IMPROVING COMMAND AND CONTROL IN THE MEXICAN ARMY AND AIR FORCE TO SUPPORT LAND OPERATIONS

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This thesis studies the Mexican Army and Air Force (MAAF) current capabilities to exercise command and control (C2) in support of land operations. The study focuses on finding optimal solutions to improve current capabilities based on the available options in the U.S Doctrine. The analysis process of the study is guided by the Capability Based Assessment (CBA) and Doctrinal, Organizational, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) processes. The study also considers examples of robust C2 frameworks employed within the U.S. military services. Thesis findings relate to possible doctrinal, organizational and materiel solutions the MAAF might embrace to improve C2 in support of land operations. MAAF's current challenges relate to Disaster Relief Operations and Inter-institutional Operations. Thesis Findings would increase readiness and situational awareness to effectively act upon these challenges. Findings rely on technology as a key element for the MAAF to improve C2 in support of land operations. With the employment of technology, MAAF would be more operational and its threats would be diminished in close coordination with civil authority, who ultimately must be responsible to retake full control of the areas affected by criminals. The final aim is that government legitimacy prevails over organized crime.

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ABSTRACT

IMPROVING COMMAND AND CONTROL IN THE MEXICAN ARMY AND AIR FORCE TO SUPPORT LAND OPERATIONS, by Major Mariano Valencia Lopez, 107 pages.

This thesis studies the Mexican Army and Air Force (MAAF) current capabilities to exercise command and control (C2) in support of land operations. The study focuses on finding optimal solutions to improve current capabilities based on the available options in the U.S Doctrine. The analysis process of the study is guided by the Capability Based Assessment (CBA) and Doctrinal, Organizational, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) processes. The study also considers examples of robust C2 frameworks employed within the U.S. military services. Thesis findings relate to possible doctrinal, organizational and materiel solutions the MAAF might embrace to improve C2 in support of land operations. MAAF's current challenges relate to Disaster Relief Operations and Inter-institutional Operations. Thesis Findings would increase readiness and situational awareness to effectively act upon these challenges. Findings rely on technology as a key element for the MAAF to improve C2 in support of land operations. With the employment of technology, MAAF would be more operational and its threats would be diminished in close coordination with civil authority, who ultimately must be responsible to retake full control of the areas affected by criminals. The final aim is that government legitimacy prevails over organized crime.

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ACRONYMS

ADP	Army Doctrine Publication
ADRP	Army Doctrine Reference Publication
ADCON	Administrative Control
AOC	Air Operations Center
ATTP	Army Tactics, Techniques and Procedures
A2C2S	Airborne Command and Control System
BFT	Blue Force Tracker
C2	Command and Control
CBA	Capability Base Assessment
DHS	Department of Homeland Security
DHHS	Department of Health and Human Services
DOS	Department of State
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and education, Personnel, Facilities and Policy
FLIR	Forward Looking Infrared System
FMF	Fleet Marine Force
FM	Field Manual
GDP	Gross Domestic Product
GPS	Global Positioning System
HF	High Frequency
INEGI	Mexican National Institute of Statistics and Geography
JP	Joint Publication
JFACC	Joint Forces Air Component Commander

MAGTF	Marine air-ground task force
NDP	National Development Plan
NSS	National Security Strategy
OPCON	Operational Command
SATCOM	Satellite Communications
SINAPROC	Mexican National Civil Protection System
TACON	Tactical Control
TRADOC	Training and Doctrine Command
U.S.	United State.
USMC	United States Marine Corps
VHF	Very High Frequency
WAC	World Aeronautical Chart

CHAPTER 1

INTRODUCTION

Armies achieve success in combat not only with the destructive power of its weapons, but also with sound organization, and command and control. The Mexican Army like other armies in the world strives to integrate the optimal organization capable of achieving its missions with the major advantage.

The organization of an army must be integrated with essential elements such as qualified leaders, trained personnel, doctrine, weapons and many other elements that would vary on the amount of economic resources invested to accomplish national interests stablished by governments.

To accomplish its missions, army leaders combine those essential elements with realistic training, experience and creativity to develop innovative actions that potential enemies cannot foresee. Commanders' creativity is a powerful tool to develop plans with unexpected maneuvers to defeat an enemy with more resources. Additionally, technology fosters creativity and reinforces commanders' portfolio with more options to defeat potential enemies.

Training and experience are excellent complements to boost commanders' actions in order to confront the enemy with more probability to success. Once in battle, Army commanders rely not only in the available personnel and weapons, but also in the high valued skills that could help them win battles. One of those skills in battle is command and control (C2).

All forces on the ground, air, sea or maritime environment must know the location and disposition of their subordinate units. All commanders need to coordinate actions and

receive reports, share information, and create synergy among their forces to defeat an enemy.

As an essential skill in battle, armed forces develop C2 with different elements. Developing countries may achieve C2 using only High Frequencies (HF) radios and satellite telephones mounted on ground vehicles to control their deployed forces and transmit orders. Well developed countries may employ ground vehicles, fixed wing aircraft, rotary wing aircraft, and a robust cyber infrastructure to retaliate any enemy action that violates their national interests.

Rotary wing aircraft is a mobile asset that allows Army commanders to coordinate ground forces from the air. The rapid movement of rotary wing aircraft and the availability of integrated communications increase effectiveness against changing threats like insurgent groups (Arey 2004).

Rotary wing aircraft also offers versatility for Army commanders to move throughout the battlefield in order to synchronize maneuvers without reducing their ability to exert C2. This versatility enables commanders to coordinate operations not only with subordinate units but also with adjacent military units, interagency elements or elements from other Services (Department of the Army 2004b).

The purpose of this study is to provide solutions to the current capability gaps and to emphasize the importance of Command and Control (C2) for the Mexican Army and Air Force. The emphasis relies on the successful application of C2 to enable a ground commander to maneuver his forces to facilitate mission accomplishment.

C2 must also be understood as a complement to skillful leadership that allows commanders to accomplish missions following doctrinal concepts to employ forces in different operational environments.

As a peaceful and developing country, the United Mexican States must consider financial resources required to design a Command and Control network to adequately support military operations of the Mexican Army and Air Force. Furthermore, integrating air and ground C2 capabilities would require trained personnel, sound doctrine, and appropriate facilities to support acquired equipment for military operations.

Background

The Mexican Army has a long history of brave action and continuous evolution to adapt itself to the changing threats within the Mexican borders. Fully committed with the Army, the Mexican Air Force joins its air assets to work together within the range of their general missions in benefit of the Mexican population.

Both Armed Forces work together to accomplish missions related with maintaining national sovereignty, internal order, and support of Mexican population in case of disasters. In 2006, the Mexican Armed Forces were also tasked to assist in Inter-institutional operations in support of civil authorities to reinforce actions against organized crime primarily along the Mexican borders.

This protracted fighting required Mexican Army commanders to act and apply military action according to the changing scenarios driven by the organized crime. The Mexican Army and Air Force share assets to perform Command and Control with the available resources. Currently, the Mexican Army and Air Force lack of an airborne capability equipped with modern technology dedicated exclusively to perform Command

and Control in support of land operations. Given this shortfall, this thesis studies existing technology in the U.S. Services to develop solutions for the Mexican Army and Air Force.

Coordination and synchronization of Mexican forces on the ground would be benefited with an airborne asset providing visual identification of potential threats in different environments. Additionally, force readiness and effectiveness could also be improved with modern technology to assist Mexican Army commanders when maneuvering their forces in response to the operating environment.

Research Question

Primary research question:

How Can the Mexican Army and Air Force improve Command and Control in support of land operations?

Secondary questions:

1. What doctrinal solutions could best improve Mexican Army and Air Force Command and Control in support of land operations?
2. What organizational solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?
3. What materiel solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

Assumptions

Several assumptions are essential in order to preserve the importance of the theme studied in this thesis. These assumptions are:

1. Mexican Army land operations do not have an adequate, dedicated air asset to perform Command and Control.
2. Mexican Army land operations employ some Mexican Air Force fixed and rotary wing aircraft to perform C2 with operational limitations.
3. Mexican Air Force will continue to support the Mexican Army land operations.
4. The potential threats to the Mexican Army and Air Force will remain active and improve their tactics employing modern technological means.
5. Technology will continue evolving and will be available by the time the Mexican Army and Air Force decide to acquire new equipment.

Terms

Armed Forces of the United States: "A Term used to denote collectively all components of the Army, Marine Corps, Navy, Air Force, and Coast Guard (when mobilized under Title 10, United States Code, to augment the Navy)". (Department of Defense 2013b, 161).

Art of command: "The creative and skillful exercise of authority through timely decision making and leadership" (Department of the Army 2014, 23).

Authority: "The delegated power to judge, act, or command" (Department of the Army 2014, 23).

Combatant Command: "A unified or specified command with a broad continuing mission under a single commander established and so designated by the President, through the Secretary of Defense and with the advice and assistance of the Chairman of the Joint Chiefs of Staff. Also called CCMD" (Department of Defense 2013b, 161).

Command: “The authority that a commander in the armed forces lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. It also includes responsibility for health, welfare, morale, and discipline of assigned personnel” (Department of the Army 2014, 23).

Command and control: “The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Also called C2” (Department of Defense 2013b, 161).

Control: “The regulation of forces and warfighting functions to accomplish the mission in accordance with the commander’s intent” (Department of the Army 2014, 23).

Joint: “Connotes activities, operations, organizations, etc., in which elements of two or more Military Departments participate (Department of Defense 2013b, 164).

Joint Force Commander: “A general term applied to a combatant commander, sub unified commander, or joint task force commander authorized to exercise combatant command (command authority) or operational control over a joint force. Also called JFC” (Department of Defense 2013b, 164).

Military Department: “One of the departments within the Department of Defense created by the National Security Act of 1947, which are the Department of the Army, the Department of the Navy, and the Department of the Air Force. Also called MILDEP” (Department of Defense 2013b, 165).

Mission command: “(Army) The exercise of authority and direction by the commander using mission orders to enable disciplined initiative within the commander’s intent to empower agile and adaptive leaders in the conduct of unified land operations” (Department of the Army 2014, 24).

National Security: “A collective term encompassing both national defense and foreign relations of the United States with the purpose of gaining: a. A military or defense advantage over any foreign nation or group of nations; b. A favorable foreign relations position; or c. A defense posture capable of successfully resisting hostile or destructive action from within or without, overt or covert” (Department of Defense 2013b, 165).

National Security Strategy: “A document approved by the President of the United States for developing, applying, and coordinating the instruments of national power to achieve objectives that contribute to national security. Also called NSS” (Department of Defense 2013b, 166).

Operational Control: “The authority to perform those functions of command over subordinate forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction necessary to accomplish the mission. Also called OPCON” (Department of Defense 2013b, 166).

Readiness: “The ability of military forces to fight and meet the demands of assigned missions” (Department of Defense 2010, 204).

Tactical Control: “The authority over forces that is limited to the detailed direction and control of movements or maneuvers within the operational area necessary to accomplish missions or tasks assigned. Also called TACON” (Department of Defense 2013b, 167).

United States: “Includes the land area, internal waters, territorial sea, and airspace of the United States, including United States territories and other areas over which the United States Government has complete jurisdiction and control or has exclusive authority or defense responsibility” (Department of Defense 2013b, 168).

United States Armed Forces: “Used to denote collectively the Army, Marine Corps, Navy, Air Force, and Coast Guard” (Department of Defense 2013b, 168).

Limitations

This thesis is limited to a review of the available doctrinal concepts and advanced technology in the U.S. Army, U.S. Air Force, and U.S. Marine Corps. The review focuses on the employment of command and control networks that could be employed by the Mexican Army and Air Force to support land operations. The analysis considers the review of the doctrine, organization, training, material, leadership and education, personnel, facilities, and policy (DOTMLPF-P) solutions to capability gaps. However, it focuses only on solutions within the doctrine, organization and materiel domains.

Although there are many required capabilities to consider in the area of command and control, this thesis will analyze the three deemed as the highest priority requirements. These required capabilities are:

Capability 1: The capability to maintain situational awareness throughout mission execution by providing a current and integrated picture of ongoing operations.

Capability 2: The capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats.

Capability 3: The capability to observe current force positions on the ground to assess operational effectiveness, and further, to analyze the possible effects of roads, mountains, populated areas, lines of communication, rivers, lakes, and other points of interest existing on the operational area.

Delimitations

This thesis will focus mainly on the analysis of available technological options for airborne Command and Control systems onboard rotary wing aircraft. Due to the nature of the Mexican Army land operations, the analysis will strive to fill the gap in ground to air coordination during the development of specific land operations of the Mexican Army and Air Force. Among all technological options existing in the world market, this thesis will attempt to present optimal solutions to improve Command and Control in support of land operations.

Significance of the Study

This study sets the initial effort to identify potential solutions to existing Mexican Army and Air Force command and control capability gaps. The Mexican Army requires a high level of readiness to face the challenges of a continuously changing environment. The Mexican Army must strive to obtain the best possible advantage over its potential adversaries in order to properly execute the orders from the Supreme Commander of the Mexican Armed Forces.

The results of this study may provide insights to better prepare the Mexican Armed Forces to counter the threats that intend to bring harm to Mexican society and endanger the rule of law in the Mexican state.

Summary

This chapter introduced the topic of this study and provided the primary and secondary research questions that will be answered in this thesis. This chapter also discussed the problem background and assumptions within the study. Additionally, key terms were defined to provide the reader with better understanding. Finally, this chapter provided the limitations, delimitations, and the significance of the study.

CHAPTER 2

LITERATURE REVIEW

This chapter will review the available literature about the U.S. Forces Capability Development Process to define solutions that could improve the Mexican Army and Air Force Command and Control in support of land operations. With the intention of answering the primary research question, the literature review in this chapter will cover the United Mexican States Strategic importance, Mexican Federal Administration Organization, Mexican Armed Forces General Organization and missions, Command and Control, U.S. Armed Forces Command and Control, and the Capability Based Assessment Process.

United Mexican States Strategic importance

The United Mexican States conduct international relations following inalienable principles set forth in Article 89th of the Mexican Constitution. As a free nation, Mexico has the right to decide the ways and means to achieve the desired ends in the national and international environment following fundamental principles such as maintaining international peace and security (Mexican Supreme Court 2010).

In order to ensure peace and security, the Mexican government must take decisive actions to modernize the military within budget constraints. Budget constraints determine the amplitude of military means. The strategic importance of the United Mexican States relies in its geographic location between Latin America and The United States of America, which influences the economic growth and free trade not only for Mexico, but for many countries in the world. With a population of more than one hundred million

people, Mexico struggles to develop economic growth with different countries in the world.

Mexico is the 14th economy in the world (World Bank 2016a). Mexico has a network of 12 Free Trade Agreements with 46 countries, 32 Agreements for the Promotion and Reciprocal Protection of Investment with 33 countries, and 9 limited scope agreements related to Economic Complementation Agreements and Partial Scope Agreements in the framework of the Latin American Integration Association (Mexican Secretariat of the Interior 2017).

The United States of America with a gross domestic product of more than 18 million dollars is the first world economy (World Bank 2016b). The fact that both countries share a more than 1,800 miles of common frontier boosts the economy, and at the same time is a significant challenge to face common threats that jeopardize security for both countries. The ample frontier is also seen as a good opportunity for organized crime groups to transport drugs coming from Central and South America using Mexican territory as a natural bridge to sell them into the United States of America (Department of Justice 2016).

Mexican Federal Administration Organization

The United Mexican States is a representative, democratic and federal Republic, consisting of free and sovereign states for all matters concerning their internal affairs, but united in a federation. The general structure of the Mexican government includes 18 state secretariats to support the president in specific matters. The Secretariat of National Defense and Secretariat of the Navy integrate the military effort to support presidential guidance concerning national security.

The Mexican military effort comprises the three Armed Forces, which are the Mexican Army, Navy and Air Force. As guarantor of the permanent existence of the Federation, the Mexican Armed forces have legal existence under the constitution of the United Mexican States. The Constitution is the supreme document that grants the president the legal authority to make use of the armed forces to conduct the exterior defense of the Federation (Mexican Supreme Court 2010). Knowledge about the Mexican Federal Administration will help identify the general attributions and responsibilities of the Mexican Secretariat of National Defense, which is responsible to command the Army and Air Force as part of the government structure.

The 18 Secretariats must coordinate functions and activities working towards the benefit of the Mexican population and national development. The Mexican Secretariat of the Interior coordinates specific actions with the Secretariat of National Defense related with the national strategy against criminal organizations and support to civil authorities in case of national disasters (Mexican Secretariat of the Interior 2016). This close coordination requires communication channels that are tied with the Army and Air Force capabilities. Therefore, any improvement on the Command and Control related to the primary research question will also impact support to Mexican civil authorities.

Mexican Armed Forces General Organization and Missions

The Political Constitution of the United Mexican States indicates the existence of the Mexican Armed Forces as legal institutions to maintain the Federation's interior security and defense. This document also establishes the legal attribution for the President to use the armed forces to protect the Federation against threats to sovereignty.

The Mexican Regulation for Territorial Commands, Military Garrisons and Military Posts establishes guidance for the general organization of the Mexican Army and Air Force. Territorial Commanders may also perform Inter-institutional operations in support of civil authorities upon request or ordered by the President, who is the supreme commander of the Armed Forces.

The Mexican Army and Air Force perform the command and control function in support of land operations according to the level the operation is going to be conducted. For example, the Mexican Army and Air Force plan Inter-institutional operations when there is the need to conduct operations against organized crime. Some of the institutions the military coordinate with are: the office of Attorney General of the Republic, Secretary of the Interior, and state Governors. Close coordination is also implemented for disaster relief operations (Mexican Secretariat of the Interior 2016).

The Mexican Army and Air Force missions include specific actions conducted both in war and peace. Peace time missions require coordination with civil authorities to develop special operating procedures to counter actions against the law or situations that might endanger the population (Mexican Secretariat of National Defense 2014).

Command and Control

Command and control is a fundamental function for both the United States of America and the United Mexican States. Command and control is employed to coordinate and conduct actions towards the achievement of national goals. At the strategic level, the President of the United States of America establishes the national goals in the document titled “National Security Strategy”.

The National Security Strategy (NSS) orders actions for: National Defense, Homeland Security, Combating Terrorism, Preventing the Spread and Use of Weapons of Mass Destruction, Climate Change, Energy Security, Science, Technology, and Innovation, Global Economic Order and Support Emerging Democracies. This document also directs necessary coordination measures between governmental departments such as: Department of Defense (DOD), Department of Homeland Security (DHS), Department of State (DOS), Department of Health and Human Services (DHHS) (National Security Strategy 2015).

The NSS document is important not only because it sets the strategic guidance for American government coordination, but also because it communicates the government intentions to the American people. The NSS mandates that the President retains command and control (C2) authority for all U.S. Forces. This includes the authority and responsibility to plan, organize, coordinate, control and employ these forces. Since the U.S. Armed forces accomplish missions throughout the world, operational control (OPCON) may fall under a U.S. geographic combatant commander operating in Europe, Africa, or Asia (Department of Defense 2013b).

The NSS document is relevant for the purpose of this thesis because gives the military direction of the U.S. Armed Forces to accomplish national goals and sets the foundations for the U.S. Command and Control infrastructure required to support military operations to face threats in the continental Unites States and abroad.

On the side of Mexico, the Political Constitution of the United Mexican States and the National Development Plan establish the strategic guidance to conduct policy and

governmental actions to achieve national goals. Article 89th of the Political Constitution establishes fundamental principles abided by the President to perform foreign policy.

The strategic guidance principles are: self-determination of peoples, non-intervention, settlement of disputes, to refrain in their international relations from threats or use of force, equal rights of states, international cooperation for development, and to maintain international peace and security (Mexican Supreme Court 2010).

The constitution is important for this thesis because it establishes the range and focus of the international policy followed by the Mexican government. As a free nation, Mexico has the right to decide the ways and means to achieve the desired ends in the national and international environment. The constitution also sets the legal foundations and existence of the Mexican Armed Forces as part of the government infrastructure to protect and defend Mexican territory and population.

The National Development Plan is the document in which the Mexican President establishes strategic goals to be achieved during his presidential mandate. The document gives specific responsibility to each of the Mexican secretariats such as: Secretary of the Interior, Secretary of Foreign Affairs, Secretary of Finance, and Secretary of Defense to work within its area of responsibility and to coordinate with other government institutions to achieve national goals (Mexican Chamber of Deputies 2013).

This document is important because it indicates the responsibilities for each Secretariat to work towards common goals of the Mexican government. This plan is also important for this thesis because the responsibilities assigned to the Mexican Secretary of Defense include to modernize training and infrastructure to best perform its duties. This thesis will strive to develop solutions that could fit into these purposes.

The employment of doctrinal concepts highlights the importance of command and control to guide the actions and to build a C2 infrastructure. Mission command is one of the most important principles to be applied when constructing the network. Mission command has two approaches that define the actions taken by commanders at the strategic, operational and tactical levels. This principle sets the philosophical approach and the warfighting function approach to guide commanders during the decision making process (Department of the Army 2014).

Command and control are fundamental concepts that assist commanders to focus the employment of resources and managing personnel, facilities, computers, communications and other means to set up a C2 infrastructure in a specific service or joint environment (Department of Defense 2013b).

These concepts are important for this thesis because they establish the direct relation between the means employed by commanders and ends they want to achieve. Technological resources such as computers, radio or satellite communications are a fundamental aspect of the C2 networks. This thesis will emphasize to identify the most suitable option for the Mexican Armed Forces to improve the Command and Control in support of land operations.

Military personnel perform their duties to achieve command and control. The command and control activities must to be controlled by commanders. Depending on the unit level and the desired degree of control, commanders may assign operational control or tactical control to subordinate commanders. Operational control requires commanders to organize and employ the assigned forces. When commanders of the U.S. Army, Navy,

Marine Corps or Air Force assume operational control, they can designate objectives and give authoritative directions related to mission accomplishment.

Commanders with tactical control of forces can exercise control of the attached forces. With tactical control, commanders give directions and control the movements or maneuvers within the operational area to accomplish a specific mission (Department of Defense 2013b). Operational and tactical control are significant for this thesis because they establish command relationships to exercise authority and coordinate actions using C2 resources to accomplish the commander's intent.

To achieve success against a common enemy, ground forces must coordinate operations with the Air Force to save time and manage human effort against an adversary. Within the joint air environment, the Joint Forces Air Component Commander (JFACC) is responsible to plan, execute, and assess air missions in concert with the other services in order to support the objectives of the Joint Force Commander (Department of Defense 2014b).

The application of the air effort is important for this thesis because it establishes the concept of employment of air assets to achieve command and control from the Air Force perspective. Additionally, the air effort is important for the effective performance of air and land operations acting together to achieve common goals. With the analysis of the concept of air asset employment to achieve C2, this thesis will develop doctrinal options for the Mexican Armed Forces to improve this fundamental function.

Doctrinal concepts define the direction for organizations to follow in both peace and war. United States Armed Forces doctrine provides the fundamental principles to guide forces to achieve unity of effort. These principles are employed in the joint

environment and are related to the effective command and control of the means to achieve the ends in any type of conflict.

This thesis will consider joint concepts to analyze the way forces are employed and the benefit that commanders obtain from their employment. The principles to be consider are: unity of command, unity of effort, general support, mutual support, direct support, administrative support, information management and knowledge sharing, communication, timely decision making, coordination mechanisms, situational awareness, and mutual trust (Department of Defense 2013b).

These principles contain doctrinal guidance for commanders to appropriately use personnel, facilities, and equipment that are part of a C2 network. Additionally, in order to employ a C2 network, commanders must follow these doctrinal procedures to make the best use of these capabilities.

The strategic guidance and doctrinal concepts applied in the U.S. Armed Forces are based on their national goals, which require them to act globally. On the other hand, the United Mexican States do not have military goals outside its borders. This means the Mexican Armed Forces have not yet developed doctrinal principles to be applied externally to the Mexican border.

The required capabilities for the Mexican Armed Forces to have a Command and Control network must also be framed to achieve national goals. Mexican national goals are set for the government to act internationally to promote: the peaceful settlement of disputes, to refrain in their international relations from threats or use of force, equal rights of states, international cooperation for development, and to maintain international peace and security.

U.S. Armed Forces Command and Control

In the U.S. Armed Forces, command and control is a function studied as part of a single service or as a joint function performed by all of the armed forces. Additionally, each service can develop a command and control system to achieve missions employing assets that are service unique.

Commanders must develop and design a C2 infrastructure to enable them to control their assets in a ground, air, or maritime environment. Commanders must also consider other important factors before designing a C2 system such as: the mission, the threat, the number of subordinate units, and the level of subordinate units in the area of responsibility (Department of Defense 2013b).

Understanding how the U.S. Armed Forces operate in the joint environment is important for this thesis because it provides an overview of coordination actions between two or more forces operating together towards a single objective. Additionally, it provides an example of a single C2 network dealing with compatibility issues and how they can be solved to achieve effective C2.

Each U.S. service has the capability to achieve Command and Control acting within its specific domain. The U.S. Air Force states that C2 should be considered along with technological developments in the short, medium and long term. The development of these elements may define the parameters of envisioned capabilities. Additionally, command and control relates to airpower as part of the tenet “centralized control and decentralized execution” philosophy for the Air Force (Department of the Air Force 2015).

The air domain demands that the Air Force have specific procedures to control high speed and versatile assets acting in contested areas. The Air Force needs to apply key considerations to manage the airspace and deny an enemy control of it.

Key considerations such as commander's intent and command relationships are fundamental guidance and authority that commanders are given to coordinate with superior, subordinate, and lateral force commanders. Commanders of the Air Force Forces (CAFF) deployed in an area of operations must have a true understanding of their personnel and equipment capabilities before employing them in the operational environment. Also, subordinate commanders must understand the higher commander's intent to apply air power for a specific objective (Department of the Air Force 2014).

Air Force commanders must accomplish missions at different levels. At each level, the commander has the responsibility to accomplish his mission in line with the higher commander's intent. Since the air domain is a complex environment and its control vital to land forces, commanders must be prepared to act immediately against air threats.

These command relationships are developed in the form of: operational control (OPCON) which provides the authority to command subordinate forces to assign tasks, designate objectives, and give authoritative direction necessary to accomplish the mission; tactical control (TACON) which provides the limited authority over forces to give detailed direction and control movements and maneuvers within the operational area necessary to accomplish missions; and administrative control (ADCON) which provides direction or exercise of authority over subordinate commands to perform administration and support functions (Department of Defense 2013b).

The Air Operations Center (AOC) integrates Air Force assets to achieve command and control. The AOC allows the commander to plan, direct, and assess the activities of the forces committed to achieve his missions. Air Force assets such as computers, radio communications, satellite communications, and software interact with Air Force subordinate units and the operations centers from other services to perform command and control.

The AOC articulates the tasks related to the development of: the component strategy and requisite planning products, mission execution, assessing day-to-day component operations, planning and executing intelligence, surveillance, and reconnaissance appropriate to assigned missions, and conducting operational-level assessment (Department of the Air Force 2013).

The Air Force approach to command and control, which includes tenets, command relationships, and general organization is important for this thesis because it depicts the agile and versatile management of the air assets to quickly respond to any threat. The Air Force approach contains information about its contribution to the joint environment and the manner in which they integrate their efforts to increase capabilities.

The maritime environment is another domain valuable for this thesis. This domain requires forces to properly organize against threats. The maritime domain requires the employment of both the U.S. Navy and U.S. Marine Corps. Typically, when a mission requires the Marines to act outside of the U.S., the U.S. Navy supports their deployment and initial sustainment requirements as they begin employment within an operational area. (Department of the Navy 2004).

Maritime domain management comprises the employment of C2 assets onboard Navy ships and within a Marine air-ground task force (MAGTF) to accomplish assigned missions. The Marine Aviation Combat Element commander integrates air assets to conduct air operations in Support of the Fleet Marine Force (FMF) to include: offensive air support, anti-air warfare, assault support, electronic warfare, air reconnaissance, and control of aircraft and missiles (Department of the Navy 2004).

The Marine Air Command and Control system concept of operations is supported by a robust structure of personnel and equipment ready to deploy anywhere in the world. Marine elements are properly trained to manage communications and operate sophisticated communications equipment. The Marine Air Command and Control system is employed to exercise command and control in support of the Marine air-ground task force (MAGTF) operations (Department of the Navy 1997).

Understanding the organization, command and control assets, missions, and forces employed in the maritime domain is important for this thesis in order to include the U.S. Navy and Marine Corps contribution to the joint environment. Additionally, the Marine Corps employment of air assets is of particular interest because they manage two domains simultaneously when conducting land operations.

The U.S. Army has a robust infrastructure to organize the command and control network to accomplish its missions. U.S. Army power is based on solid doctrinal principles that set the foundation for the coordinated and accurate actions to defeat an enemy. Several of these fundamental principles are:

1. Art of Command: the means in which commanders make decisions and exercise authority over subordinates. This principle also states that a commander must be

creative and have a good understanding of his subordinates to be an effective leader (Department of the Army 2012a).

2. Command: the legal right for commanders to exercise authority over his unit. A commander exercises command using his granted rank or special assignment to issue orders to accomplish missions (Department of the Army 2012a).

3. Control: the means to integrate infantry, cavalry, artillery, or aviation using the warfighting functions to defeat the enemy by following the commander's intent (Department of the Army 2012a).

4. Mission Command: a philosophical approach for a commander to understand the importance of providing a clear intent to allow subordinate leaders execute operations within this intent. Commanding forces is not only a matter of giving orders, but being responsible for subordinates' actions on the battlefield. Additionally, the concept describes the importance of mission command as a warfighting function, enabling a commander to lead and coordinate the employment of forces towards a common goal (Department of the Army 2012a).

5. Science of Control: the infrastructure employed by a commander to enable broader understanding of the tactical situation to accomplish his missions (Department of the Army 2012a).

These concepts are important because they drive the commander's mindset to lead soldiers and manage resources in order to successfully accomplish assigned missions. The commander's mindset begins with the personal intention to cultivate his personal knowledge in order to gain personal power over his subordinates. This personal power is an important aspect of mission command. Commanders must be leaders capable of

synchronizing subordinate actions, not only by giving verbal directions but inspiring them to act accordingly with the mission's requirements.

The relationship between a commander and his subordinates begins with the motivation and inspiration he provides to his soldiers. A commander leads his forces while considering the assigned missions and the available means to achieve them. Finally, a commander uses systems and procedures to control the information and operations in coordination with other commanders.

The U.S. Army has the capability to perform major operations worldwide. When conducting these operations, the Army organizes its assets with other U.S. Services in a joint environment. The joint environment requires a specific doctrine to organize and coordinate elements to achieve objectives. In addition to joint doctrine, doctrine must also provide principles to enable U.S. military organizations to operate with other U.S. Government departments and agencies, as well as with multinational partners during operations (Department of Defense 2014e).

The use of the airspace for military operations is specially coordinated in areas where operations involve the employment of land-based Army or Navy forces to achieve commander's intent and to avoid casualties or fratricide (Department of the Army 2002). Airspace is controlled employing different altitudes depending on the aircraft missions, requiring close coordination measures. (Department of the Army 2007a).

The importance of understanding U.S. Army organizational concepts within a joint or multinational environment, and the C2 network required to coordinate the airspace within its area of responsibility is significant for this thesis because demonstrates the complexity of commanding and controlling forces in a multi-dimensional

environment. U.S. Army experience in employing C2 assets over the past decade provides valuable lessons to consider in order to develop required capabilities for improving Command and Control for the Mexican Armed Forces.

To conduct national defense operations, the Mexican Army and Air Force organize and function as a single institution named the Mexican Secretariat of Defense. Both armed forces have an adequate staff to conceive, prepare and conduct joint operations to maintain sovereignty. Working as a single institution provides them the flexibility to be organized, equipped, trained, educated, and managed to achieve their general mission (Mexican Secretariat of National Defense 2014). Both the Army and Air Force have units to achieve missions in the air or land domain. They can act independently, or plan together to perform joint missions.

The command and control function in support of land operations is performed at all military levels. The Mexican Army coordinates with territorial commanders who perform military operations against threats to the territory, disaster relief operations in support of the population, or Inter-institutional operations in support of civil authorities when necessary or ordered by the President (Mexican Secretariat of National Defense 2013). Understanding the Mexican Armed Forces' organization and missions is important for this thesis because they demonstrate the extent of the C2 network needed to improve Command and Control in support of land operations.

Capability-Based Assessment Process

The U.S. Army manages its requirements through a dedicated process to provide solutions that improve capabilities in a specific area of interest. The Joint Capabilities Integration and Development System (JCIDS) is the overarching process to develop

capabilities within the Department of Defense. Within the JCIDS process, the military services use the Capabilities Base Assessment (CBA) to validate required capabilities, determine capability gaps, and then to provide recommended solutions to these capability gaps. The U.S. Army Training and Doctrine Command (TRADOC) is the institution responsible to support the Army in developing solutions for the commanders' requirements.

The CBA process starts with an analysis of the future joint operating environment, including an analysis of the physical, demographic, political, economic, technological, and military conditions in which the Army forces will operate during the next 25 years. From this analysis, TRADOC develops a prioritized list of required capabilities. These required capabilities are then considered within the context of current capabilities to determine the capability gaps. To develop solutions to these capability gaps, TRADOC considers solutions within the domains of doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P) (Department of the Army 2016).

DOTMLPF-P is a systematic and disciplined framework that analyzes requirements in detail. These requirements follow a determined path within the process and are linked to specific organizations responsible to implement developed solutions. The end result of the analysis provides suitable solutions for commanders' requirements. If a materiel solution is the optimal solution, TRADOC must develop the Initial Capabilities Document (ICD) to provide sufficiently detailed capability requirements to aid in the development of new materiel through the Defense Acquisition System. If non-material solutions are recommended, then a DOTMLPF Change Recommendation (DCR)

must be developed to inform the organizations responsible to implement the solutions. When a non-materiel solution related to a Doctrinal or Organizational capability gap is identified, TRADOC is responsible to develop the appropriate solution (s) within the Army Concept Framework for future implementation in the units (Department of the Army 2013b).

Understanding the process to identify capability gaps is important for this thesis because the Mexican Armed Forces can focus specifically in its requirements in a certain area of interest. The process is extremely useful in developing options to improve Command and Control in support of land operations.

CHAPTER 3

RESEARCH METHODOLOGY

The last chapter reviewed the existing literature on the Mexican Armed Forces, the doctrine of Command and Control and how it is applied in the U.S. Armed Forces in support of land operations, as well as the U.S. capability development process. This chapter will describe the research methodology designed to answer the primary and secondary research questions.

Research Questions

Primary research question:

How Can the Mexican Army and Air Force improve Command and Control in support of land operations?

Secondary research questions:

1. What organizational solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

2. What doctrinal solutions could best improve Mexican Army and Air Force Command and Control in support of land operations?

3. What materiel solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

Importance of the research.

Usefulness of the researched manuals and public documents was considered employing criteria that meets validity, reliability, practicability, suitability and simplicity (Northcote 2012, 6).

Validity of the information refers to the specific topic that is explained in the thesis and the capability gap that is intended to fulfill the need of the Mexican Army and Air Force. Reliability is related to the proven concepts employed by the U.S. Services that have gained positive results in the application of command and control operations.

Practicability is achieved by the similar employment of troops and resources by both the Mexican Army and Air Force and the U.S. Services, adaptation to technological assets is then viable to improve Command and Control.

Suitability is achieved by employing the appropriate doctrinal principles to fulfill a current capability gap. The possible solutions were analyzed considering doctrinal concepts currently used by the U.S. Army.

Finally, simplicity in this thesis is achieved by using terms and concepts easy to understand and apply in the specific Mexican environment. The mentioned criteria will allow the development of recommended solutions for the Mexican Army and Air Force to improve Command and Control in support of land operations.

Type of Research

The research method will be a qualitative study using a Capabilities-Based Assessment to answer the primary and secondary research questions. The required capabilities for the Mexican Army and Air Force to conduct the analysis include the following capabilities:

Capability 1: The capability to maintain situational awareness during mission time providing real time and integrated clear air picture of ongoing situations.

Capability 2: The capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats in a short time.

Capability 3: The capability to watch real time positions of troops on the ground in order to assess operation' effectiveness and to analyze on digital maps the possible effects of roads, mountains, populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation.

Each required capability will be compared to the current capability to determine the capability gaps. The author will analyze the literature and identify potential doctrinal, organizational, and materiel solutions to the gaps.

Summary

This chapter described the research methodology designed to answer the primary and secondary research questions. The answer to the questions considered the needs of the Mexican Army and Air Force. Chapter 4 will provide the analysis of command and control capability gaps and provide potential doctrinal, organizational and materiel solutions to solve these gaps.

CHAPTER 4

ANALYSIS

Introduction

The Mexican Army and Air Force strive to develop new capabilities to face current and future challenges. This analysis provides options to consider in developing capabilities to counter current challenges faced by the Mexican Army and Air Force.

The end result of the effort will be the development of potential doctrinal, organizational and materiel solutions to achieve those capabilities. The analysis of the desired capabilities is driven by the primary and secondary research questions to improve Command and Control in support of the Mexican Army and Air Force's land operations.

Research questions

Primary research question:

How Can the Mexican Army and Air Force improve Command and Control in support of land operations?

Secondary research questions:

1. What organizational solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

2. What doctrinal solutions could best improve Mexican Army and Air Force Command and Control in support of land operations?

3. What materiel solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

Required Capability 1

The first main capability to be analyzed is: the capability to maintain situational awareness during mission time providing real time and integrated air picture of ongoing situations. The achievement of this capability will be analyzed considering the current capability and capability gap, followed by recommended doctrinal, organizational and materiel solutions to solve this capability gap.

Current capability

The Mexican Army and Air Force receive mission orders from the Mexican Secretariat of Defense when conducting joint operations. The planning process for any mission must consider fiscal constraints due to scarce resources to develop operations. The Mexican Armed Forces are committed to support the Mexican population. The Mexican Army and Air Force work closely with civil authorities when disasters overcome their capacity. Due to the geographic position of the Mexican Republic, two types of operations are more likely to develop in support of civil authorities.

One event that triggers military action is the presence of natural disasters. Inter-institutional operations are another event that triggers military action in support of civil authorities. Inter-institutional operations are those carried out by institutions and authorities working towards the achievement of National Security, working in their respective area of responsibility (Mexican Chamber of Deputies 2005).

In the case of natural disasters, the Mexican Army and Air Force develop doctrinal concepts to serve as general guidance for the employment of military units. This doctrinal guidance enables coordination among units located in mountainous, desert or urban areas to act as a single effort (Mexican Secretariat of National Defense 2015a).

When military effort is needed, the Mexican Army and Air Force provide assistance to maintain public order, protect civilian people and their property and rebuild affected areas. To accomplish this mission, they conduct “Plan DN-III-E”, which is a military operating instrument that establishes the general guidelines for the armed forces to aid civilians in case of disasters. The plan is implemented automatically by military personnel deployed in the Military Regions and Zones (Mexican Secretariat of National Defense 2015b)

Situational awareness for this type of operation is achieved using civilian and military tools. Hurricanes are detected through complex weather forecasts. The weather forecasts track and update its movement and evolution. The Mexican military meteorology service is responsible to develop and update weather forecasts. This service was established in 1950 at the Military Meteorology School.

The school supports the Mexican Air Force with professional education that reinforces military operations. The military meteorology service coordinates with national and international civilian agencies to verify data and share phenomenon technical information likely to affect other countries.

One international agency frequently consulted is the U.S. National Weather Service, National Oceanic and Atmospheric Administration (NOAA) to monitor atmospheric phenomenon likely to affect the Mexican Republic. The primary focus of the U.S.A./Mexico coordination since 1996 relates to hydrology and flood forecasting. The coordination is focused on upper-air observation network, surface hydro meteorological observation network, and weather radar observation network (Department of Commerce. 2015).

Coordinated meetings and briefings employ technical information at different levels to assess the situation and plan actions according to the movement of the phenomenon. Military and civilian meteorologists make projections which are compared to define the most accurate point of impact of the phenomenon.

Regional Military and Air commanders follow every detail of the phenomenon movement and activate coordination plans for forces to act according to the most likely point of impact and assessment of the expected damage. Situational awareness requires regional commanders to be prepared for any contingency derived from the expected effects of the hurricane. Hurricane effects could flood farmlands. Rain in small towns may block drainage systems and flood the area requiring the action of authorities.

Civil authorities send pictures of the hurricane effects to the military regional commands to alert them of the possible actions to benefit the population. Civil and military authorities constantly update current status of risks maps, population census, shelter capabilities, urgent care facilities, hospital capacity, transportation means and phone books to act accordingly upon the effects of the hurricane.

Civil and military authorities comply with coordination actions mandated by the National Civil Protection System (SINAPROC). The National Civil Protection System guides the action of all government institutions likely to participate in support of disaster relief operations in order to benefit population in the event of disasters (Mexican Chamber of Deputies 2006).

HF/VHF or telephone networks are linked to achieve command and control of forces and military resources. Both military and civilian authorities work together to save human lives and restore public services. If the weather allows flights, the ground

commander employs fixed wing aircraft or rotary wing aircraft to perform area reconnaissance to analyze damage in the area. Air reconnaissance may obtain valuable information about the current conditions of roads, electric lines, water sources, and other valuable data to be employed according with the hurricane progress.

Disaster relief operations consider the collected data to plan and execute further operations. Disaster relief operations may include transport operations, emergency evacuation operations, and supply deliver for people in need located in isolated areas.

Line of sight VHF radios allow aircraft control. If necessary, civil-military coordination would consider preventive population evacuation to save human lives when strong effects are foreseen. The military and civil authorities maintain situational awareness at national, regional, and local levels in order to take appropriate actions at the proper level to support affected people.

In case the civil authority and military capabilities at the regional level are overcome by the effects of the hurricane, then the Mexican Army and Air Force activate strategic assets such as: heavy engineer units, community kitchens, search and rescue units, and chemical units to reinforce local action.

Based on the assessment of regional military commanders, the Secretary of Defense authorizes the employment of strategic assets to alleviate suffering and diminish its effects on the population. Strategic means are located in Mexico City. Strategic assets integrate a Strategic Rapid Response Team (FACD) for immediate deployment to the place of disaster. The Rapid Response Team include fixed wing aircraft such as, the Hercules C-130 or B-727 and rotary wing aircraft such as the MI-8 to quickly deploy

ground forces and heavy engineer equipment to reinforce regional commanders helping civil population (Mexican Secretariat of National Defense 2015c).

Finally, as the mentioned information suggests, the Mexican Army and Air Force achieve situational awareness primarily with ground assets. The employed elements such as: weather forecasts, meetings, briefings, police patrols, and military patrols increase situational awareness during mission time and demand high compromise from military commanders, and civil authorities to quickly coordinate actions in benefit of the affected population.

The other event that triggers military action in support of civil authorities is the planning and execution of Inter-institutional operation. Situational awareness in this case is achieved through constant coordination between the civil authorities and the regional military commanders.

The application of rule of law is the prime consideration for this kind of operation. Civil authorities receive the personnel, equipment, weapons or vehicles seized during military operations. The seized materiel serves as proof during further investigations.

Sharing a porous frontier with the United States of America, Mexico faces a great challenge. Geography plays a significant role in the behavior of the organized crime gangs. Organized crime is legally defined in the Mexican Federal Law against Organized Crime. Organized crime is defined as “When three or more persons organized in fact to perform, on a permanent or repeated behavior that by itself or attached to other, have as their purpose or result commit terrorism, collection and arms trafficking, trafficking in persons, trafficking in organs, corruption of persons under the age of eighteen years of

age, crimes on trafficking in persons and smuggling, shall be punished by that fact alone, as members of the Organized Crime" (Mexican Chamber of Deputies 2012).

Mexican judicial authorities are responsible to investigate, pursue, and set the convictions for indicted persons. High demand for drugs from some sectors of American society make the Mexican territory a transit zone for cocaine coming from Central and South America. Marijuana, heroin, and methamphetamines elaborated in Mexico are also sent by drug dealers to the norther border where prices are too high and multiply economic benefits for organized crime.

On the Mexican side of the border, the legal responsibility to fight against drug cartels belongs to the Secretariat of the Interior. One responsibility of the Secretariat of the Interior is to formulate and implement policies aimed at guaranteeing the public security of the nation and its inhabitants. Another responsibility is to present to the Senate the criminal policy and safeguarding the integrity and the rights of persons. The third responsibility is to guarantee the preservation of the freedoms, public order and peace (Mexican Secretariat of the Interior 2016).

Since 2006, the Mexican Army and Air Force act in support upon official request by this Secretariat. Inter-institutional operations require close relationship with local police authorities in every city. Special meetings and briefings are organized to analyze the organized crime behavior in order to achieve situational awareness. The Inter-institutional cooperation has resulted in the seizure of different means employed by organized crime to transport drugs to the United States of America.

Current and possible future tendencies are considered to act or adjust actions to counter and deter criminal operations. As for the military, current threat capabilities are

considered in terms of kind of maneuvers, amount of weapons, caliber of weapons and sized vehicles to consider updates in the military training.

Additionally, to maintain situational awareness, Army forces perform ground reconnaissance or establish security checkpoints to deter criminal freedom of maneuver in the cities. Air Force Aircraft execute aerial reconnaissance to collect valuable data for further operations. In aerial reconnaissance operations, command and control is achieved employing a HF/VHF and telephone communication network to keep control of the personnel, vehicles and airplanes employed.

The current capability demonstrates how the Mexican Army and Air Force are performing command and control in support of land operations. Considering the current approach and the required capability, this thesis now will describe the capability gap which sets the foundations for the solutions.

Capability Gap

The available ground means of the Mexican Army and Air Force currently allows them to achieve partial situational awareness for natural disasters and Inter-institutional operations. By law, legal responsibility to develop support policies to help the population in need starts with the civil authority. The Secretariat of the interior is responsible to present the new policies to the Mexican president. The Secretariat of the interior, through its different subordinate organizations, establishes initial contact with national authorities to coordinate the approved policies. Meetings, and coordination briefings help to achieve high degree of mutual understanding among civil authorities and the military.

Additionally, permanent coordination with international organizations aids in sharing information because phenomenon such as hurricanes usually affect more than one

country. International efforts allow information sharing and to improving responses to disasters in order to alleviate population suffering. However, they are insufficient to achieve the desired capability of having real time and integrated air picture of ongoing situations.

For disaster relief operations, having an integrated air picture of the ongoing situation would help ground commanders observe the terrain. This observation would be more useful when ground commanders observe the phenomenon effects from a secure position. Analysis of the effects would assist ground commanders in assessing the damage more accurately and enable them to better manage their resources.

Additionally, air photographs and video would allow ground commanders to observe the degree of damage suffered from hurricanes such as overflowing dams, flooded areas, and human casualties. Mexico's geographic position offers a highly likely area for hurricanes to hit its territory. In 2015, for instance, Hurricane Patricia hit the pacific coast of Mexico as a category 5 hurricane on the Saffir-Simpson Hurricane Wind Scale. Patricia was the strongest hurricane on record in the eastern North Pacific and North Atlantic (Department of Commerce 2015).

Having video and air photographs in advance would be beneficial for ground force action because they would understand what the area looks like before moving some miles ahead of their position. With current image and video support, ground units could plan and assess the type of equipment and supplies they will require once they arrive to the affected area.

On the other hand, Inter-institutional operations require constant coordination between military units and civil authorities to fight against organized crime. Ground

operations require plans and procedures to counter drug cartel operations. Ground operations have had successful results. However, the lack of a dedicated asset to obtain an integrated air picture of the ground situation may derive in unwanted results like fratricide.

Observing the current ground situation of any operation would allow commanders to provide early warning to his forces of possible enemy movement towards friendly forces positions. Viewing the current situation from the air would also give commanders the opportunity to assess the situation and call for reinforcement, or adjust the previous plan to counter unexpected enemy actions.

The described capability gap demonstrates some aspects that need to be solved by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides the possible doctrinal solutions to achieve the capability of maintaining situational awareness during missions to provide a real time and integrated air picture of ongoing situations.

Doctrinal Solutions

The lack of an integrated clear air picture to observe ongoing situations in which the Mexican Army and Air Force develop their missions also indicates a lack of specific doctrinal concepts to perform this activity. Command and Control (C2) is a function that is included in the Mexican doctrine, however doctrinal concepts concerning the employment of an air assets to obtain an integrated air picture of ongoing situations on the ground needs greater consideration within Mexican doctrine.

The doctrinal solution for the Mexican Army and Air Force to use real time and integrated air picture of ongoing situations could be the development of a Field manual

(FM). The manual would include concepts and command relationships focused on the integration of a C2 with air assets to obtain video and photographs to increase situational awareness. The concepts and relationships would be described focusing the need to synchronize military efforts, equipment capabilities, and commanders' intent.

The concepts must consider the current Mexican Army and Air Force capabilities and the existing doctrinal concepts from an advanced C2 infrastructure similar to the one existing in the U.S. Army.

U.S. Army doctrine serves as a model for these concepts to be exploited. U.S. Army concepts must be adapted to the Mexican Army and Air Force means to strengthen Mexican doctrine. The useful concepts to achieve the capability of maintaining situational awareness during mission time providing real time and integrated air picture of ongoing situations are the following:

1. Administrative Control: the "Direction or exercise of authority over subordinate or other organizations in respect to administration and support. Also called ADCON." (Department of the Army 2015, 13).

2. Close Support: "That action of the supporting force against targets or objectives which are sufficiently near the supported force as to require detailed integration or coordination of the supporting action" (Department of the Army 2015, 28).

3. Communications security: "The protection resulting from all measures designed to deny unauthorized persons information of value that might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in their interpretation of the results of such possession and study. Also called COMSEC." (Department of the Army 2015, 31).

4. Direct Support: “A support relationship requiring a force to support another specific force and authorizing it to answer directly to the supported force’s request for assistance” (Department of the Army 2015, 41).

5. General Support: “That support which is given to the supported force as a whole and not to any particular subdivision thereof” (Department of the Army 2012b, 75).

6. Information Management: “The function of managing an organization’s information resources for the handling of data and information acquired by one or many different systems, individuals, and organizations in a way that optimizes access by all who have a share in that data or a right to that information. Also called IM.” (Department of Defense 2017, 209).

7. Mutual Support: “That support which units render each other against an enemy, because of their assigned tasks, their position relative to each other and to the enemy, and their inherent capabilities” (Department of the Army 2015, 75).

8. Operational Control: “A command authority that may be exercised by commanders at any echelon at or below the level of combatant command. Operational control includes authoritative direction over all aspects of military operations and joint training necessary to accomplish missions assigned to the command” (Department of the Army 2012b, 77).

9. Situational Awareness: the “Knowledge and understanding of the current situation which promotes timely, relevant, and accurate assessment of friendly, enemy, and other operations within the battlespace in order to facilitate decision-making. An

informational perspective and skill that fosters an ability to determine quickly the context and relevance of events that are unfolding." (Department of the Army 2004c, 9).

10. Tactical Control: "Command authority over assigned or attached forces or commands, or military capability or forces made available for tasking, that is limited to the detailed direction and control of movements or maneuvers within the operational area necessary to accomplish missions or tasks assigned. Tactical control is inherent in operational control. Tactical control may be delegated to, and exercised at any level at or below the level of combatant command. Tactical control provides sufficient authority for controlling and directing the application of force or tactical use of combat support assets within the assigned mission or task" (Department of the Army 2012b, 78).

11. Unity of Command: "The operation of all forces under a single responsible Commander who has the requisite authority to direct and employ those forces in pursuit of a common purpose" (Department of the Army 2013a, 47).

12. Unity of Effort: "Coordination and cooperation toward common objectives, even if the participants are not necessarily part of the same command or organization—the product of successful unified action" (Department of the Army 2014, 24).

The described doctrinal solution establishes the fundamental concepts to be employed by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides an organizational solution to achieve the capability to maintain situational awareness during mission time providing real time and integrated air picture of ongoing situations.

Organizational Solutions

The Mexican Army and Air Force are organized in units and installations throughout the Mexican Republic. Each Mexican military unit employs materiel assets to best exploit their capabilities. Resources with new and specific capabilities are normally designated to a unit created for a single purpose. This means there must be a designated command and control organization to manage the new assets in order to achieve the capability of maintaining situational awareness for the Mexican Army and Air Force.

Due to limited economic resources, the Mexican Army and Air Force must look for a balance between the desired capabilities and the available budget to achieve them. The technological assets needed to maintain situational awareness would be organized in a cell level organization assigned to a Brigade level unit. The Brigade has operational and tactical control over maneuvering units such as infantry battalions or cavalry squadrons.

The missions requiring the integrated air picture of ongoing situations are the disaster relief operations and Inter-institutional operations. The temporary nature of these missions suggest a small organization. Post-analysis of each mission at the Brigade level will provide progressive experience for commanders, staff officers, and operators to correct inaccuracy. The initial cell level organization would grow based on the achieved results and availability of economic resources.

The organizational solution described the possible organization of personnel to be employed by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides the materiel solution to achieve the capability to maintain situational awareness during mission time providing real time and integrated air picture of ongoing situations, as follow.

Materiel Solutions

The Mexican Army and Air Force capability to achieve situational awareness from the air would be improved by employing a Forward Looking Infrared System (FLIR). This system is basically integrated by a thermal camera which allows individuals to observe humans, animals, vehicles, as well as natural and man-made obstacles on the terrain on an electronic screen (FLIR 2017). The FLIR system would be the Star SAFIRE 380-HDc model. The FLIR system allows the army commander to observe and record video of the interested areas and to have digital pictures for planning purposes (FLIR 2016).

This system basically consists of: a high definition thermal imager, high definition color camera, infrared camera, high definition zoom, Global Positioning System (GPS), auto tracker, and system interfaces. The high definition thermal imager allows the system to be employed during night time to record video of specific events.

The night capability allows the system to observe activities of interest from the air and record them. The high definition video gives the operator and commanders the opportunity to observe details which could be of special interest for planning purposes.

For example, a commander may have the need to observe night activities on a suspicious house employed as a drug deposit. The commander would want to increase situational awareness in the area and prepare a plan against the threat in the house. The thermal imager activated and employed from the air would detect the house and its surroundings. Also, the equipment has the capability to detect people and vehicles.

The thermal imager would allow the commander to observe personnel and vehicle movement from the air. The commander could analyze details of the activities on the

ground. Movement of vehicles might unravel illicit activities. He could observe if the arriving trucks are loaded and if the departing trucks are unloaded. The thermal imager would enable the commander to observe if trucks arrive loaded from north and depart unloaded to south. Additionally, he could observe if the personnel near the house are men or women, and if they are armed. These details could assist the commander and his staff to plan specific actions against criminal activities.

The high definition color camera and infrared camera would allow operator to take photographs for post-mission analysis. The high definition zoom provides close up views of focused activities. The laser range finder provides accurate information about the existent distance between the target and the FLIR equipment. The Global Positioning System (GPS) and auto tracker give the commander the position of targets of interest in the focused area. If a specific mobile objective is locked in the system, then the auto tracker can follow its movement reducing the operator's fatigue. Indeed, employing a Forward Looking Infrared system would reinforce the Mexican Army and Air Force Commanders capabilities to achieve situational awareness.

Required Capability 2

The second required capability to analyze is: the capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats in a short time. The achievement of this capability will be first analyzed considering the current capability and the capability gap. Afterwards, this thesis will provide doctrinal, organizational and materiel solutions focused on this required capability.

Current Capability

The Mexican Army and Air Force work together to respond rapidly and accurately to disaster relief and Inter-institutional operations. Disaster relief operations are conducted under the framework of the "Plan DN-III-E". This plan considers the participation of forces under the authority of Regional Commanders. The Mexican Secretariat of Defense divides the Mexican territory in Military Regions (Mexican Secretariat of National Defense 2016a). Regional commanders have permanent forces garrisoned to accomplish missions assigned by the Secretariat of Defense. Regional commanders have subordinated forces which are organized in Military Zones (Mexican Secretariat of National Defense 2016b).

Disaster relief operations are conducted by forces distributed to the levels of military zones, battalions, companies and even platoons. The amount of forces and equipment deployed in disaster relief operations depend mainly on the degree of damage inflicted by disasters. Initially, local forces assigned to each regional command respond to the disaster. Regional and military zone commanders assess the situation based on meteorological information. Regional and military zone commanders coordinate simultaneous actions with civilian authorities at each level. Thus, the effects of the disaster are countered by civil authorities supported by local military forces.

Civil authorities guide their actions following the rule of law such as the General Civil Protection Law. The General Civil Protection Law establishes the general coordination basis for population crisis support at the Federal, State and Municipal levels of the Mexican Government. If the disaster's effects overcome the supporting capabilities

of local military commanders, then Regional commanders request major support from to the Secretariat of Defense.

In this case, heavy aircraft like the Air Force C-130 are employed to quickly deploy more forces, equipment, and food to the nearest airport to support disaster relief operations. C-130 aircraft have the capability to quickly deploy units and up to 10,000 kilograms of equipment and supplies. A rapid deployment using this aircraft has the advantage of transporting large amounts of supplies near the area where they are needed the most. However, the size of the aircraft is a restrictive employment factor in small towns with no runways. Additionally, for these aircraft to save fuel and time, they usually fly at high altitude from their point of departure to their point of destination. They also require ground services to unload supplies and refueling to fly to another location. Once at the destination point, cargo rotary wing aircraft are employed to deliver support in small quantities. Also, rotary wing aircraft are employed to re-deploy smaller units to specific areas to support population.

Rotary wing aircraft are employed to transport supplies and forces from one point to another. They can operate at low altitude to fly over mountains and deliver support in small towns located in restrictive terrain. If necessary, rotary wing aircraft can hover to assess the terrain before landing, or dropping supplies in areas where they cannot land. Communications onboard rotary wing aircraft are usually employed for aeronautical purposes, such as take-off and landing instructions at the points of departure.

In areas affected by disaster, communications onboard the rotary wing aircraft serve to coordinate landings at improvised heliports. Deployed radio operators employ line of sight radios to control inbound and outbound rotary wing aircraft.

Communications onboard rotary wing aircraft are not integrated in any workstation. Pilot and copilot radios are employed for multipurpose missions. At the same time, the high mobility of rotary wing aircraft is employed primarily for supplying and transport missions.

Additionally, the Air Force supports disaster relief operations with fixed wing aircraft to perform air reconnaissance. Air crew perform visual reconnaissance, and radio communication capabilities allow aeronautical contacts similar to the rotary wing aircraft. Even though radio communication with ground forces could assist pilots to obtain situational awareness, they must maintain radio communication with air traffic control agencies during flight for security reasons.

Take-off and landing operations in an airport with a control tower, as well as flying in the airspace, require aircraft to have two-way radio communication capability (Department of Transportation 2016a). Fixed wing aircraft are usually deployed immediately to the affected areas. Fixed wing aircraft can fly at low altitude however, restrictive terrain and weather conditions affect them considerably more than rotary wing aircraft.

Undoubtedly, weather is critical for fixed wing aircraft and rotary wing aircraft, but weather such as low level cloudy conditions affect fixed wing aircraft more than rotary wing aircraft. Rotary wing aircraft can maneuver well under low visibility conditions near mountains whereas fixed wing aircraft could be at risk when operating at low level and under low visibility conditions.

Military regional and military zone commanders have the authority to coordinate Inter-institutional operations. They plan and conduct support to civil authorities based on

mutual assessments of situations and decide proper actions against organized crime operations. Regional commanders have the authority to coordinate specific actions with the Governor of the state. Command and control within Inter-institutional operations is executed relying on ground systems. HF radio communication networks are normally established and employed for this type of operation.

The current capability demonstrated how Mexican Army and Air Force deploy and operate radio communications to coordinate operations with civil authorities in order to reinforce actions against common threats. Considering the current approach and the second required capability, this thesis now will describe the capability gap to develop further solutions.

Capability Gap

The current capabilities of the Mexican Army and Air Force are oriented for delivering supplies and deploy forces in different areas. The rapid deployment capability offered by fixed wing aircraft does not fit into the required capability to operate at low altitude. Fixed wing aircraft fly at high altitudes and allow a quick response against disaster effects. Moving supplies from one place to another is useful in case of a large disaster. However, fixed wing aircraft do not have the capability to operate at low altitude over restrictive terrain.

On the other hand, cargo rotary wing aircraft have the capability to fly over restrictive terrain and at low altitude. They can reach remote places under low visibility conditions and land in small areas of terrain. Cargo rotary wing aircraft can maneuver to redeploy units or deliver support. Rotary wing aircraft can increase the mobility of units and alleviate population suffering. Nevertheless, rotary wing aircraft are not able to

manage integrated capabilities for taking video and air photographs. Current cargo rotary wing aircraft are not able to handle communications to coordinate operations on the ground.

The combination of rapid deployment and low level operation capabilities provided by rotary wing aircraft could be considered together with integrated communications. The lack of an air picture to assess ground situations denies disaster relief operations to accurately assess the effects. Having a rotary wing asset to quickly deploy to the area where a disaster happened saves time to respond and deal with crisis. Moving rapidly onboard rotary wing aircraft, enables commanders to have more options for landing in case of emergencies. At the same time, commanders have the capability to observe the terrain and determine the possible disposition of their forces to support the population.

Integrated air to ground communications, additional to the aeronautical communications employed by pilot and copilot, would reinforce a commander's ability to coordinate his forces on the ground. If the commander has the ability to observe his forces on the ground in real time, he would also be able to adapt his previous plan to the current situation and respond effectively to unexpected situations. Employing integrated communications, the commander could communicate his new decisions to his subordinate commanders working on the ground simultaneously to save time and alleviate suffering.

The described capability gap demonstrated some aspects that need to be filled by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides a doctrinal solution to achieve the capability to

quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats.

Doctrinal Solutions

Lack of doctrine to employ dedicated air assets to improve command and control in support of land operations could be solved with the integration of a Field manual (FM). Besides the concepts described for capability 1, the FM should include aspects related to the employment of rotary wing aircraft such as:

1. Support activities provided by rotary wing aircraft.

2. Description of the responsibilities derived from the employment of rotary wing aircraft.

3. Delimitation of responsibilities for airspace use at different altitudes.

4. Altitudes to be employed for military use.

5. Coordination with civil air traffic control services.

6. Actions to take before the employment of the rotary wing aircraft such as mission analysis, weather conditions analysis, threat assessment, risk assessment, and communications verification.

7. Actions to take during the employment of the rotary wing aircraft such as weather conditions changes, communications with ground forces in the area of operations, alternative actions to follow in case of communication failure, actions to follow in case of aircraft failure, actions to follow in case of video or photograph failure.

8. Actions to take after the employment of the rotary wing aircraft such as debriefings with mission crew, debriefings with aircraft crew, generation of data bases with mission results, and compiling of lessons learned.

The manual must promote the mutual understanding of ground and air commanders. Also, it would be mission-oriented in order to provide guidance for pilots and operators during mission execution. The useful concepts to achieve the capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats in a short time, are the following:

1. Damage assessment: “The determination of the effect of attacks on targets” (Department of the Army 2004c, 63).

2. High density airspace control zone: “Airspace of defined dimensions, designated by the airspace control authority, in which there is a concentrated employment of numerous and varied weapons / airspace users” (Department of the Army 2006, 305).

3. Landing zone: “Any specified zone used for the landing of aircraft. Also called LZ.” (Department of the Army 2004c, 121).

4. Lift: “All rotary wing aircraft assigned to a particular mission to move forces, supplies, and equipment” (Department of the Army 2004c, 124).

5. Main command post: “consists of those staff activities involved in controlling and sustaining current operations and in planning future operations. The main CP normally operates under control of the chief of staff. In addition to the chief of staff, the main CP consists of G1, G2, G3, and G4 elements; fire support and chemical elements, TACP element, and an A2C2 element consisting of ADA and Army aviation staff

elements. The main CP exercises C2 of the current operation in cases where a tactical CP is not employed (Department of the Army 2006, 307).

6. Maneuver: “The movement of forces supported by fire to achieve a position of advantage from which to destroy or threaten destruction of the enemy” (Department of the Army 2006, 308).

7. Reconnaissance: “A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or adversary, or to secure data concerning the meteorological, hydrographic or geographic characteristics of a particular area. Also called RECON” (Department of the Army 2015, 88).

8. Route reconnaissance: “A directed effort to obtain detailed information of a specified route and all terrain from which the enemy could influence movement along that route” (Department of the Army 2004c, 177).

9. Sortie: “One aircraft making one takeoff and one landing. An operational flight by one aircraft” (Department of the Army 2006, 312).

10. Tactical command post: “A facility containing a tailored portion of a unit headquarters designed to control portions of an operation for a limited time” (Department of the Army 2015, 101).

11. Tactical operations center: “Physical grouping of those elements of general and special staff concerned with the current tactical operations and the tactical support thereof. Also called TOC” (Department of the Army 2004c, 195).

12. Target: “An area, complex, installation, force, equipment, capability, function, or behavior identified for possible action to support the commander’s objectives,

guidance, and intent. Targets fall into two categories: planned and immediate" (Department of the Army 2004c, 196).

13. Zone reconnaissance: "a directed effort to obtain detailed information concerning all routes, obstacles (to include chemical or radiological contamination), terrain, and enemy forces within a zone defined by boundaries. A zone reconnaissance normally is assigned when the enemy situation is vague or when information concerning cross-country traffic-ability is desired" (Department of the Army 2006, 315).

The described doctrinal solution would establish the fundamental concepts to be employed by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides the organizational solution to achieve the capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats in a short time, as follow:

Organizational Solutions

The general concepts of organization and economic constraints for the Mexican Army and Air Force explained in capability 1, also apply for capability 2. The most suitable is a cell level organization. The cell level organization assigned to a Brigade level unit would be flexible enough to manage personnel, logistic and support from the two armed forces. Also, managing the new cell would require funding from the Army and Air Force to function properly. The shared budget could be employed to provide service support to the aircraft such as: fuel, maintenance, crew lodging, training facilities and technical equipment support.

Air Force personal would fly the aircraft, operate the FLIR equipment, and provide maintenance to the helicopter. Army personnel from the Brigade staff would be included to manage communications with subordinate units on the ground, and to assist the Army commander onboard the rotary wing aircraft to take actions in the area of operations.

With this organization, the army commander onboard the rotary wing aircraft conducting a disaster relief operation would have the capability to observe the effects of a disaster with a long range camera and have pictures of the desired points for later assessment or to report to superior commanders. Also, with the infrared capability, the army commander would have more opportunity to find injured or missing personnel persons among the disaster debris. With communications onboard the fixed wing aircraft, the G-2 or G-3 would have the option to recommend new disposition of forces or re-direct the efforts according to the changes observed in the current situation.

Additionally, with this organization the army commander onboard the rotary wing aircraft conducting an Inter-institutional mission would have the capability to observe the movement of civil authorities on the ground and assess the effectiveness of the coordination procedures. Furthermore, the army commander would have the capability to observe the movement of his forces on the ground, have photographs for post-mission analysis, decide new actions according to the observed situation, and to communicate mission adjustments directly to the ground commanders.

The organizational solution described the suggested organization of personnel and fixed wing aircraft to be employed by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides the materiel

solution to achieve the capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate operations with military units and civil authorities in order to reinforce actions against common threats in a short time, as follow:

Materiel Solutions

The solution for rapid deployment and operating at low level must be agile. Rapid deployment could be achieved with fixed wing aircraft. However, it is not safe for fixed wing aircraft to operate at low level. Besides, fixed wing aircraft would not satisfy the need of having an army unit commander onboard to supervise operations in a specific area of operation. Additionally, areas affected by disasters and populated cities are restrictive and dangerous for the operation of fixed wing aircraft.

For example, in the Mexican territory, continuous rain from hurricanes can flood areas with more than three feet of water. That means runways would not be usable by fixed wing aircraft. The lack of runways to land would be fulfilled only with the employment of a rotary wing aircraft. Aviation companies in the international market produce several types of rotary wing aircraft. There are rotary wing aircraft employed for law enforcement agencies that carry FLIR systems. Law enforcement agencies usually conduct their duties in densely populated areas.

Law enforcement rotary wing aircraft carry an operator for the FLIR systems. They do not carry commanders to supervise operations. On the other hand, Army commanders need to move quickly from one place to another. They need to observe the ongoing situation and communicate orders to subordinate commanders on the ground. Army commanders must fill those gaps with the employment of a rugged, fast rotary wing aircraft such as the UH-60. This rotary wing aircraft has the capability to fly at 156

knots as its maximum speed, and flies extended missions for five hours with the command and control configuration.

Since rotary wing aircraft has advanced technology equipment, it must be operated properly to exploit all its capabilities (Department of the Army 2006). Pilots must consider the technical parameters to maintain the aircraft in the best mechanical condition in order to accomplish the assigned missions. There are important parameters to be verified by the air crew before, during, and after the missions to reduce risk of failure and to achieve missions.

Each rotary wing aircraft available in the international market has its own parameter to fly safely. The correct safety values of each parameter are stated in the flight and maintenance manuals issued by each company. Pilots of an UH-60 rotary wing aircraft must verify minimum safety parameters to fly missions. The safety parameters include the following aspects:

1. Fuel system.
2. Flight controls.
3. Hydraulic and pneumatic system.
4. Flight instruments.
5. Aeronautical communications.
6. Navigation systems.
7. Loading limits.
8. Airspeed limits.
9. Maneuvering limits.

10. Performance data such as maximum torque available, hover, cruise, and restrictions to fly (Everyspec 1996).

As part of the integrated communications, which are different from those employed by the pilots for aeronautical purposes, the UH-60 rotary wing aircraft could be integrated with a secure communication configuration including HF, VHF, and UHF radios. The AN/PRC-117F(C) multiband radio can be an option to be considered due to its capability to integrate several distinct radios into one like the VHF-LO FM for combat net radio (CNR). A Combat Net Radio System is the employment of several pieces of radio equipment interconnected and managed in the easiest manner to provide C2 communications with deployed units (Department of the Army 1990).

Other possibilities include: the VHF-HI AM for public safety and ground-to-air, UHF-AM for military ground-to-air, and UHF TACSAT (tactical satellite) communications. The employment of new technology to improve military satellite communications would give the Mexican Army and Air Force the capability to manage uncertainty and to reduce friction in the operations (King 2010). Additionally, the radios would have Type-I encryption for secure communications.

To guarantee the air-to-ground coordination of missions, forces on the ground must have the same radio equipment to establish and maintain communications with the army commander onboard the helicopter.

As for the satellite communications, they are necessary to be employed as redundant communications in case radio communications fail. Satellite communications allow the army commander to maintain situational awareness, direct his forces on the ground, and receive information for further operations. Satellite communications could be

developed with the SATCOM, UHF (PSC-5) to establish a Near Term Digital Radio (NTDR) network (Department of the Army 2004a).

Additionally, the army commander may have the need to accomplish missions during night operations. All the described equipment has the capability to be used both during day and night. However, pilots would require special devices to conduct night flight. Flying at night would require pilots to receive special training to employ the night vision googles. Night vision googles are special devices that enhance the pilot's capability to observe objects and human beings during night time and to fly the aircraft safely.

Night vision googles mounted on the pilot's helmet amplify the low level visual light and near infrared energy to allow pilots to observe those objects as a green phosphorus image (Schmickley 2001). The equipment likely to be employed for pilots' operations is the AN/AVS-6 (Department of the Army 2006). This equipment allows the pilot and copilot to fly the rotary wing aircraft with high precision and accuracy.

The UH-60 rotary wing aircraft equipped with a FLIR system, integrated communications, and the capability to conduct day and night time missions is a solution for the Mexican Army and Air Force to improve command and control in support of land operations.

In case of disaster relief operations, the army commander could take advantage of the rotary wing aircraft speed to deploy rapidly from the army installation to flooded areas. The army commander would then have the opportunity to coordinate forces on the ground for rescue missions. Since the disaster effects may occur in different areas, the army commander would have the flexibility to move to the area as needed and collect

valuable data to brief higher commanders. If necessary, the army commander may relocate his forces and communicate directly with subordinate commanders on the ground to clear areas and integrate efforts with civilian authorities.

In the case of Inter-institutional operations, a rotary wing aircraft would also allow the commander to quickly deploy to the area of operations. An army commander would have the capability to observe the terrain and populated areas where ground forces conduct operations. Observing from the air, the army commander would be able to assess the friendly and enemy situation. The army commander would also support forces on the ground, and coordinate support with civilian authorities.

Required Capability 3

The third required capability is: to observe real time positions of forces on the ground in order to assess operational' effectiveness and to analyze on digital maps the possible effects of roads, mountains, populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation.

The achievement of this capability will be analyzed considering the current capability and the capability gap, and then this thesis will provide doctrinal, organizational, and materiel solutions for this capability gap.

Current capability

The Mexican Army and Air Force conducts disaster relief operations and Inter-institutional operations working together in a single effort for rapid support of the population. Army and Air Force staff officers plan the operations to support the population. Staff officers strive to include every possible detail and requirements that

forces may encounter during order execution. However, friction is also present in disaster relief operations. “Friction is the only concept that more or less corresponds to the factors that distinguish real war from war on paper.” (Clausewitz 1976, 119).

Available information and previous experiences are analyzed and considered into the plans to act upon disasters. The army commander and his staff analyze the situation in the affected area and decide the best options to employ forces. However, friction would be present in the form of unexpected situations derived from the physical effort or dangerous situations.

Disaster relief operations sometimes include the employment of fixed wing aircraft to transport food and supply in large quantities. Rotary wing aircraft are also employed to distribute small stocks of supplies towards isolated areas over restricted terrain. Additionally, Air Force aircraft conduct reconnaissance missions to collect information related to the damage inflicted by disasters. Information collected during visual reconnaissance sometimes is related to the force disposition and civil authorities within the affected areas.

Pilots observe the force disposition through several patterns made by the aircraft over a specific location to distinguish forces and authorities among the debris and obstacles. The aircraft’s patterns are made at different altitudes and speeds to observe the more possible details of the situation. Pilots relay the information to the army commander on the ground by employing aeronautical radios onboard the aircraft.

The geographical position of the force disposition on the ground has the reference provided by pilots and the information does not have a georeferenced position. In other

words, during reconnaissance missions the pilots might find a platoon or crew size unit trying to save a civilian person into a flooded area.

Also, during reconnaissance missions, pilots may find people injured or trapped in mud slides along roads. For these two situations, pilots would want to send reports to the army commander who is on the ground. Pilots would want to provide accurate coordinates of force on the ground helping civilians employing aeronautical radio communication. For army commanders on the ground, the position of the rescue areas is important for them to send ambulances to treat and evacuate personnel.

Pilots usually provide the positions considering references on the ground such as crossroads or small towns in the nearby area. Also, the pilots may use the aeronautical maps onboard to have a more accurate position. A similar situation occurs when Army and Air Force support civil authorities during Inter-institutional operations.

Civil authorities counter organized crime organizations and request support when their capabilities are exceeded. Rotary wing aircraft of civil authority observe situations and send reports back to their headquarters. Civil authorities and military commanders share the available information and plan actions to counter criminal activities. The reports concerning criminal activities are referenced in aeronautical maps or with local references on the ground.

The current capability demonstrated how the Mexican Army and Air Force obtain ground force positions and analyze information on maps. Considering the current approach and the third required capability, this thesis now will describe the capability gap to develop further solutions, as follows:

Capability Gap

The capability of the Mexican Army and Air Force to observe real time positions of forces on the ground is currently limited to visual observation. Military and civil authorities conduct extensive planning and information exchange. Coordination measures include instructions to act together on the ground and articulate efforts against expected effects. The established procedures allow the Mexican Army and Air Force to support the population immediately after they observe the effects on the population. This information exchange includes the national, state, and municipal levels to coordinate actions before, during, and after operations.

In the case of Disaster Relief Operations, the coordination procedures try to predict as many situations as possible to articulate force ground movement. However, the effects of every disaster on the population are typically unique. If the effects are minimum, then coordinated measures will cover the actions needed. If the disaster inflicts major damage, then forces and authorities will face difficult situations where they might also be affected.

Weather is a factor that affects visibility for visual reconnaissance. Low visibility hinders the location and identification of forces disposition on the ground. The lack of electronic devices like the Blue Force Tracker (BFT) and electronic maps restrain the Mexican Army and Air Force from assessing disaster relief operations with real time information.

“Blue Force Tracking is a GPS enabled system that provides the location of friendly forces, with the color of blue denoting friendly forces. The system provides a

common picture of the location of friendly forces, therefore it is referred to as the “Blue Force” tracker” (Janos 2013).

Having a Blue Force Tracker capability would allow the army commander onboard the rotary wing aircraft to observe real time disposition of forces on the ground from a safe altitude. The Blue Force Tracker allows the army commander to observe forces movement in relation to obstacles. Observing the force disposition on the ground would be an advantage for the army commander because he would have real time information onboard the rotary wing aircraft to determine ground force effectiveness. The equipment is capable of giving accurate position of forces in highly contested areas when timely decisions are needed to overcome moving threats (Conatser 2005).

Additionally, the army commander would have the opportunity to analyze new dispositions according to the disaster’s effects. On the other hand, the lack of digital maps delays the pilots’ ability to communicate the position of events of interest to Army commanders on the ground. A digital map is a representation of a geographic area or phenomenon that can be displayed in a computer. If pilots find something that could be of interest for ground commander such as: isolated personnel on rooftops in a flooded area, vehicles hit by mud displacements with people injured, or major accidents of public transportation buses with injured people, then they can use aeronautical charts to refer the accidents according with the aircraft position.

The aeronautical chart is a type of chart used for navigation by pilots of moderate speed aircraft and aircraft at high altitudes (Department of Transportation 2016b). The lack of digital maps hinders a pilot’s ability to give precise location of events. Usually

what they communicate is the position of the aircraft as a close reference for ground forces to locate the mentioned events.

Digital maps would allow the army commander onboard the rotary wing aircraft to observe the force positioning on the ground. Furthermore, force disposition could be seen in reference to digital maps. This means that every soldier or vehicle carrying the electronic device associated with the Blue Force Tracker will be visible on a screen on board the helicopter.

The existing gap in time and effectiveness to assess ground situations could be improved with technology. In other words, the existing procedure of observing force disposition with visual reconnaissance and referencing events with aeronautical maps would be replaced by Blue Force Tracker devices and digital map technology.

As for the Inter-institutional operations, military commanders act upon specific requests from civil authorities at the national, state, and municipal levels. The procedures stated by law will not change. Initial air reconnaissance missions against criminals are conducted by civil authorities. If civil authorities find data to be exploited, they send law enforcement elements to verify the data. In case civil authorities are overwhelmed by criminal activities, they usually request support from the Mexican Army and Air Force.

The described capability gap showed some aspects that need to be filled by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides doctrinal solution to achieve the capability to observe real time positions of forces on the ground in order to assess operation' effectiveness and to analyze on digital maps the possible effects of roads, mountains,

populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation.

Doctrinal Solutions

The lack of capability for the Mexican Army and Air Force to observe real time positions of forces on the ground and to analyze dispositions on digital maps could be solved with the integration of a Field Manual (FM). The manual should explain the importance of observing real time ground forces disposition.

Previous plans to conduct Disaster Relief operations and Inter-institutional operations consider as many situations as possible. However, last minute situational changes are almost impossible to foresee. The importance of observing the real time disposition on the ground allows the army commander to adjust force disposition according to the current situation.

Although observing forces on an electronic screen is useful, it must be complemented with digital maps to have precise references of forces and obstacles. The advantage of having a FM to fill the knowledge gap would increase the common understanding between the Army and Air Force commanders. Together with understanding and mutual trust, readiness would increase if both armed forces share the same doctrinal concepts.

Doctrine to employ an equipped rotary wing aircraft to observe forces on the ground and to analyze dispositions on digital maps should explain the importance of having this technology and how to use the resulting products. Doctrinal concepts should include the importance of aspects such as:

1. Geographical obstacles (mountains, rivers, roads) near populated areas in case of disasters.

2. Exploit rapid mobility provided by a rotary wing aircraft to support population the affected areas.

3. Establishing air traffic control measures to avoid accidents with other aircraft on the area of operations.

4. Establish coordination mechanisms to employ civil facilities to support population in case of major damages and the need to transport them to safe areas.

5. Authentication of airspace users to employ radio and satellite communications.

6. Coordination procedures in case of aircraft emergencies.

7. Command relationships with civil authorities.

8. Employment of the technological devices needed to maintain real time observation of ground forces.

9. Employment of satellite and radio communications.

10. Fixing, observing, and reporting the location and movement of friendly forces.

11. Position of ground forces on digital maps to analyze current actions.

The useful concepts to achieve the capability to observe real time positions of forces on the ground in order to assess operation' effectiveness and to analyze on digital maps the possible effects of roads, mountains, populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation, are the following:

1. Common operational picture: “A single display of relevant information within a commander’s area of interest tailored to the user’s requirements and based on common data and information shared by more than one command” (Department of the Army 2012a, 51).

2. Command relationships: “The interrelated responsibilities between commanders, as well as the operational authority exercised by commanders in the chain of command; defined further as combatant command (command authority), operational control, tactical control, or support” (Department of Defense 2013b, 162).

3. Reconnaissance: “A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or adversary, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. Also called RECON” (Department of Defense 2013d, 140).

4. Adversary template: “Model based on an adversary’s known or postulated preferred methods of operation illustrating the disposition and activity of adversary forces and assets conducting a particular operation unconstrained by the impact of the operational environment” (Department of Defense 2009, 277).

5. Aeronautical chart: “A specialized representation of mapped features of the Earth, or some part of it, produced to show selected terrain, cultural and hydrographic features, and supplemental information required for air navigation, pilotage, or for planning air operations” (Department of Defense 2012a, 130).

6. Topographic map: “A map that presents the vertical position of features in measurable form as well as their horizontal positions” (Department of Defense 2012a, 134).

7. Adversary: “A party acknowledged as potentially hostile to a friendly party and against which the use of force may be envisaged” (Department of Defense 2017, 205).

8. Airspace control area: “Airspace which is laterally defined by the boundaries of the area of operations. The airspace control area may be subdivided into airspace control sub-areas” (Department of the Air Force 1998, 79).

9. Friendly force tracking: “The process of fixing, observing, and reporting the location and movement of friendly forces. Also called FFT” (Department of Defense 2014d, 123).

10. Airspace coordination area: “A three-dimensional block of airspace in a target area, established by the appropriate commander, in which friendly aircraft are reasonably safe from friendly surface fires. Also called ACA” (Department of Defense 2014a, 353).

11. Command net: “A communications network that connects an echelon of command with some or all of its subordinate echelons for the purpose of command and control” (Department of Defense 2014a, 353).

12. Global Positioning System: “A satellite-based radio navigation system operated by the Department of Defense to provide all military, civil, and commercial users with precise positioning, navigation, and timing. Also called GPS” (Department of Defense 2013e, 129).

13. Air land operation: “An operation involving movement by air with a designated destination for further ground deployment of units and personnel and/or further ground distribution of supplies” (Department of Defense 2013a, 131).

14. Airfield: “An area prepared for the accommodation (including any buildings, installations, and equipment), landing, and takeoff of aircraft” (Department of Defense 2013a, 131).

15. Air sovereignty: “A nation’s inherent right to exercise absolute control and authority over the airspace above its territory” (Department of Defense 2013c, 141).

16. Airspace control: “Capabilities and procedures used to increase operational effectiveness by promoting the safe, efficient, and flexible use of airspace” (Department of Defense 2014c, 94).

17. Airspace management: “The coordination, integration, and regulation of the use of airspace of defined dimensions” (Department of Defense 2014c, 95).

18. Commander’s communication synchronization: “A process to coordinate and synchronize narratives, themes, messages, images, operations, and actions to ensure their integrity and consistency to the lowest tactical level across all relevant communication activities. Also called CCS” (Department of Defense 2016, 136).

19. Population at risk: “The strength in personnel of a given force structure in terms of which casualty rates are stated. Also called PAR” (Department of Defense 2012b, 334).

20. Communications security: “The protection resulting from all measures designed to deny unauthorized persons information of value that might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in

their interpretation of the results of such possession and study. Also called COMSEC" (Department of Defense 2015, 114).

The described doctrinal solution established the fundamental concepts to be employed by the Mexican Army and Air Force to improve command and control in support of land operations. This thesis now provides the organizational solution to achieve the capability to observe real time positions of forces on the ground in order to assess operation' effectiveness and to analyze on digital maps the possible effects of roads, mountains, populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation, as follow:

Organizational Solutions

The general concepts of organization and economic constraints for the Mexican Army and Air Force explained in capabilities 1 and 2 also apply for capability 3. The current organization of the Mexican Army and Air Force supports the execution of disaster relief and Inter-institutional operations. New elements like a rotary wing aircraft with new equipment would reinforce commanders in their assigned missions. The cell level organization assigned to a Brigade level unit would be flexible to manage personnel, logistics, and support from the two armed forces.

With this organization, the options of observing real time positions of forces on the ground and analyzing their location on digital maps would be new capabilities to improve reaction against disasters and, upon request of civil authority, Inter-institutional operations. In the cell level organization, Air Force personal would be employed to fly the aircraft, operate the FLIR system and to apply maintenance to the helicopter. An Army operator from the Brigade staff would be included to manage communications with

subordinate units on the ground and to transmit the Army commander orders in the area of operations.

The cell level unit must include dedicated personnel capable of performing coordination activities among military units and commanders. Since activating a new organization is always difficult due to the lack of experience, the coordination cell could be integrated with one senior officer (Coronel or Lieutenant Coronel) as a team leader, two staff officers to support coordination among staffs and three enlisted personnel to support the administrative workload. Some of the coordination activities might include the following aspects:

1. Explain the capabilities and importance of the new tactical command and control post to the regional commanders.
2. Receive the regional commander's guidance to plan the missions.
3. Participate in the regional commanders' staff briefings to track information related with disaster relief and Inter-institutional operations.
4. Establish contact with civil authorities before operations to know details about their planned actions in the areas affected by disasters, focusing on the employment of air assets.
5. Keep track and report to the regional commander the current status of the aircraft and sensors to maintain their operability.
6. Collect the technical information needed for the air crew and sensor operators, before and during flight execution such as frequencies for communications, participating units, ground commander call signs to establish air-to-ground communications, and ground unit's mission.

7. Update the air crew and sensor operators with current situations related to disaster relief or Inter-institutional mission to be performed.

8. Support the air crew and sensor operators to plan the mission accordingly.

9. Coordinate any additional air support in the area of operations with the Mexican Air Force.

10. Make arrangements for the logistical support of the aircraft crew and sensor operators when operating in different airports such as refueling, maintenance, lodging, food, and security.

11. Support the army ground commander onboard the rotary wing aircraft when conducting the after mission assessment, providing the necessary technical information to best exploit each experience.

12. Coordinate with regional commanders and Air Force support for the cell level organization, including coordinating and tactical personnel. Support must include at a minimum, aircraft maintenance facilities, aircraft spares, aircraft fuel, ground vehicle availability, vehicle fuel, lodging, and subsistence.

The cell should also include tactical elements to accomplish the missions based on the coordination products. The tactical elements are the pilot, copilot, aircraft mechanic, and sensor operators such as the FLIR system operator, communications operator, and Blue Force Tracker operator. Each of these elements must perform their duties before, during, and after each mission. They would be responsible to employ the aircraft capabilities against identified threats in disaster relief and Inter-institutional operations.

The organizational solution described the suggested organization of personnel and rotary wing aircraft to be employed by the Mexican Army and Air Force to improve

command and control in support of land operations. This thesis now provides the materiel solution to achieve the capability to observe real time positions of forces on the ground in order to assess operation' effectiveness and to analyze on digital maps the possible effects of roads, mountains, populated areas, lines of communications, rivers, lakes, and other points of interest existing on the areas of operation.

Materiel Solutions

The existing capability gap for the Mexican Army and Air Force related to observe real time positions of forces on the ground and to analyze dispositions on digital maps could be fulfilled with the employment of the Blue Force Tracker (BFT) equipment. Basically, the Blue Force Tracker onboard the rotary wing aircraft consists of a rugged computer, satellite antenna with a direct link with ground personnel, and a Global Positioning System (GPS) receiver (Rider 2005).

This equipment is currently used in the U.S. Army as a tool for commanders to increase situational awareness on the battlefield, and to provide command and control of Army assets on the ground.

Additionally, the BFT allows the army commander to send messages to other users within the network in order to reduce the communication workload and maintain operations security. As a planning tool, the BFT presents accurate information about the geographic position of forces on the ground. Inferences and assumptions could be based in current and accurate information placed on top of digital maps to help commanders in their decision making process. With increased responsibilities and missions, the U.S. Army BFT is currently employed in war related missions such as air defense, direct fires, medical evacuation, and C2 coordination (Department of the Army 2007b). BFT

capabilities could also be employed in peace-time missions to satisfy the Mexican needs with this technology. The products achieved with the BFT such as ground force disposition and visualization over digital maps would improve the current needs for the Mexican Army and Air Force to improve command and control in support of land operations.

The location of each element on the ground is obtained by employing radio devices with each element. There are several radio devices with capability to communicate with the blue force tracker in order to send force disposition on the ground. One device currently employed is the Harris Falcon III AN/PRC-152A Type I wideband networking handheld radio.

The radio hardware configuration options include a GPS receiver that displays local positions and provides automatic position location information for situational awareness on the battlefield. This is a light radio with voice and data capability. The radio communications could be operated within an open or secure environment to enhance decision making process (Harris Company 2016).

Soldiers on the ground could carry one of these radios while accomplishing disaster relief or Inter-institutional missions. The GPS enabled capability of the radios would send the position directly to the Blue Force Tracker onboard the helicopter. This way, the army commander on the aircraft could improve his situational awareness and adjust previous plans.

Additionally, BFT's picture could be shared with Army commanders on the ground. For instance, in a disaster relief operation, there might be the need for ground commanders to have a clear picture of their unit disposition. If there is the need for army

ground commanders to have the BFT picture, then a computer with BFT system, satellite antenna and compatible radios must be installed onboard a vehicle. The Army ground commander than could have the chance to see the current disposition of his forces.

On an Inter-institutional mission, the BFT would allow the army commander to observe ground force disposition. This capability provides the advantage of coordinating force movement. Also, the coordination with civil authorities would be more accurate. In addition, the capability to observe friendly forces would help Army commanders and civil authorities to save lives by reducing the risk of fratricide.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

Modern technology can significantly increase any army's capability to conduct operations. The U.S. Army, as one of the most powerful armies in the world, employs modern technology to strengthen its commanders' span of options to defeat an enemy. Technology also enables friendly forces to engage the enemy with minimal human contact. Indeed, destroying the enemy by limiting friendly casualties increases moral among forces. Nevertheless, the introduction of new technology within a military organization requires a detailed analysis of the impact on the other DOTMLPF-P domains.

New equipment requires personnel to best exploit its capabilities. Officers and enlisted personnel will require training to properly employ the equipment. In the case of the Mexican Army and Air Force, new technology imposes new changes. These changes would start with a new mindset towards the employment of an airborne asset to increase command and control in support of land operations.

One single rotary wing aircraft would cause no problem flying in different areas to coordinate ground forces. However, future operations for the Mexican Army and Air Force would require to establish airspace deconfliction measures in the case other fixed or rotary wing aircrafts operate in the same area (Department of the Army 2009).

The employment of a rotary wing aircraft to perform command and control is a new concept in the Mexican Army and Air Force. It is necessary to start with fundamental concepts and move towards the design and employment of a new

organization. The final chapter of the thesis concludes with recommendations resulting from the research and analysis of the required capabilities.

Research questions

Primary research question:

How Can the Mexican Army and Air Force improve Command and Control in support of land operations?

Secondary research questions:

1. What organizational solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

2. What doctrinal solutions could best improve Mexican Army and Air Force Command and Control in support of land operations?

3. What materiel solutions could be employed by the Mexican Army and Air Force to improve Command and Control in support of land operations?

Conclusions

The achievement of success in war is determined by timely and synchronized actions of all organizations involved. The synchronization of personnel on land, air, sea and space is achieved by commanders at all levels through staff officers. Synchronization depends not only in bright staff officers but also in the means they employ to quickly deliver orders to all levels of command.

Command and control networks are the key elements to satisfy the commanders' need to quickly deliver his intent and receive reports to integrate a complete assessment of military operations. The command and control function by itself does not destroy the

enemy air defenses. Command and control is not the weapon used to destroy the enemy or make them surrender. Moreover, command and control does not develop plans to defeat the enemy. Command and control is the means to make forces work together to accomplish the mission. Command and control infrastructure allows the commander to integrate weapons, facilities, and manpower capabilities to act as a single effort to confront an enemy.

Secure facilities and communications allow commanders at all levels to keep the flow of information up and down the chain of command. Secure protocols to manage facilities and equipment facilitate understanding among users. If protocols are understood by all users, then priority information and reports can be sent quickly to designated commanders. Indeed, command and control is the tool that supports the commanders' need for rapid coordination and action against threats.

Without belittling the other factors to achieve success in war, command and control infrastructure plays a vital role for the commanders to achieve the required synergy on the battlefield. In the case of the U.S. Army, command and control in support of land operations is conducted by the U.S. Army Aviation Brigades. The coordination starts at the theater level and flows down to the Brigade, and even battalion and company levels to execute command and control in support of ground units.

In the case of the Mexican Army and Air Force, the existing command and control capabilities to conduct disaster relief and Inter-institutional operations is useful in terms of the current assets available. Traditional methods employed so far could remain with the same level of effectiveness in the current operational concept.

Every military organization must always look for new ways to improve organization and strength to counter foreseeable threats. Technology could also improve current coordinating procedures with civil authorities in order to reinforce actions against common threats. The Capability Based Assessment (CBA) and the Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) analysis process was an invaluable tool to find solutions enabling the Mexican Army and Air Force to increase its capabilities.

The identified capability gaps within the Mexican Army and Air Force to improve command and control would be fulfilled with technology, doctrine, organization, and new procedures. Financial constraints would be a factor in developing new innovations in the Mexican Army and Air Force. New technology would be expensive to acquire, but it would be of great benefit to increase readiness in support of people in need in times of disasters. Additionally, new technology would reinforce the coordination procedures with civil authorities to diminish risk of fratricide in the area of operations when conducting Inter-institutional operations.

Some of the expectations for the Mexican Army and Air Force with the employment of new technology would be the following:

1. Overcoming shortfalls in communications.
2. Minimize the risk of fratricide.
3. Increase coordination with civil authorities.
4. Increase reaction time to contingencies.
5. Improve situational awareness and readiness to conduct disaster relief and Inter-institutional operations.

6. Increase ground force effectiveness in the area of operations.

7. Increase effectiveness in search and rescue missions for people affected by disasters.

8. Increase interoperability among the Mexican Army and Air Force.

9. Modernize tactics and procedures to improve command and control in support of land operations.

Recommendations

In order to answer the primary research question, the author conducted a capability-based assessment process on three required capabilities related to command and control within the Mexican Army and Air Force. The existing capability gaps were considered and the proposed solutions are based on the result an analysis of those gaps. The solutions for the Mexican Army and Air Force to improve command and control in support of land operations were considered within the doctrinal, organizational and materiel solution domains.

Doctrinal solutions

The employment of new materiel within the Mexican Army and Air Force to improve Command and Control in support of land operations must be oriented through the proper doctrinal concepts. Facing new challenges with innovative equipment will be initially difficult to manage. However, with self-improvement and commitment from the Mexican population, Mexican Army and Air Force regional commanders will continuously improve procedures to make the best use of these new capabilities.

This thesis offers the integration of a Field Manual (FM) as a doctrinal solution. The field manual should include concepts related to the organization of the unit managing the personnel and equipment. Also, the manual should include concepts related to the employment of the UH-60 rotary wing aircraft equipped with a FLIR system, air-to-ground communications, and Blue Force Tracker. The FLIR system is capable of working during day and night to employ video and camera. The Blue Force Tracker and air-to-ground communications would be mounted in the rotary wing aircraft to work together with the FLIR system.

The Field Manual should include concepts related to the development of the capability to maintain situational awareness during missions, providing real time and integrated clear air picture of ongoing situations. This could be achieved integrating the Field Manual with the concepts of Unity of Command, Unity of Effort, Operational Control, Tactical Control, General Support, Mutual Support, Direct Support, Close Support, Administrative Control, Information Management, Communication security, and Situational Awareness.

Additionally, the capability to quickly deploy, operate at low altitude, and employing radio communications should be developed with the doctrinal concepts of damage assessment, high density airspace control zone, landing zone, lift, main command post, maneuver, reconnaissance, route reconnaissance, air sortie, tactical command post, tactical operations center, target, and zone reconnaissance.

Finally, the Field Manual would improve the capability to observe real time force positions on the ground. The capability to analyze information on digital maps would be improved with the concepts of common operational picture, command relationships,

reconnaissance, adversary template, aeronautical chart, topographic map, adversary, airspace control area, friendly force tracking, airspace coordination area, command net, Global Positioning System, air land operation, airfield, air sovereignty, airspace control, airspace management, commander's communication synchronization, population at risk, and communications security.

Organizational solutions

The current organization of the Mexican Army and Air Force supports the execution of disaster relief and Inter-institutional operations. The employment of a UH-60 rotary wing aircraft with new technology would reinforce the commanders' capability to accomplish missions. The organizational solution in this thesis consists of the integration of a Cell Level Organization. The cell level organization would be assigned at the Brigade Level.

Due to limited economic resources, the Mexican Army and Air Force must look for a balance between the desired capabilities and the available budget to achieve them. Also, managing the new cell would require resources from both the Army and Air Force to function properly. The shared cost would enable service support to the aircraft such as: fuel, maintenance, crew lodging, training facilities, and technical support.

The army commander onboard the aircraft must be accompanied with at least the G-2 and G-3 to assist him during the mission in order to assess the current situation. Air Force personnel would be required to fly the aircraft, operate the FLIR system, and to perform maintenance on the rotary wing aircraft. An Army operator from the Brigade staff must be included to manage communications with subordinate units on the ground, and to transmit the army commander orders in the area of operations.

The cell unit would also comprise elements capable of performing coordination activities among military units and commanders. These elements would not fly with the army commander, but must be at the Brigade facilities. The coordination elements would be integrated with one senior officer (Coronel or Lieutenant Coronel) as a team leader, two staff officers to support coordination among the staffs and three enlisted personnel to support the administrative workload. Some of the coordination activities might include the following aspects:

1. Explain the capabilities and importance of the new rotary wing aircraft and equipment to the regional commanders.

2. Receive the regional commander's guidance to plan the missions.

3. Participate in the regional commanders' staff briefings to track information related with disaster relief and Inter-institutional operations.

4. Establish contact with civil authorities before operations to know details about their planned actions in the areas affected by disasters, focusing on the employment of air assets.

5. Keep track and report to the regional commander the current status of the aircraft and sensors to maintain their operability.

6. Collect the technical information needed for the air crew and sensor operators, before and during flight execution such as frequencies for communications, participating units, ground commander call signs to establish air-to-ground communications, and ground unit missions.

7. Update the air crew and sensor operators with the current situation related to disaster relief or Inter-institutional mission to be performed.

8. Support the air crew and sensor operators to plan the mission accordingly.

9. Coordinate any additional air support in the area of operations with the Mexican Air Force.

10. Make arrangements for the aircraft crew and sensor operator logistical support when operating in different airports such as refueling, maintenance, lodging, food, and security.

11. Support the army ground commander onboard the rotary wing aircraft when conducting the after action review, providing the necessary technical information to best exploit each experience in future missions.

12. Coordinate with regional commanders and Air Force staff the support for the cell level organization which are the coordinators, air crew, and sensor operators. Support must include at least aircraft major maintenance facilities, aircraft spares, aircraft fuel, ground vehicle availability, vehicle fuel, lodging, and subsistence.

Personnel working with the Cell Level Unit would be addressed as tactical elements which are the pilot, copilot, aircraft mechanic, and sensor operators. Sensor operators are integrated by the FLIR system operator, communications operator, and Blue Force Tracker operator. Personnel working in coordinating activities would be addressed as coordinators. Each one of these elements must perform their duties before, during, and after each mission. They would be responsible to employ the aircraft's capabilities against identified threats in disaster relief and Inter-institutional missions.

Materiel solutions

The challenge to solve the existing capability gaps in the Mexican Army and Air Force demands a thorough commitment to analyze the current threats and the means to

counter these threats. Under these circumstances, budget constraints remain a factor to be considered in the development of any new materiel solution for the Mexican Army and Air Force to improve command and control in support of land operations. Consequently, essential elements have been considered to integrate the materiel solution to achieve that end.

The materiel solution to maintain situational awareness during operations, while providing a real time and integrated air picture of ongoing situations could be improved by employing a Forward Looking Infrared System (FLIR). The FLIR system would be the Star SAFIRE 380-HDc model. This system consists of a high definition thermal imager, high definition color camera, infrared camera, high definition zoom, laser range finder, Global Positioning System (GPS), auto tracker, and system interfaces.

The FLIR system focuses on and records video and takes digital pictures in the area of interest. The high definition thermal imager allows the system to be employed during night time to record video of specific events. The laser range finder provides accurate information about the existent distance between the target and the FLIR equipment. The night capability allows the system to "observe" activities of interest from the air and record them. The high definition of the video gives the operator and the commander the opportunity to observe details which could be of special interest for planning purposes.

To achieve the capability to quickly deploy, operate at low altitude, and to employ radio communications to coordinate military units with civil authorities would be achieved with a rotary wing aircraft. This thesis proposes the employment of a rugged and fast UH-60 rotary wing aircraft. As part of the integrated communications, which are

employed to communicate with forces on the ground, are different than those employed by the pilots for aeronautical purposes. The UH-60 rotary wing aircraft would be integrated with a communication configuration of FM, HF, VHF, and UHF radios. The AN/PRC-117F(C) multiband radio could be employed to integrate several distinct radios into a VHF-LO FM for combat net radio, VHF-HI AM for public safety and ground-to-air, UHF-AM for military ground-to-air and UHF TACSAT (tactical satellite) communications.

Additionally, Type-I encryption would be included to achieve secure communications. Army commanders on the ground must have the same radio equipment to establish and maintain communications with the army commander onboard the rotary wing aircraft in order to guarantee the air-to-ground coordination of missions. As for the satellite communications, they are necessary as redundant communications in case radio communications fail.

Satellite communications would be developed with the SATCOM, UHF (PSC-5) to establish a Near Term Digital Radio (NTDR) network. Additionally, the army commander may have the need to accomplish missions during night operations. The described rotary wing aircraft and sensors have the capability to operate during day and night, however, pilots would require special devices to conduct night flight. The equipment that would be considered for pilots' night flight is the AN/AVS-6.

The materiel solution to observe real time force positions force on the ground and to analyze force disposition on digital maps would be achieved with the employment of the Blue Force Tracker (BFT) equipment. The Blue Force Tracker onboard the rotary

wing aircraft consists of a rugged computer, a satellite antenna directly linked with ground personnel, and a Global Positioning System (GPS) receiver.

The equipment is useful to increase situational awareness, airspace deconfliction and to provide command and control of army assets on the ground. The equipment enables organizations to share messages within the network in order to reduce the communication workload and maintain the secrecy of operations. As a planning tool, the BFT presents accurate information about the geographic position of the force on the ground.

The disposition of each element on the ground is obtained by the employment of man portable radio devices like the Harris Falcon III AN/PRC-152A Type I wideband networking handheld radio. This equipment allows individual radio communication within an open or secure environment to enhance the decision making process. This means that only soldiers carrying the hand radio would be needed onboard the rotary wing aircraft with the Blue Force Tracker.

The GPS enabled capability of the radios would send the position directly to the Blue Force Tracker onboard the rotary wing aircraft. This way, the army commander on the aircraft would improve his situational awareness and his ability to adjust previous plans.

Additionally, the BFT's picture would be shared with Army commanders on the ground. A computer with BFT system, satellite antenna and a compatible radio must be installed onboard a vehicle.

Further research

The research, analysis, conclusions and recommendations on this thesis were focused on disaster relief operations and Inter-institutional missions. These Mexican Army and Air Force missions are achieved in peacetime and in close coordination with civil authorities.

Further research for this thesis could comprise wartime scenarios. The possible scenarios must include the Mexican Army, Air Force, and Navy working together under an integrated command and control framework. While the employment of UH-60 rotary wing aircraft equipped with advanced equipment would improve command and control for current peacetime missions, the configuration of the same UH-60 rotary wing aircraft could be updated with weapons and electronic counter measures providing additional capability to conduct combat missions. The required capability to conduct combat missions could be explored in future research.

Summary

The Mexican Army and Air Force dedicate personnel and assets to support population in the event of disasters. Upon request of federal, state and municipal government, military assets are employed with civil authorities to conduct Inter-institutional operations in order to reinforce actions against organized crime. Current assets are employed to lead ground force within these missions.

The achieved results have been satisfactory. However, materiel innovations offer new options for the Mexican Army and Air Force to improve command and control in support of land operations. The expectations are high since the investment would be

costly. Employing a UH-60 rotary wing aircraft equipped with high technology equipment would certainly increase the capabilities of the Mexican Army and Air Force.

These capabilities would provide the ability to: overcome shortfalls in communications, minimize the risk of fratricide, increase coordination with civil authorities, improve situational awareness and readiness to conduct disaster relief and Inter-institutional operations, and to increase interoperability among Mexican Army and Air Force. The doctrinal, organizational, and materiel solutions recommended within this research will provide these capabilities and enable the Mexican Army and Air Force to improve command and control in support of land operations.

REFERENCE LIST

Arey, Howard E. 2004. “The A2C2S: Extending Battle Command.” *Military Review* (November-December 2004): 31-38. Accessed 20 April 2017. https://www.questia.com/library/journal/1P3-785106821/the-a2c2s-extending-battle-command.

Clausewitz, Carl V. 1976. *On War*. Edited and Translated by Michael Howard and Peter Paret. Princeton, NJ: Princeton University Press.

Conatser, James L., and Vincent E. Grizio. 2005. “Force XXI Battle Command Brigade and Below-Blue Force Tracking (FBCB2-BFT). A Case Study in the Accelerated Acquisition of a Digital Command and Control System during Operations Enduring Freedom and Iraqi Freedom.” Master’s Thesis, Naval Postgraduate School, Monterey.

Department of the Air Force. 1998. *Airspace Control in the Combat Zone*. Washington, DC: Government Printing Office.

———. 2013. *Air Force Doctrine Volume II1, Command*. Washington, DC: Government Printing Office.

———. 2014. *Annex 3-52 Air Space Control*. Washington, DC: Government Printing Office.

———. 2015. *Air Force Doctrine Volume 1, Air Force Basic Doctrine*. Washington, DC: Government Printing Office.

Department of the Army. 1990. Field Manual (FM) 11-32, *Combat Net Radio Operations*. Washington, DC: Government Printing Office.

———. 2002. Field Manual (FM) 3-52, *Army Airspace Command and Control in a Combat Zone*. Washington, DC: Government Printing Office.

———. 2004a. Field Manual (FM) 6-02.90, *Air, Land and Sea Application Center. UHF TACSAT/DAMA Multi-Service Tactics, Techniques, and Procedures for Ultra High Frequency Tactical Satellite and Demand Assigned Multiple Access Operations*. Washington, DC: Government Printing Office.

———. 2004b. Army Research Laboratory (ARL-TR-3317), *Initial Assessment of the Manpower Requirements for the Army Airborne Command and Control System (A2C2S) System operator Via the Improved Performance Research Integration Tool (IMPRINT)*. Washington, DC: Government Printing Office.

———. 2004c. Field Manual (FM) 1-02, *Operational Terms and Graphics*. Washington, DC: Government Printing Office.

———. 2006. *Brigade Aviation Element Handbook*, Washington, DC: Government Printing Office.

———. 2007a. Field Manual (FM) 3-04.120, *Air Traffic Services Operations*. Washington, DC: Government Printing Office.

———. 2007b. Field Manual (FM) 3-04.111, *Aviation Brigades*. Washington, DC: Government Printing Office.

———. 2009. Training and Doctrine Command (TRADOC) Pamphlet 525-7-3, *Airspace Command and Control for the Future Modular Force*. Washington, DC: Government Printing Office.

———. 2012a. Army Doctrine Reference Publication (ADRP 6-0), *Mission Command*. Washington, DC: Government Printing Office.

———. 2012b. Army Doctrine Reference Publication (ADRP 5-0), *The Operations Process*. Washington, DC: Government Printing Office.

———. 2013a. *Army Mission Command Strategy FY 13-19*. Fort Leavenworth, KS: Combined Arms Center.

———. 2013b. Training and Doctrine Command (TRADOC) Regulation 71-20, *Force Development, Concept Development, Capabilities Determination, and Capabilities Integration*. Washington, DC: Government Printing Office.

———. 2014. Army Doctrine Publication (ADP 6-0), *Mission Command*. Washington, DC: Government Printing Office.

———. 2015. Army Doctrine Reference Publication (ADRP 1-02), *Terms and Military Symbols*. Washington, DC: Government Printing Office.

———. 2016. Army Force Management Model, *How the Army Runs. A Senior Leader Reference Handbook*. Washington, DC: Government Printing Office.

Department of Commerce. 2015. *Tropical Cyclone Report, Hurricane Patricia*. National Oceanic and Atmospheric Administration (NOAA). Accessed 20 April 2017. http://www.nhc.noaa.gov/data/tcr/EP202015_Patricia.pdf

Department of Defense. 2009. Joint Publication (JP) 2-01.3, *Joint Intelligence Preparation of the Operational Environment*. Washington, DC: Government Printing Office.

———. 2010. Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*. Washington, DC: Government Printing Office.

———. 2012a. Joint Publication (JP) 2-03, *Geospatial Intelligence in Joint Operations*. Washington, DC: Government Printing Office.

———. 2012b. Joint Publication (JP) 4-02, *Health Service Support*. Washington, DC: Government Printing Office.

———. 2013a. Joint Publication (JP) 3-17, *Air Mobility Operations*. Washington, DC: Government Printing Office.

———. 2013b. Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States*. Washington, DC: Government Printing Office.

———. 2013c. Joint Publication (JP) 3-27, *Homeland Defense*. Washington, DC: Government Printing Office.

———. 2013d. Joint Publication (JP) 2-0, *Joint Intelligence*. Washington, DC: Government Printing Office.

———. 2013e. Joint Publication (JP) 3-14, *Space Operations*. Washington, DC: Government Printing Office.

———. 2014a. Joint Publication (JP) 3-09.3, *Close Air Support*. Washington, DC: Government Printing Office.

———. 2014b. Joint Publication (JP) 3-31, *Command and Control for Joint Land Operations*. Washington, DC: Government Printing Office.

———. 2014c. Joint Publication (JP) 3-52, *Joint Airspace Control*. Washington, DC: Government Printing Office.

———. 2014d. Joint Publication (JP) 3-09, *Joint Fire Support*. Washington, DC: Government Printing Office.

———. 2014e. Joint Publication (JP) 3-30, *Command and Control of Joint Air Operations*. Washington, DC: Government Printing Office.

———. 2015. Joint Publication (JP) 6-0, *Joint Communications System*. Washington, DC: Government Printing Office.

———. 2016. Joint Publication (JP) 3-61, *Public Affairs*. Washington, DC: Government Printing Office.

———. 2017. Joint Publication (JP) 3-0, *Joint Operations*. Washington, DC: Government Printing Office.

Department of Justice. 2016. *National Drug Threat Assessment Summary.* Drug Enforcement Administration. Accessed 20 April 2017. https://www.dea.gov/resource-center/2016%20NDTA%20Summary.pdf.

Department of the Navy. 2004. *The Marine Air Command and Control System (MACCS)*. Washington, DC: Government Printing Office.

———. 1997. *Marine Air Command and Control System Handbook*. Washington, DC: Government Printing Office.

Department of Transportation. 2016a. *Pilot's Handbook of Aeronautical Knowledge*. Federal Aviation Administration. Accessed 21 April 2017. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/pilot_handbook.pdf.

———. 2016b. "Terminal Aeronautical Chart." Federal Aviation Administration. Accessed 21 April 2017. https://www.faa.gov/air_traffic/flight_info/aeronav/productcatalog/vfrcharts/terminalarea/.

Everyspec. 1996. "TM 1-1520-237-10 UH-60L Helicopter manual." Accessed 22 April 2017. http://everyspec.com/specifications-about.php.

FLIR. 2016. "FLIR Star Safire 3-80 datasheet." Accessed 25 April 2017. http://www.flir.com/uploadedFiles/flirGS/Surveillance/Products/Star_SAFIRE_HD_Family/Star_SAFIRE_HD_Family/380-HDc/flir-star-safire-380-hdc-datasheet.pdf.

———. 2017. *The Ultimate Infrared Handbook for R&D Professionals*. Accessed 25 April 2017. http://www.flirmedia.com/MMC/THG/Brochures/T559243/T559243_EN.pdf.

Harris Company. 2016. "Harris Falcon III. AN/PRC-152A Type 1 Wideband Net Working." Handheld Radio data sheet. Accessed 20 April 2017. https://www.harris.com/sites/default/files/downloads/solutions/harris-falcon-iii-an-prc-152a-wideband-networking-handheld-radio.pdf.

King, Mak, and Michael J. Riccio. 2010. "Military Satellite Communications: Then and Now." *Aerospace Magazine*. Accessed 22 April 2017. http://www.aerospace.org/crosslinkmag/spring-2010/military-satellite-communications-then-and-now/.

Mexican Chamber of Deputies. 2005. "Mexican National Security Law." *Official Journal of the Federation*. Accessed 20 April 2017. http://www.diputados.gob.mx/LeyesBiblio/pdf/LSegNac.pdf.

———. 2006. *National Civil Protection System Manual*. Accessed 20 April 2017. http://www.secofi-sniim.gob.mx/sicia/ProteccionCivil.pdf.

———. 2012. *Federal Law Against Organized Crime*. Accessed 20 April 2017. http://www.pgr.gob.mx/Fiscalias/feadle/Documents/LEY%20FEDERAL%20CONTRA%20LA%20DELICUENCIA%20ORGANIZADA.pdf.

———. 2013. *National Development Plan 2013-2018*. Accessed 21 May 2017. http://www.sev.gob.mx/educacion-tecnologica/files/2013/05/PND_2013_2018.pdf.

Mexican Secretariat of the Interior. 2016. *Organic Law of the Federal Public Administration*. Official Journal of the Federation. Accessed 20 April 2017. http://www.ordenjuridico.gob.mx/Documentos/Federal/pdf/wo13235.pdf.

———. 2017. *National Indicators*. National Geography and Statistic Institute (INEGI). Accessed 20 April 2017. http://www.inegi.org.mx.

Mexican Secretariat of National Defense. 2013. "Mexican Regulation for Territorial Commands." *Official Journal of the Federation*. Accessed 23 April 2017. http://www.diputados.gob.mx/LeyesBiblio/regla/n373.pdf.

———. 2014. "Organic Law for the Mexican Army and Air Force." *Official Journal of the Federation*. Accessed 20 April 2017. http://www.ordenjuridico.gob.mx/Documentos/Federal/pdf/wo13238.pdf.

———. 2015a. "Plan DN-III-E." SEDENA Portal. Accessed 20 April 2017. http://www.gob.mx/sedena/acciones-y-programas/plan-dn-iii-e.

———. 2015b. "What is the Plan DN-III-E?" SEDENA Portal. Accessed 20 April 2017. http://www.gob.mx/sedena/acciones-y-programas/que-es-el-plan-dn-iii-e.

———. 2015c. "What is the Rapid Response Team?" SEDENA Portal. Accessed 20 April 2017. http://www.gob.mx/sedena/acciones-y-programas/fuerza-de-apoyo-para-casos-de-desastre-plan-dn-iii-e.

———. 2016a. "Military Regions." SEDENA Portal. Accessed 23 April 2017. http://www.gob.mx/sedena/acciones-y-programas/regiones-militares.

———. 2016b. "Military Zones." SEDENA Portal. Accessed 24 April 2017. http://www.gob.mx/sedena/acciones-y-programas/zonas-militares.

Mexican Supreme Court. 2010. *Political Constitution of the United Mexican States*. 4th ed. World Intellectual Property Organization. Accessed 21 April 2017. http://www.wipo.int/edocs/lexdocs/laws/en/mx/mx047en.pdf.

Northcote, Maria T. 2012. "Selecting Criteria to Evaluate Qualitative Research." Research paper, Avondale College, Australia. Accessed 20 April 2017. http://research.avondale.edu.au/edu_papers/38.

Rider, Timothy L. 2005. “Blue Force Tracking to Expand Across Force.” *Army AL&T Magazine*. Accessed 21 April 2017. http://asc.army.mil/docs/pubs/alt/2004/5_SepOct/articles/02_Blue_Force_Tracking_to_Expand_Across_Force_200405.pdf.

Schmickley, Dennis L. 2001. “Night Vision Goggles.” Boeing Helicopter Co. Accessed 22 April 2017. http://nvgsafety.com/NVG_Support/Night_Vision_Goggles/Night_Vision_Goggles_Chap7.pdf.

World Bank. 2016a. “Countries data sheets, Mexico.” Accessed 20 April 2017. http://www.worldbank.org/en/country/mexico.

———. 2016b. “Countries data sheets, United States of America.” Accessed 20 April 2017. http://www.worldbank.org/en/country/unitedstates.