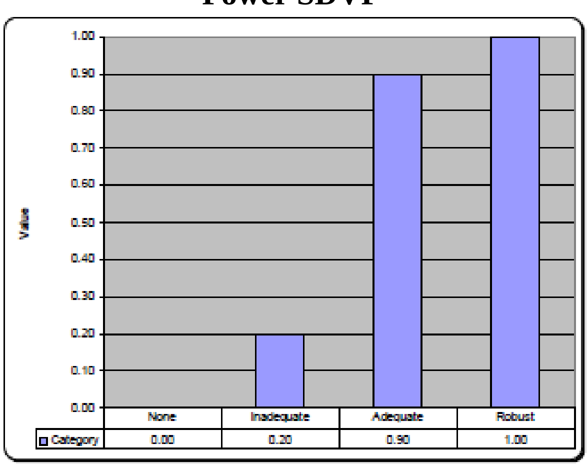

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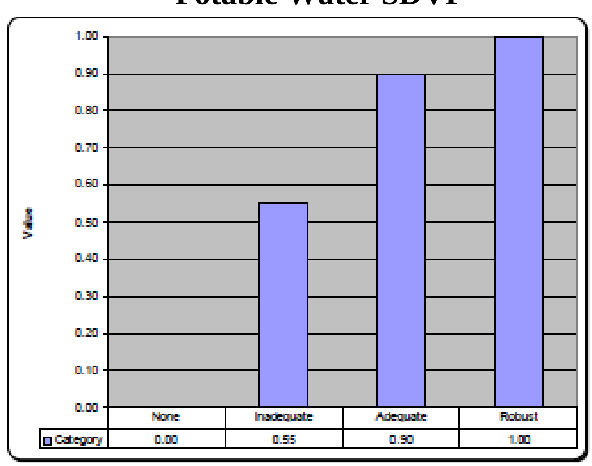

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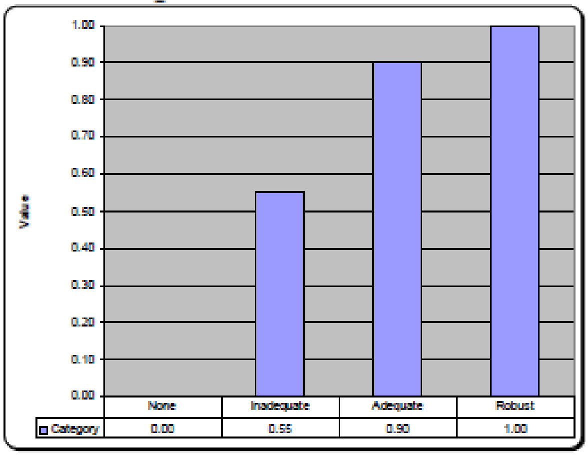

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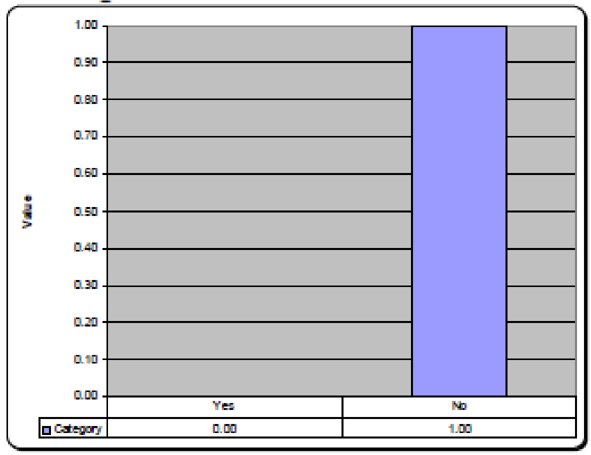

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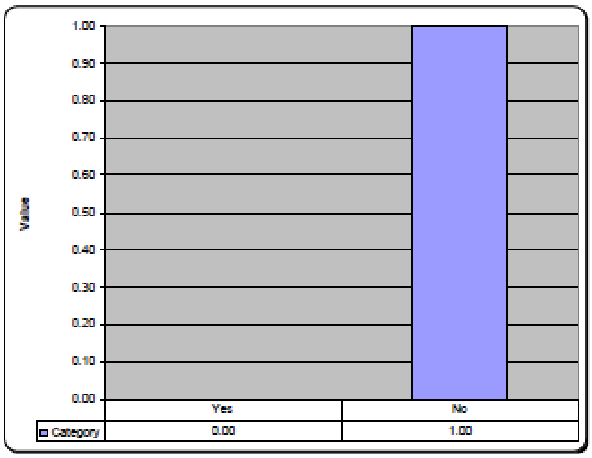

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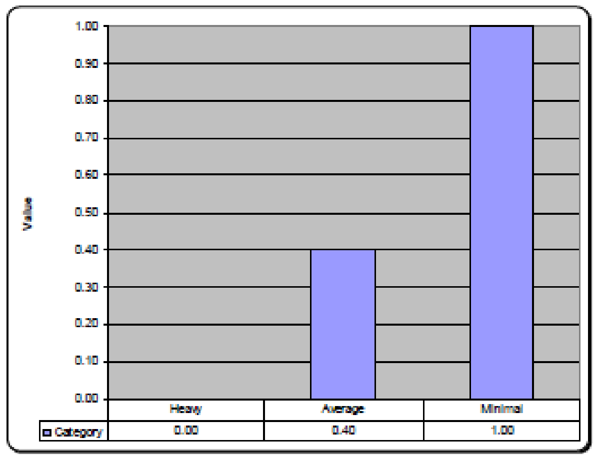

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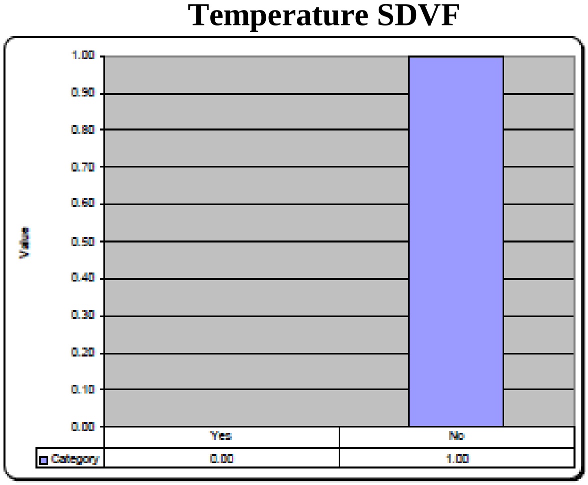

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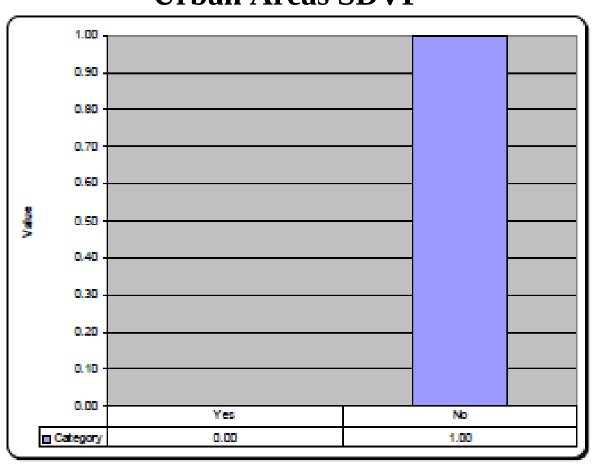

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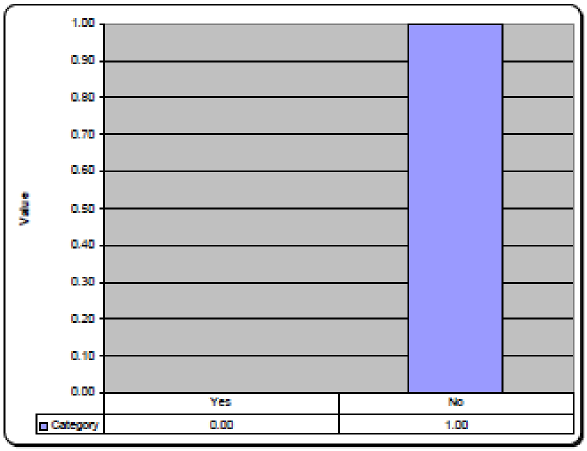

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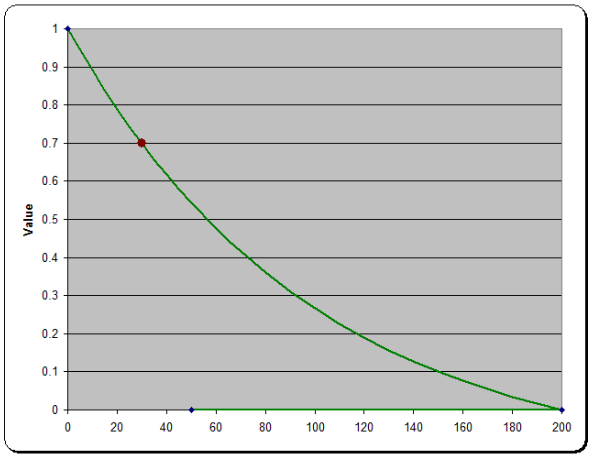
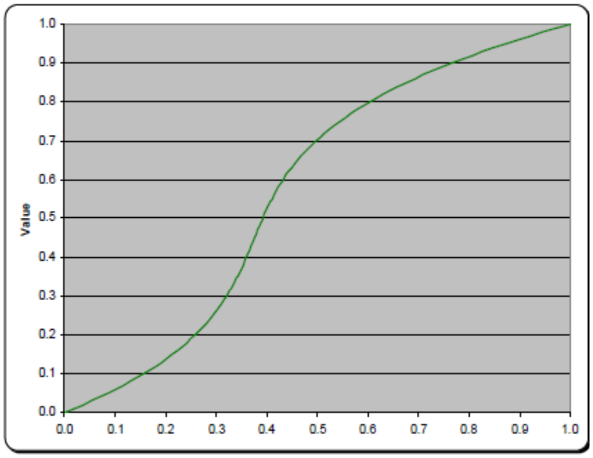


Operational Model Value Functions

Probability of Utilization SDVF



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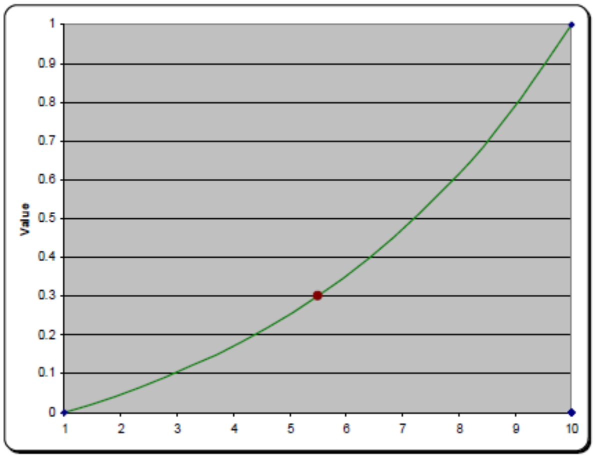

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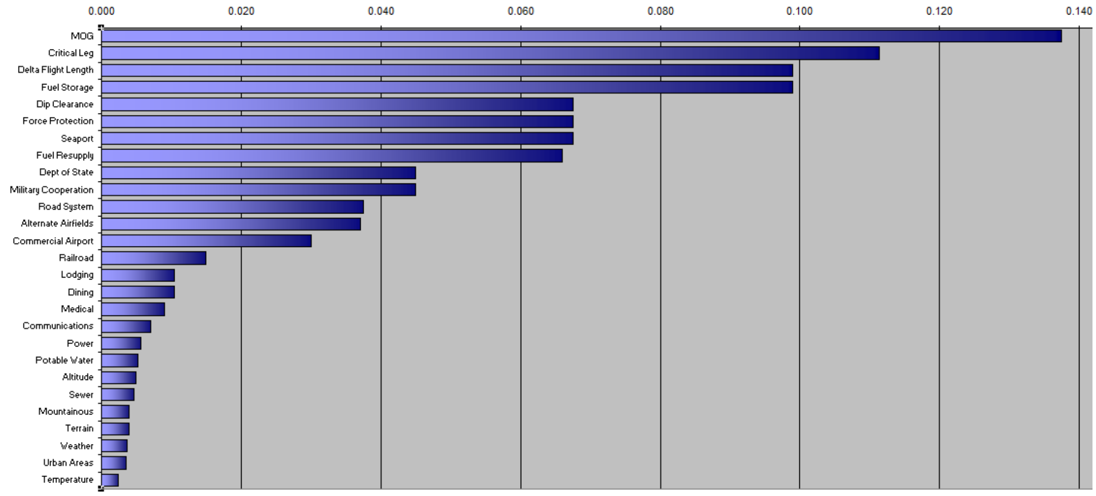

APPENDIX C

Blue Dart Quad Chart

APPENDIX D

Blue Dart Submission Form and Text

Blue Dart Submission Form

First Name: Peter Last Name: Axtell

Rank (Military, AD, etc.): Major / O-4

Position/Title: Student, Advanced Studies of Air Mobility, 2011

Phone Number: 609-754-7749 E-mail: peter.axtell@us.af.mil

School/Organization: AFIT / ASAM

Status: [X] Student [ ] Faculty [ ] Staff [ ] Other

Optimal Media Outlet (optional): ______

Optimal Time of Publication (optional): ______
{*e.g., anniversary of a specific event, etc.*}

General Category / Classification:

[ ] core values	[ ] command	[X] strategy
[ ] war on terror	[ ] culture & language	[ ] leadership & ethics
[ ] warfighting	[ ] international security	[ ] doctrine

[ ] other (specify): ______

Suggested Headline: Value Focused Analysis of the Pacific Theater's Future Air Mobility En Route System

Keywords: Value Focused Thinking, En Route, Basing, Strategic Airlift, Mobility
{*e.g., leadership, ethics, Nuremburg, Giessen, intimidation, chain of command*}

Blue Dart Text {either type in or cut and paste from another document}—Limit to approximately 750 words:

The United States' most recent National Defense Policy and overarching strategies to carry out that policy highlight a globally dispersed, requirements-based capability to sustain major campaigns in distant locations and the need for an agile and rapidly deployable capability. This underlying expectation relies on the United States Armed Force's ability to plan and operate under the premise that forces will remain expeditionary by nature. Achieving this in an uncertain and expansive operational environment like that found in the Pacific Theater (AOR) requires robust sealift, airlift, aerial refueling, and pre-positioned assets.

These assets must become an increasingly agile force able to rapidly achieve objectives in simultaneous, overlapping military operations to support a 1-4-2-1+ strategy; calling for the Armed Forces to defend the homeland, operate in and from four forward regions, win two overlapping campaigns, win decisively a single campaign and conduct a limited number of lesser contingencies. This may seem an impossible task given the state of the current economic environment and ongoing defense budget cuts. Defense Secretary Robert Gates stated, "If the Department of Defense can't figure out a way to defend the United States on a budget of more than a half a trillion dollars a year, then our problems are much bigger than anything that can be cured by buying a few more ships and planes."

As the United States' overseas military presence reduces due to global defense posture realignments, we will need to develop and leverage a more agile, expeditionary force and be capable of moving and sustaining that force over greater distances to protect our national interests. United States Transportation Command (USTC) has identified key areas in the globe that remain hot spots of hostility and instability, or are areas prone to natural disasters and will require the preponderance of airlift support. These areas are Southwest Asia, Southeast Asia, Korea, Indonesia, Africa and Eurasia.

Efficiency and effectiveness will become increasingly difficult to maintain a balance with capacity and capability to meet the needs of both the war fighter and those on Capitol Hill. The AOR's tyranny of distance will always influence the conduct of America's wars. The challenge ahead, lies in the ability to overcome these challenges associated with moving forces over great distances and maintaining the capacity and capability to supply them with fuel, munitions and sustenance. General Hap Arnold once said, "Air power is not made up of airplanes alone. Air power is a composite of airplanes, aircrews, maintenance crews, air bases, air supply, and sufficient replacements in both planes and crews to maintain a constant fighting strength." Pacific en route bases are the key enablers of the agility, versatility and flexibility that the United States needs to achieve its strategic objectives and rapidly employ and sustain its expeditionary combat forces.

To assess mobility requirements in the post-9/11 strategic arena, two comprehensive studies are underway within the Department of Defense (DOD). USTC began its Global Access and Infrastructure Assessment (GAIA) in 2007 to examine global access and infrastructure needed to support the Joint Deployment Distribution Enterprise (JDDE), develop strategy to ensure that access and to shape the Mobility Capabilities and Requirements Study (MCRS) being conducted by DOD. The MCRS-16 study was a joint, collaborative interagency study to assess the JDDE as executed in the 2016 timeframe using 2009 programmed forces under the ability to fight 2 major theater wars and was completed in 2009. The study assessed the mobility system's performance by examining how force closures supported the achievement of U.S. objectives and was designed to coincide with and shape the 2010 Quadrennial Defense Review.

To accomplish the full spectrum of passenger and cargo movement and overcome the constraints of time, distance and environment within the AOR, Air Mobility Command (AMC) and USTC must optimize its en route structure. The current system has not adapted to the post-9/11 National Military Strategy, nor has it adapted to greater technological advances in both the organic and commercial fleets. The purpose of this research is to analyze AMC's proposed en route structure for 2016 and beyond and determine if an optimal and appropriate level of access will exist to meet our national security strategies well into the future. This study utilizes a Value Focused Thinking methodology and decision analysis tool to analyze 27 different measures at a location to provide a comprehensive analysis of command values. This study will aid in providing the analytical underpinnings in which the proposed en route posture and required infrastructure in the Pacific will be based on for future years.

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Glossary

AE	Aeromedical Evacuation
AFB	Air Force Base
AFRICOM	United States Africa Command
AMC	Air Mobility Command
AMMP	Air Mobility Master Plan
AMOG	Air Mobility Operations Group
AMOW	Air Mobility Operations Wing
AMS	Air Mobility Squadron
AOR	Area of responsibility
APOD	Aerial Port of Debarkation
APOE	Aerial Port of Embarkation
CAST	Conflict Assessment System Tool
CENTCOM	United States Central Command
DoD	Department of Defense
DPO	Distribution Process Owner
EERISC	European En Route Infrastructure Steering Committee
GAIA	Global Access and Infrastructure Assessment
GAO	Government Accountability Office
GERISC	Global En Route Infrastructure Steering Committee
GERBIL	Global En Route Base Infrastructure Location
GERS	Global en route system
JDDE	Joint Deployment Distribution Enterprise
JDPAC	Joint Distribution Process Analysis Center
JOE	Joint Operating Environment
JTF-PO	Joint Task Force-Port Opening
MILCON	Military-funded Construction
MCAS	Marine Corps Air Station
MCRS	Mobility Capabilities & Requirements Study
MOG	Maximum on Ground
MRC	Major Regional Conflict
MRS	Mobility Requirements Study
MRS-BURU	Mobility Requirements Study Bottom-Up Review Update
NM	Nautical Mile
NMS	National Military Strategy
OSD	Office of the Secretary of Defense
PACOM	United States Pacific Command
PERISC	Pacific En Route Infrastructure Steering Committee
QDR	Quadrennial Defense Review
SDVF	Single Dimensional Value Function
STONS	Short tons
SSGN	Ohio Class Guided Missile Submarine
TACC	Tanker / Airlift Control Center
USTC	United States Transportation Command
VFT	Value Focused Thinking

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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5c. PROGRAM ELEMENT NUMBER

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Axtell, Peter G., Maj, USAF

5d. PROJECT NUMBER

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

Proper optimization in number, location, and function of supply chain nodes to reduce costs with simultaneous improvements in distribution effectiveness is a key goal for United States Transportation Command (USTC) in its execution of the National Defense Strategy. As the distribution process owner (DPO) for all things transportation, USTC ensures America's ability to project power rapidly and sustain operations globally. Studies such as the Mobility Capabilities and Requirements Studies (MCRS) as well as the Global Access and Infrastructure Assessment (GAIA) have been conducted to assist USTC in identifying key infrastructure locations and capabilities to increase accessibility and improve effectiveness. This research utilizes a Value Focused Thinking (VFT) methodology and decision analysis tool to analyze the proposed en route system in the Pacific Theater, as identified by Air Mobility Command, for coverage gaps or additional capability opportunities and provide leadership with a decision tool to optimally and effectively meet America's future security challenges.

15. SUBJECT TERMS

Value Focused Thinking, Air Mobility Command, En Route Airfields, Pacific Theater, Strategic Airlift

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