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THESIS

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) IMPROVES EFFICIENCY AND EFFECTIVENESS OF THE MARINE RIFLE SQUAD WHILE REDUCING RISK

by

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December 2018

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13. ABSTRACT (maximum 200 words)

U.S. Marine Corps rifle squads are the tip of the spear in expeditionary warfare. However, they do not have organic intelligence, surveillance, and reconnaissance (ISR) assets, potentially hindering effectiveness and efficiency. This thesis explores how the Marine Rifle Platoon (MRP) can be more effective and efficient while operating in unconventional and/or asymmetrical environments. These challenging environments require an analysis of doctrine, organization, training, materiel, leadership, education, personnel, and facilities in order to determine possible gaps in each of the elements. Characterizing the allocation of ISR assets at the battalion, platoon, and squad level will illustrate the impact to response time. The results show that as detection distance is increased, response time is increased. The increase in response time leads to more effective and efficient attacks and counterattacks. The author recommends that each squad require its own organic ISR asset with various sensor configurations. These ISR assets can improve the effectiveness and efficiency of each squad, the MRP, the company, and thus the battalion as a whole, especially in asymmetric warfare.

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INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) IMPROVES EFFICIENCY AND EFFECTIVENESS OF THE MARINE RIFLE SQUAD WHILE REDUCING RISK

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ABSTRACT

U.S. Marine Corps rifle squads are the tip of the spear in expeditionary warfare. However, they do not have organic intelligence, surveillance, and reconnaissance (ISR) assets, potentially hindering effectiveness and efficiency. This thesis explores how the Marine Rifle Platoon (MRP) can be more effective and efficient while operating in unconventional and/or asymmetrical environments. These challenging environments require an analysis of doctrine, organization, training, materiel, leadership, education, personnel, and facilities in order to determine possible gaps in each of the elements. Characterizing the allocation of ISR assets at the battalion, platoon, and squad level will illustrate the impact to response time. The results show that as detection distance is increased, response time is increased. The increase in response time leads to more effective and efficient attacks and counterattacks. The author recommends that each squad require its own organic ISR asset with various sensor configurations. These ISR assets can improve the effectiveness and efficiency of each squad, the MRP, the company, and thus the battalion as a whole, especially in asymmetric warfare.

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LIST OF ACRONYMS AND ABBREVIATIONS

COIN	insurgency/counterinsurgency
CT	terrorism/counterterrorism
DoD	Department of Defense
FID	Foreign Internal Defense
GCE	Ground Combat Element
ISR	intelligence, surveillance, and reconnaissance
IW	irregular warfare
MAGTF	Marine Air-Ground Task Force
MRP	Marine Rifle Platoon
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
SE	systems engineering
STAB	stability operations
UAS	unmanned aerial system
UAV	unmanned aerial vehicle
USMC	United States Marine Corps
UW	unconventional warfare
WWII	World War II

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EXECUTIVE SUMMARY

Throughout the history of the Marine Corps, the rifle squad configuration has changed and should continue to evolve with technological developments. Prior to May 2018, the rifle squad did not have organic aerial intelligence, surveillance, and reconnaissance (ISR) assets. Usually, aerial ISR assets are not controlled at the squad level. The lack of situational awareness at the squad level affects the squad leader's ability to make timely and accurate decisions. Therefore, the squad's reaction time to potential threats and intercept ranges could impact the mission. After May 2018, the rifle squad configuration changed to include an ISR capability. This thesis explores the integration of the rifle squad and organic aerial ISR.

A squad's operation may be executed in isolation or spread out over a large area. Either situation presents a risk to the squad, which could affect mission success. A method to reduce the risk is to employ squad-organic ISR assets, better known as drones. This thesis shows how the employment of an organic ISR capability can improve the rifle squad's mission execution.

An example of a scenario for a squad is maneuvering offensively in an urban environment to neutralize a potential threat in an unknown area within the next "X" hours. The squad leader would deploy ISR assets, if organic, to search the area and provide data for that situational awareness. Without this capability, the squad leader would have to use whatever information is available, as scarce and outdated as it may be, and execute. Thus, the squad may be executing a mission using outdated information, leading to a slower and more cautious execution, which could place the squad at risk.

The recent change to the rifle squad operation requires a Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) analysis to identify what additional changes may be warranted. The background and history of the rifle squad presents questions regarding the rifle squad and organic ISR assets such as the following:

1. How effective are the current rifle squad operational tasks and capabilities in unconventional warfare?

2. Does the functional allocation within the rifle squad organization support organic ISR implementation?

3. What are the technological/organizational gaps to support organic ISR implementation?

The conclusion of this thesis is that an ISR capability at the squad level requires changes in training, tactics and procedures and improves mission execution. The sooner a threat is identified, the more time the squad has to adjust and engage using near real-time data. Otherwise, the squad is at risk of moving into an unfavorable situation, risking mission success.

A DOTMLPF-P analysis helps answer those questions and identifies existing gaps. The Marine Corps doctrine may be an area that requires modifications, since doctrine is interwoven throughout the rifle squad. The organization has already changed and does not require further discussion. The training will need to be adjusted to account for the change in the rifle squad configuration. The materiel will definitely change to address the requisite ISR assets requires to support the rifle squad mission. The leadership and education will need to adjust for the addition of a system operator and the use of and ISR capability. The personnel have been determined and thus require no further discussion. The facilities will need to account for the addition of an ISR capability at the squad level. The policy regarding the makeup of the rifle squad has been formulated, albeit verbal.

The DOTMLPF-P analysis must account for the fact that the rifle squad must operate in many environments to include irregular/unconventional warfare. In each environment, accurate, timely, and actionable information is vital to the success of its mission. Any solution that provides the requisite information must be versatile enough to adapt to any environment, as well as its employment. However, irregular/unconventional warfare brings its own challenges because the focus is on non-state actors. Thus, accurately detecting the adversary in a timely manner becomes paramount.

Regardless of the situation, the principles of war are executed in either an offensive or defensive mode. In an offensive operation, the goal is to disrupt enemy operations and movement. In defensive operations, the goal is to defeat the enemy attack and create opportunities to shift to offensive operations. As warfare moves from the conventional to unconventional/irregular, offensive or defensive operations take on roles that are more significant. Intelligence gathering helps in creating the opportunities to move from offensive to defensive operations. ISR assets provide the capability that transforms data into information. Types of ISR assets considered are in Group 1.

This thesis presents three cases that demonstrate how the probability of success, P_S, improves as smaller units owned/controlled ISR assets. Utilizing the OODA Loop process with ISR assets increased situational awareness and minimized uncertainty, thus improving squad response time to act/react to a situation. Improving response time reduces risk while increasing the probability of mission success.

Technology has advanced and can provide tactical units with smaller, lighter unmanned aircraft systems (UASs) that can be deployed at the squad levels. Several nano/micro UASs have unique design and characteristics that can provide the requisite data to the squad leader. Some of these nano/micro UASs have been used in real-world applications and proven to provide the necessary information that can be transformed into intelligence.

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This is dedicated to my wife. Thank you for your understanding and patience during this endeavor. I love you and appreciate you giving me the space to reach this milestone. I could not have done this without your support.

To Marine Corps Systems Command, thank you for giving me the opportunity to participate in this experience. I pray that something within this paper can be useful to the Marine Corps to help our Marines be more effective and efficient in every clime and place.

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I. INTRODUCTION

This thesis will explore the Marine Rifle Squad with an organic unmanned aerial intelligence, surveillance, and reconnaissance (ISR) capability. Until recently, the squad did not have an ISR capability. The Commandant of the Marine Corps (CMC) changed that recently in a speech given in May 2018.

This chapter will discuss the background and history of the Marine Rifle Squad, the objectives of this thesis, and the research questions regarding the problem. This chapter will identify the problem statement along with the assumptions and constraints to determine the parameters for analysis. A discussion of the systems engineering (SE) approach used during this research and an identification of the next steps will end the chapter.

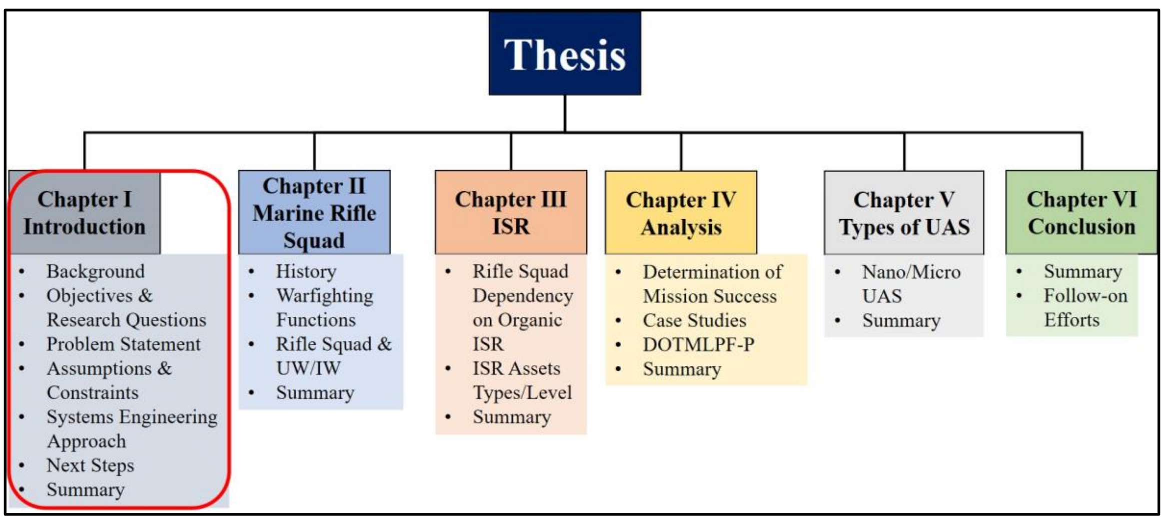

Figure 1. Chapter I Outline

The Marine Rifle Squad is a small unit within the Ground Combat Element (GCE). It is the Marine Corp's tactical unit that locates, closes with and destroys the enemy by fire and maneuvers to "repel the enemy's assault by fire and close combat" (Caulfield 2002, 1–1). The intent of the rifle squad is to "create an operational advantage at a specific time and location. An operational advantage may be in the form of adversarial" decision-making "or targeted audience behaviors. This advantage enables [the rifle squad] to maneuver and execute actions because the adversary" may not be able to "communicate timely, accurate guidance or direction to its forces. On the other hand, an operational advantage may be one that permits the squad leader to make more timely and accurate decisions than the adversary, resulting in an advantage in the initiative, the tempo of operations, and momentum" (Amos, MCDP 1–0 2011, 3–20).

Operations tempo is critical in today's modern warfare. Many squad operations may be executed in isolation or spread out over a large area. With limited personnel, either situation presents a risk to the squad, especially if the squad is isolated from other units.

One method to reduce this risk is to employ squad-organic assets, such as unmanned airborne sensors. The objective of this thesis is to show how the employment of an organic aerial ISR capability can improve a small unit's situational awareness, which supports timely and accurate decision-making. Figure 2 depicts squad ISR concept outlined in this document. The user would be the squad and the organic capability would be an ISR asset.

An example of a challenging operational scenario for a squad is maneuvering offensively in an urban environment to neutralize a potential threat in an unknown area within the next "X" hours. The squad leader (leader) would require situational awareness of the area. The squad leader would request intelligence, via the platoon commander, to search the area and provide data back for that situational awareness.

However, if the ISR asset is not available, the leader would have to use whatever information is available, as scarce and outdated as it may be, and execute from there. Thus, the squad may be executing a mission using outdated information, leading to a slower and more cautious execution: traditional reconnaissance.

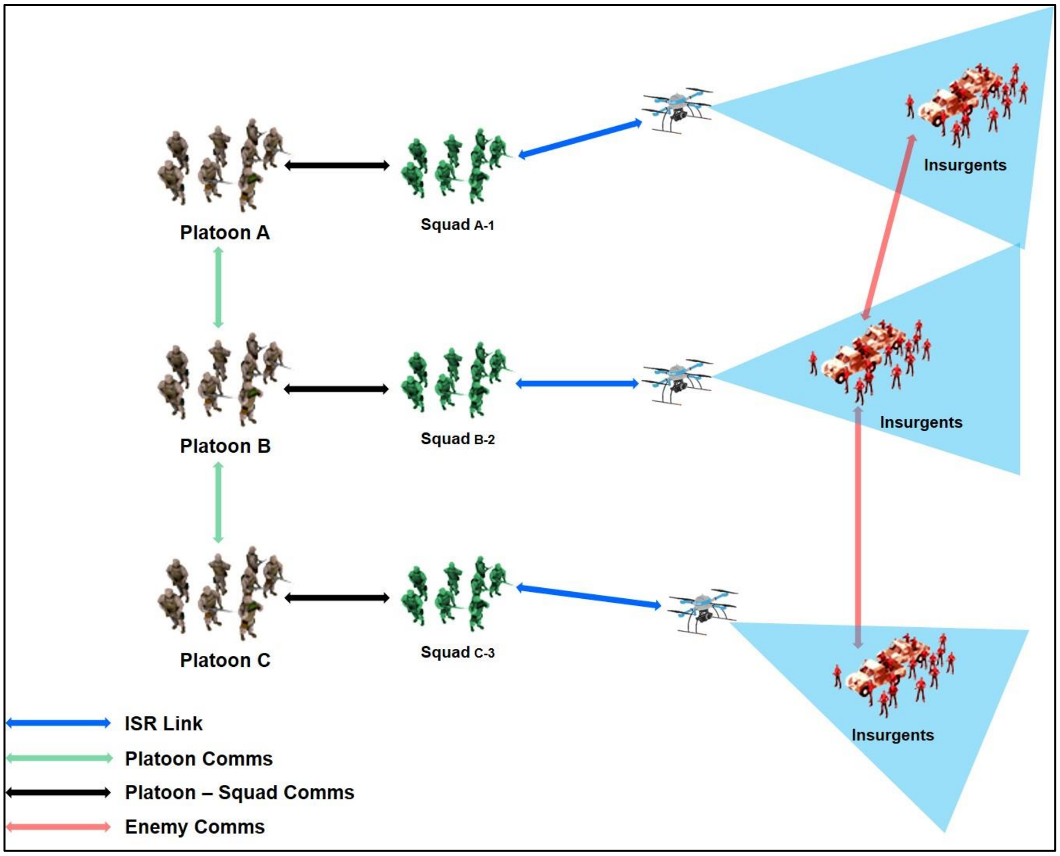

Figure 2. OV-1 – Rifle Squad w/Aerial ISR Asset

On the other hand, using the same scenario, if the squad has its own organic aerial ISR asset, the commander could employ those assets immediately and obtain the requisite data. With organic sensors at further ranges from the threat, data gathering could occur even while on the move allowing the squad leader to make informed decisions and adjust as needed. The squad could move quickly into a position in a relatively short time frame and execute its mission with speed and accuracy. An organic capability would reduce the demand for higher echelon ISR assets. However, this capability does come at a cost. This capability would require more logistics, maintenance, and training at lower levels,such as at the platoon level and possibly at the squad level.

The scope of this study frames two different scenarios for the rifle squad, one without organic aerial ISR asset, and one with organic aerial ISR asset. This thesis explores the employment of organic ISR assets within the rifle squad to execute its mission effectively. Doctrinal changes may also occur as a result of this concept.

A. BACKGROUND

General James F. Amos, as quoted from the 35th Commandant of the Marine Corps Commandant's Planning Guidance, states that

> the Marine Corps is America's Expeditionary Force in Readiness—a balanced air-ground-logistics team. We are forward-deployed and forward-engaged: shaping, training, deterring, and responding to all manner of crises and contingencies. We create options and decision space for our Nation's leaders. Alert and ready, we respond to today's crisis, with today's force … TODAY. Responsive and scalable, we team with other services, allies and interagency partners. We enable and participate in joint and combined operations of any magnitude. A middleweight force, we are light enough to get there quickly, but heavy enough to carry the day upon arrival, and capable of operating independent of local infrastructure. We operate throughout the spectrum of threats—irregular, hybrid, conventional—or the shady areas where they overlap. Marines are ready to respond whenever the Nation calls … wherever the President may direct. (Amos 2010, 5)

The Marine Corps "has long provided the nation with a [military] force adept at rapidly and effectively solving security challenges." (Amos, MCDP 1–0 2011, 1). The Marine Corps conducts military specific objective operations such as Movement to Contact, Attack, and Position and Mobile Defenses.

The Marine Corps is not optimized to dominate all domains. The Marine Corps is expeditionary to fill the gaps using its speed and efficiency. Marine Corps forces are employed as Marine Air Ground Task Forces (MAGTFs) to leverage combinations of amphibious shipping, maritime prepositioning, and airlift. Marines can accomplish the heavy missions or provide coverage until additional forces arrive. They provide the Joint Force with versatility, flexibility, and scalability. Because of that versatility, flexibility, and scalability, being mobile and sustainable by amphibious ships gives Marines an asymmetric advantage.

In a speech during the Marine Corps Association and Foundation Annual Ground Awards Dinner on May 3, 2018, the 37th CMC, General Robert Neller, recently changed the structure of the Marine rifle squad. The new configuration would consist of three, three-

Marine fire teams and a command element of three — a squad leader, assistant squad leader and squad systems operator (Smith 2018). This is a change from the prior 13-member squad. The Marine rifle squad continues to evolve to address the gaps identified by the Marine Corps leadership.

The squad is also where the actual fighting will occur. The squad is the "pointy end of the spear." The squad is the first to engage the adversary. Therefore, the squad is where the need for ISR assets exists. The structural changes have provided the ISR capability to the rifle squad. This paper will focus on the squad and the integration of ISR assets.

According to the Marine Rifle Squad warfighting publication, MCWP3-11.2, the primary mission of the rifle squad "is to locate, close with, and destroy the enemy by fire and maneuver or to repel an assault by fire and close combat. The rifle squad is the basic maneuver element of the rifle company (Caulfield 2002, 1-1)." Figure 3 emphasizes the rifle squad within the Marine Rifle Platoon (MRP).

The intent of the squad is to "create an operational advantage at a specific time and location. An operational advantage [enables] the [squad leader to] make more timely and accurate decisions, resulting in an advantage in the initiative, the tempo of operations, and momentum" (Amos 2011, 3–20).

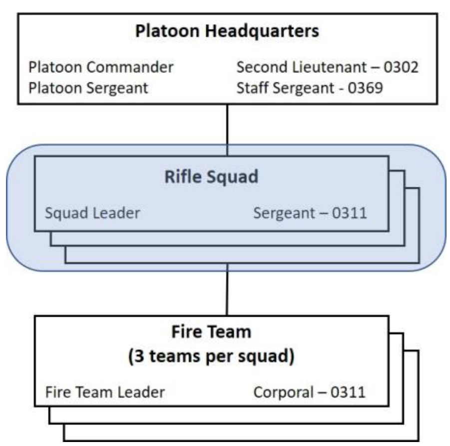

Figure 3. Rifle Platoon with Squad Emphasis. Source: Glueck (2014).

Glueck (2014) has noted that an overview of warfare throughout history would reveal that, while technology influenced the methods and tactics of conflict, the strategies and forms of war remain unchanged. Large-scale formalized warfare occurred between kingdoms and nation-states; whereas, insurgencies, guerilla warfare, and asymmetrical techniques have always been a strategy of choice for weaker parties in the face of overwhelming force (Glueck 2014).

Although the Marines are a small unit, this thesis will explore how the rifle squad can exploit organic aerial ISR assets can gain a tactical advantage in asymmetric warfare.

The Marine Corps remains "committed to improving the quality of manning, training, equipping efforts and resultant warfighting capability. The increasingly uncertain, complex, and decentralized operating environment" (Dunford 2015, 2) presents challenges and places new demands on leaders at all levels. Moreover, as General Alfred Gray, the 29th Commandant said, "Like war itself, our approach to warfighting must evolve. If we cease to refine, expand, and improve our profession, we risk being outdated, stagnant, and defeated" (Dunford 2015). Warriors "must win today's battles while evolving, innovating, and adapting to win tomorrow's fight" (Dunford 2015, 2). Regardless of when the fight occurs, present or future, the capabilities of the rifle squad, according to the Infantry Company Operations manual, MCWP 3 11.1, Table 1, are still valid until deemed otherwise.

Table 1. Rifle Squad Capabilities. Adapted from Glueck (2014).

Tactical capabilities	seize, secure, occupy, and retain terrain
	defeat, destroy, neutralize, suppress, interdict, disrupt, block, canalize, and fix enemy forces
	breach enemy obstacles
	deny, bypass, clear, contain, and isolate
General capabilities	conduct day and night offensive and defensive operations in all types of environments
	conduct semi-independent, noncontiguous, and distributed actions
	conduct small unit operations
	participate in amphibious operations
	provide security for stability operations

B. OBJECTIVES AND RESEARCH QUESTIONS

This thesis explores the integration of the rifle squad and organic aerial ISR as a larger system. Systems thinking archetypes are used to evaluate the impacts each system had on the other and determined whether the existing doctrine applies or requires modification.

The research questions are as follows:

1. How effective are the post May 2018 rifle squad operational tasks and capabilities in warfare?

2. Does the functional allocation within the rifle squad organization support organic squad aerial ISR implementation?

3. What are the technological/organizational gaps to support organic squad aerial ISR implementation?

C. PROBLEM STATEMENT

Currently, the rifle squad does not have organic aerial ISR assets. However, recent changes to the rifle squad have made provisions for this capability. Usually, ISR assets are not controlled at the squad level and may take an exorbitant amount of time for a squad to gain access to an ISR asset. This delay could lead to less than optimal situational awareness and decisions. Therefore, the squad's ability to make timely and accurate decision and reaction time to potential threats and intercept ranges is reduced, albeit mission dependent.

D. ASSUMPTIONS AND CONSTRAINTS

There are three assumptions and one constraint guiding this thesis. These assumptions are listed below.

1. Current ISR assets meet the needs of operations in conventional and unconventional or asymmetrical scenario

2. Current doctrine is changed based on the new structure

3. Users are trained to the new doctrine

One constraint is the pace of operations. In previous operations, Marines experienced limitations in obtaining the needed information, and thus the speed of operations produced knowledge gaps. In addition to the pace of operations, Marines supporting the ground effort received a lower priority for ISR assets. Consequently, Marines did not always get the needed information when it was needed. According to Garrison and Isherwood, "units below the division level have less of a chance of obtaining access to ISR assets" (Garrison and Isherwood 2008). Therefore, one could conclude that the rifle squad, which is several echelons below the division level, may not get the intelligence needed.

E. SYSTEMS ENGINEERING APPROACH

Figure 4 shows the systems engineering (SE) process that will guide this study to ensure achievement of mission-essential functions and to gain an understanding of a potential solution to a gap within the Marine Corps.

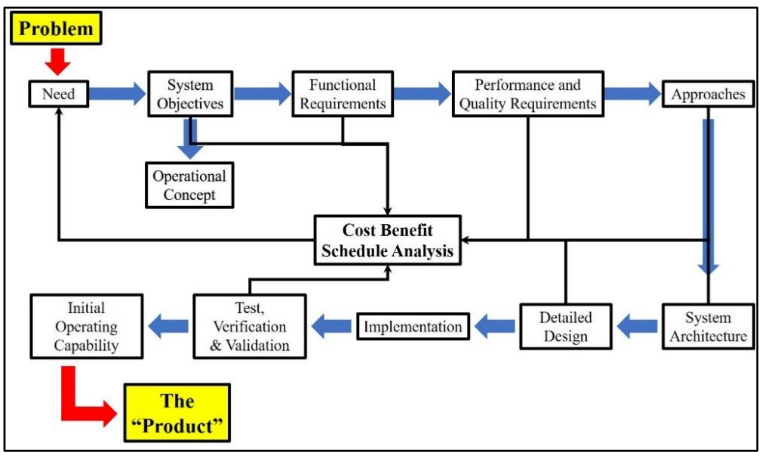

Figure 4. Systems Engineering Process. Source: Langford (2014).

The operational deployment of the rifle squad organic aerial ISR assets in warfare may be hindered by existing doctrine and systems. This research will use systems thinking methodology to execute analysis of the doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy (DOTMLPF-P) of the rifle squad change. Figure 5 depicts the concept outlined in this thesis and the recent changes to the rifle squad reinforce this concept. The current change to the rifle squad requires Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) analysis of the integration of that change to identify what additional changes may be warranted.

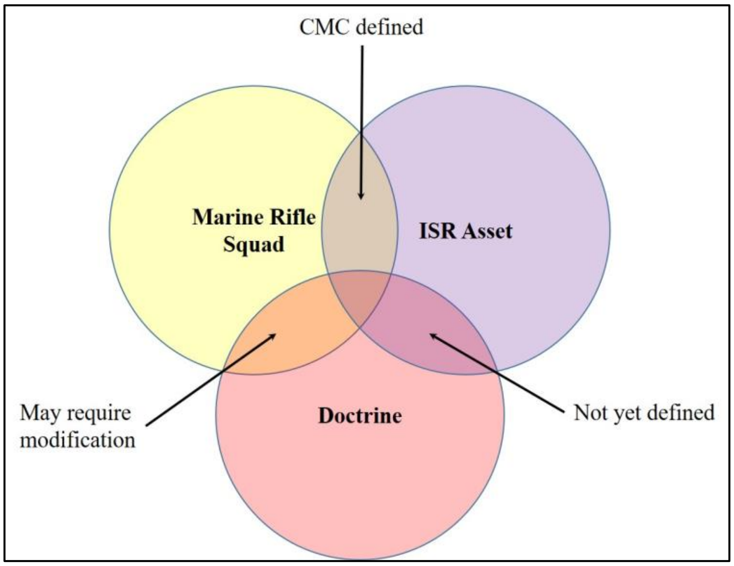

Figure 5. Concept Diagram

Figure 6 shows the context in which the ISR operates to provide requisite information to the system operator and subsequently to the squad leader.

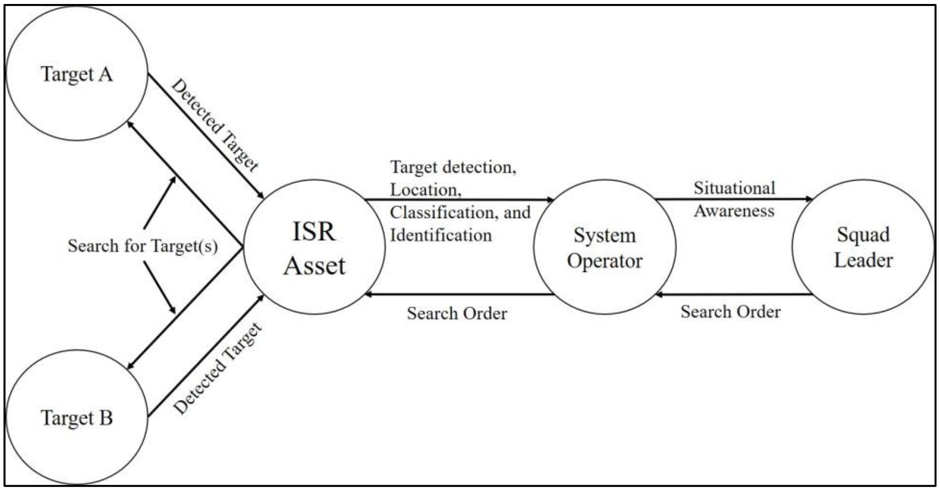

Figure 6. Context Diagram

F. NEXT STEPS

Chapter II will further explore the rifle squad structure in detail; discuss potential solutions to the problem aforementioned; identification of pros and cons of the potential solutions; and present a discussion of the potential types of analyses to be conducted and the tools that will be used to conduct the analyses. Chapter III will describe ISR and the different levels and types of ISR platform systems and the controllers of those systems. It will focus on a particular type of an ISR platform that may be conducive to squad level usage. Chapter IV will define "mission success" and provide several scenarios in the form of case studies that will be used to describe the analysis discussed in Chapter II. It will also consider the integration of different technologies and timelines into the rifle squad. Chapter V will provide conclusions and offer future efforts to advance the concept.

G. SUMMARY

The problem statement implies that there was an operational gap within the rifle squad that the CMC fixed by adding a system operator to the rifle squad. A DOTMLPF-P analysis will help determine how effective the change will be for the rifle squad. Doctrine is interwoven, which identifies the philosophy and how the rifle squad functions. The research will explore the rifle squad history, philosophy, and functionality, in detail, in the following chapters.

II. MARINE RIFLE SQUAD STRUCTURE

The topics for detailed discussion are shown in Figure 7. This chapter will discuss the history, mission, and function of the rifle squad. It will also discuss the rifle squad and Unconventional/Irregular Warfare and finally, a summary.

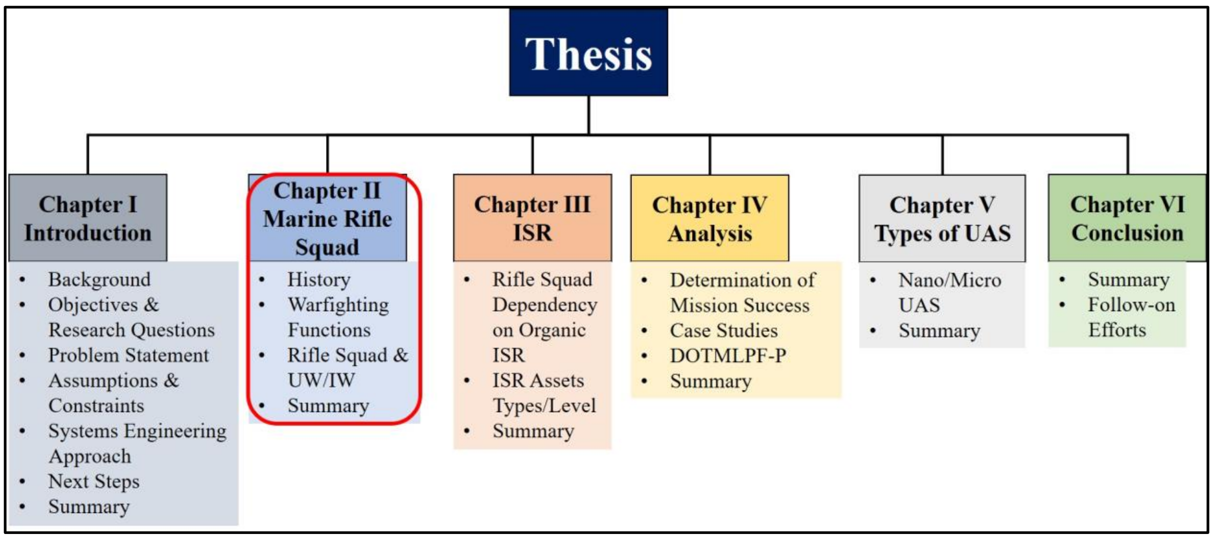

Figure 7. Chapter II Outline

There are nine principles of war that the Marine Corps embrace. Their philosophy is based on them. From their first amphibious landing in 1776 to the war in Afghanistan today, the Marines have carried the mantle of being the nation’s expeditionary force in readiness spanning the entire conflict spectrum.

The fundamentals and concepts for operations of the rifle platoon begin with the offense and then transitions to the defense. According to the Basic Officers Course publication, Introduction to Rifle Platoon Operations B3J3638, the listed in Table 2 that are applicable to the rifle squad.

Table 2. Marine Rifle Platoon Principles. Source: USMC Training Command (n.d.).

Mass	Concentrate the effects of combat power at the decisive place and time to achieve decisive results.
Objective	Direct every military operation toward a clearly defined, decisive, and attainable objective.
Offensive	Seize, retain, and exploit the initiative.
Security	Never permit the enemy to acquire an unexpected advantage.
Maneuver	Place the enemy in a disadvantageous position through the flexible application of combat power.
Surprise	Strike the enemy at a time or place or in a manner for which he is unprepared.
Simplicity	Prepare clear, uncomplicated plans and clear, concise orders to ensure thorough understanding.

A. HISTORY

Throughout the history of the Marine Corps, the rifle squad structure has varied. It started with nine members, and over time, grew to as many as 13 members. With the advent of the CMC announcement, the current number for the rifle squad is 12 members. The “mission of the rifle squad is to locate, close with, and destroy the enemy by fire and maneuver, or repel the enemy’s assault by fire and close combat” (Van Riper 2002, 1–1).

Prior to May 3, 2018, the rifle squad was “composed of 13 men: a sergeant (squad leader) and three fire teams of four men each. Each fire team consists of a corporal (fire team leader/grenadier), two lance corporals (automatic rifleman and assistant automatic rifleman), and a private or private first class (rifleman)” (Van Riper 2002, 1–1).

After May 3, 2018, the CMC changed the structure of the Marine rifle squad. The new configuration consists of three fire teams and a command element of three — a squad leader, assistant squad leader, and squad systems operator. The systems operator will be the most tech-capable Marine in the formation (Smith 2018). The size of the new rifle squad has not been solidified. However, the sizes being considered range from 11 to 14 Marines. A squad size of 12 supports an even distribution of Marines on each fire team, while a size of 11 or 14 leaves an uneven number of Marines on each fire team.

B. WARFIGHTING FUNCTIONS

According to the Basic Officer Course publication *INTRODUCTION TO RIFLE PLATOON OPERATIONS,* the warfighting philosophy of maneuver warfare and the principles of war are intricately intertwined within the Marine Corps (USMC Training Command n.d.). The “principles of war are useful aids to a commander as he considers how to execute his mission regardless of whether it is offensive or defensive” (USMC Training Command n.d., 2).

As described in the *INTRODUCTION TO RIFLE PLATOON OPERATIONS*, the rifle squad executes “four types of offensive operations: movement to contact, attack, exploitation, and pursuit.” Just as there are offensive operations, the rifle squad also execute defensive operations: position defense and mobile defense. Table 3 defines both the offensive and defensive operations as they apply to the rifle squad.

Table 3. Definitions of Offensive and Defensive Operations.
Source: USMC Training Command (n.d.).

Definitions of Offensive Operations	
Movement to contact	to establish or regain contact with the enemy and to expedite the employment and concentration of the force.
Attack	to defeat, destroy, or neutralize the enemy and emphasizes the maximum application of combat power.
Exploitation	prevents the enemy from disengaging, withdrawing and re-establishing an effective defense.
Pursuit	to catch or cut off and destroy the enemy attempting to escape
Definitions of Defensive Operations	
Position defense	focuses on the retention of terrain by absorbing the enemy in an interlocking series of positions and destroying them.
Mobile defense	the defense of an area in which maneuver is used together with fire and terrain to seize the initiative from the enemy and orients on the destruction of the attacking force by permitting the enemy to advance into a position that exposes them to counterattack.

Having organic squad aerial ISR assets within the rifle squad aids in the execution of both offensive and defensive operations. In the words of General Patton, citing a Japanese proverb; “One look is worth one hundred reports” (Wilhelm 2002, 5-22). As the rifle squad continues to evolve, the configuration of the rifle squad with technology could increase its footprint.

C. MARINE RIFLE SQUAD AND UNCONVENTIONAL/IRREGULAR WARFARE

The global scene in the 21st century presents new challenges. Many international actors recognize that engaging in military activities against the U. S. is not in their best interest. Therefore, conventional warfare is increasingly unlikely. International actors are concentrating on the nonmilitary instruments of power. The enemy uses the instruments of power as weapons.

Today, international actors will probably employ “unconventional” methods to force an adversary to comply with its desires. Techniques, referred to as “irregular,” “asymmetric,” or “unrestricted” warfare, are guerrilla warfare, terrorism, sabotage, subversion, and insurgency, as well as using other means, especially the informational, vice direct confrontation. Figure 8 shows the relationship between irregular and unconventional warfare.

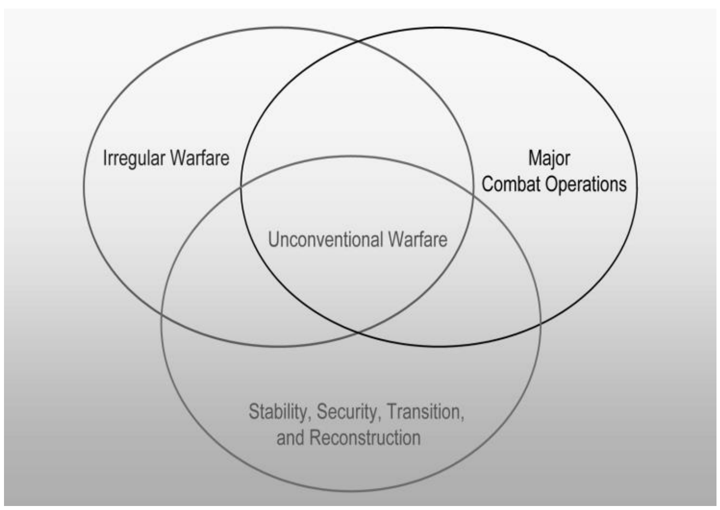

Figure 8. Joint Operating Concept Relationships. Source: Army (2003).

According to Army publications (2003), “operations conducted by, with, or through irregular forces in support of a resistance movement, an insurgency, or conventional military operations” is the definition of unconventional warfare. Unconventional warfare has supported conventional military operations since WWII. Examples range from

OSS/Jedburgh activities in France and OSS/Detachment 101 activities in the Pacific to more recent operations in Operation Enduring Freedom (OEF)/Afghanistan in 2001 and Operation Iraqi Freedom (OIF)/Iraq in 2003. Similar operations continue today.

The definition of "irregular warfare is a violent struggle among state and non-state actors for legitimacy and influence over the relevant populations. Irregular warfare favors indirect and asymmetric approaches and may employ the full range of military and other capabilities, to erode an adversary's power, influence, and will" (Mullen 2010, 9). Irregular warfare is multi-dimensional and has dispersed operations and focuses on people, involves close contact, deals with a "non-templatable" adversary, and has a regional focus. Irregular warfare is proactive and involves air, land, sea, cyber, and space information.

Figure 9 shows the contrast between conventional and irregular warfare. DoD IW Directive 3000.07 identified many activities; however, there are five primary activities associated with Irregular warfare. They are:

- Insurgency/Counterinsurgency (COIN)
- Unconventional Warfare (UW)
- Terrorism/Counterterrorism (CT)
- Foreign Internal Defense (FID)
- Stability Operations (STAB)

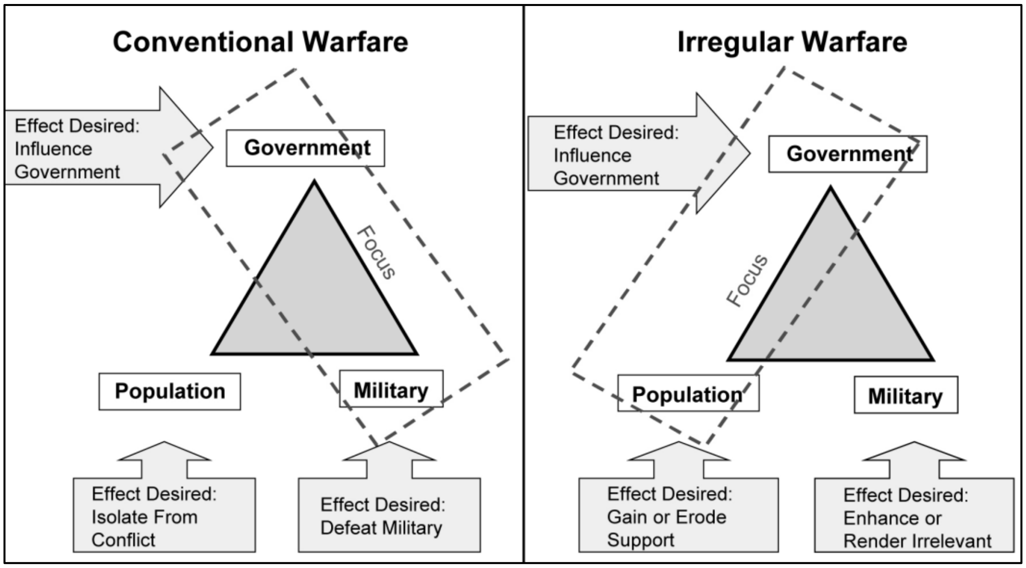

Figure 9. Contrasting Conventional/Irregular Warfare. Source: Army (2003).

D. SUMMARY

The rifle squad configuration has varied over time. Recently, its configuration evolved again from thirteen members to twelve members. The major difference being the current squad will incorporate a systems operator, which will operate an ISR asset. The squad's mission remains the same: to defeat the enemy by fire, maneuver, and close combat and to conduct other operations.

The rifle squad must operate in many environments to include irregular/asymmetric warfare. In each environment, accurate, timely, and actionable information is vital to the success of its mission. Any solution that provides the requisite information must be versatile enough to adapt to any environment, as well as its employment. This study will explore several solutions that could fulfill the need.

However, irregular warfare brings its own challenges because the focus is on non-state actors. These non-state actors force the rifle squad to operate in a manner that may requires different tools and techniques. For example, a different tool could be a small unmanned aerial platform that can mimic a bird.

The principles of war are executed either in an offensive or defensive mode. The offensive operations are to disrupt enemy operations and movement. Conversely, defensive operations defeat an enemy attack and force the enemy to reach his culminating point without achieving his objectives or create opportunities to shift to offensive operations. As warfare moves from the conventional to unconventional/irregular, offensive or defensive operations take on more significant roles. Therefore, effectiveness and efficiency become paramount. Rifle squad organic ISR assets can aid in the effectiveness and efficiency of both offensive and defensive operations.

The following chapter will discuss the different types of intelligence needed to shape the battlefield, the intelligence cycle, differing types of UASs, the groups in which they belong, the controlling echelon, and which UAS would be best for the rifle squad.

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III. INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

> Accurate, timely, and relevant intelligence is critical to the planning and conduct of successful operations. Effective intelligence uncovers enemy weaknesses, which can be exploited to provide a decisive advantage. Shortfalls in intelligence can lead to confusion, indecision, and unnecessary loss of life, mission failure, or even defeat. (Krulak 1997)

Intelligence "has two objectives: 1) to reduce uncertainty by providing accurate, timely, and relevant knowledge about the threat and the surrounding environment, and 2) to assist in protecting friendly forces" (Hanlon Jr 2003, 1–1). The phrase in General Krulak's quote, "accurate, timely, and relevant intelligence" is applicable in the context of this thesis. Intelligence, surveillance, and reconnaissance (ISR) is the ability to collect, processes, and deliver timely, actionable intelligence to provide battlespace awareness specifically tailored to enhance operations success. The context will be on the collection for threat detection and identification. Intelligence provides the squad leader with the information needed to execute both offensive and defensive missions.

Figure 10 identifies the topics that will be discussed, in detail, and provide several potential units that would be useful to the rifle squad.

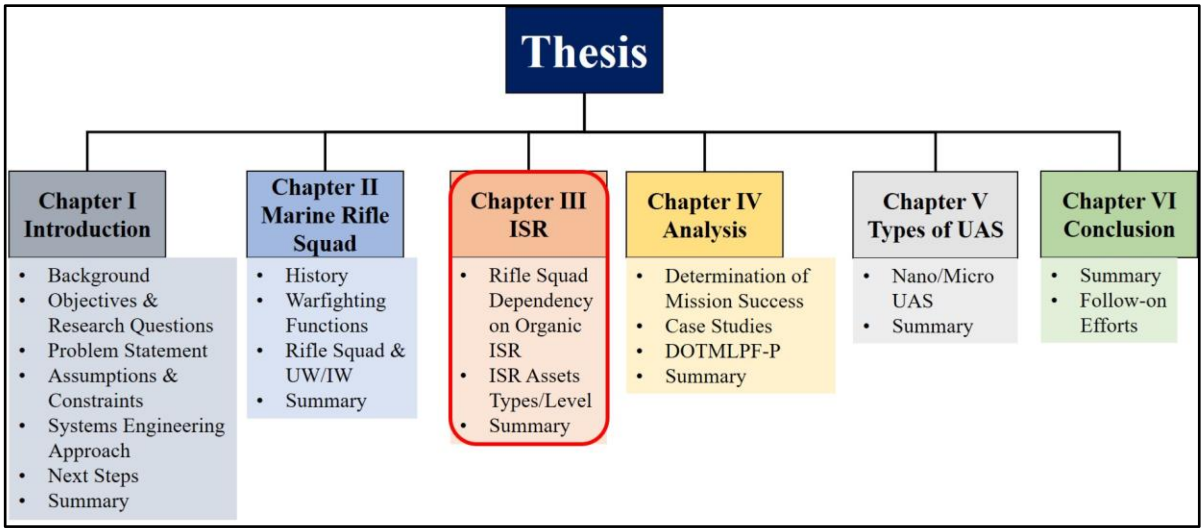

Figure 10. Chapter III Outline

The Marine Corps Intelligence, Surveillance, and Reconnaissance Enterprise (MCISR-E) Roadmap, issued in April 2010, describes USMC's "systematic and multi-faceted approach to seizing the 'high ground' afforded by intelligence superiority over the enemy." The context for this thesis explores ISR for agile execution of a mission.

The identification of an enemy's "strengths and vulnerabilities is crucial. Maneuver warfare requires acting in a manner to deceive and then striking at a time and place that the enemy does not expect and is not prepared. Maneuver warfare requires decision and action based on situational awareness" rather than on preconceived schemes or techniques (Krulak 1997, 3).

A. RIFLE SQUAD DEPENDENCY ON ORGANIC ISR

The goal is for the rifle squad to have and use organic aerial ISR assets as a capability to execute its mission, not to perform the planning of that mission. This includes using that capability on the fly, as the battlefield situation changes. The recent reconfiguration of the rifle squad provides the infrastructure to accommodate that capability.

1. Rifle Squad Leader Role

The squad leader executes orders issued by the platoon commander (Van Riper 2002). In combat, the squad leader "is responsible for the tactical employment, fire discipline, fire control, and maneuver of the squad" (Van Riper 2002,1-5). Intelligence gathered from an ISR asset enhances the ability for the squad leader to execute the assigned mission. The squad leader also has the ability to modify how the fire teams are deployed, based on the intelligence gathered from the organic ISR capability.

2. Intelligence of the Combat Space

This thesis proposes several areas where an ISR capability can help the squad leader fully understand the combat space and execute the mission: define the combat environment and employ the squad that allows the most efficient way to execute the orders of the platoon commander.

a. Define the Combat Environment

The squad leader receives an assigned sector of operation from the platoon commander. How the squad leader refines their sector is crucial, and part of this identifies characteristics of both the terrain and human environment. As the squad proceed to that sector, having an ISR capability could greatly reduce the possibility of inadvertent contact with a potential threat. The ISR aid the squad leader in defining the environment as it continually changes, assist in the tactical employment of the squad.

b. Identification of the Adversary

The ability for the squad leader to identify the adversary is critical, especially while on the move. This identification allows the squad leader to employ the squad effectively to provide the best opportunity to defeat the enemy.

c. Squad Employment

The squad leader determines where to employ the squad in order to observe and control the squad. Having an ISR capability provides the squad leader with environmental information (trees, terrain, and other cover) to provide the most advantageous location to engage the adversary. This is important because the squad leader can dictate where and when to attack.

3. Intelligence Cycle

The intelligence cycle consists of six phases: planning, collection, exploitation, production, dissemination, and utilization. It describes activities used to develop information into usable intelligence. However, in the context of this thesis, only collection and utilization will be discussed, and only from the rifle squad organic ISR aspect.

a. Collection

The squads are tasked to execute a mission from the platoon commander. While executing that mission, the squad with organic ISR assets would have the capability to collect real time or near-real time intelligence and provide that information to the squad leader.

b. Utilization

Utilization allows the squad leader to make informed decisions. Squad leader may direct collection and analyze the situation. However, the squad leader must decide and act on that intelligence and maneuver the squad to provide the best opportunity to successfully complete the mission. The information can also allow the squad leader to determine when and where to engage the enemy. The capability to be agile while executing a mission provides the squad an advantage over the enemy.

4. Intelligence Support to Operations

A website devoted to Marine domain, www.Marines.mil, describes the following: “intelligence is inseparable from operations. Operational actions develop logically from intelligence.” A leader with effective intelligence will have greater situational awareness. The leader can ascertain what population the squad will encounter, and how to effectively influence “mission accomplishment. The relationship between intelligence and operations should be as close and direct as that between intelligence and command.”

5. Intelligence Support to Execution

The website continues to distinguish “intelligence support to execution differs in from intelligence support to planning.” Unlike intelligences support for planning, intelligence support to execution is fluid and must flexible enough for use within a very short timeframe, hours, minutes, or even seconds. It noted that “success in execution often depends on the ability to provide immediate answers” about the enemy, such as its makeup, actions, and potential intentions. During execution, intelligence focuses on providing situation awareness that gives the squad an exploitable advantage over the enemy. Risk still remains during execution; however, “focused intelligence can reduce risk by providing situational awareness.”

B. ISR ASSET TYPES/LEVEL

Types of ISR assets, specifically UASs, range from Group 1 to Group 5. Figure 11 shows the DoD inventory, as of 1 July 2013. “The Marine Corps’ UAS Family of UAS CONOPS divides UAS requirements into three levels that coincide with the various echelons of command in the MAGTF. The larger and more capable systems support higher levels of command, whereas the smaller but more numerous systems directly support lower tactical units” (Walsh 2015, 1–6).

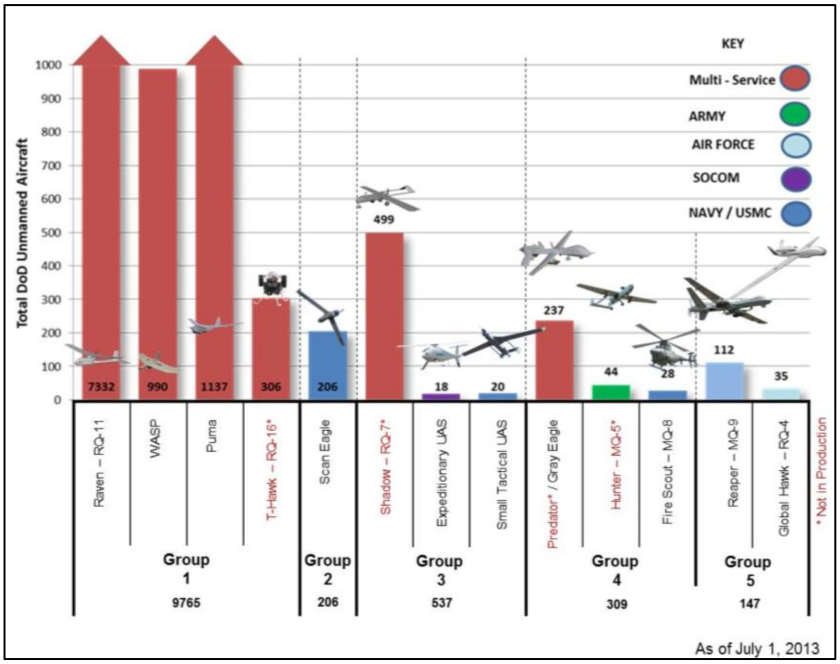

Figure 11. Inventory of DoD UAS. Source: Winnefeld and Kendall (2013).

Table 4 provides a breakdown of each grouping, technical data, and examples of the types of UASs.

Table 4. Groups. Adapted from Learning (n.d.).

UAS Group	Description	Weight UAS (lbs)	Normal Operating Altitude (ft)	Speed (knots)	Example
Group 1	These are typically lightweight, hand-launched, portable systems that fly at low speeds and altitudes. They are capable of providing nearby reconnaissance and surveillance.	0-20	Under 1200 Altitude above ground level (AGL)	100	Raven (RQ-11) WASP
Group 2	These are typically small- to medium-size systems that fly	21-55	Under 3500 AGL	<250	ScanEagle

UAS Group	Description	Weight UAS (lbs)	Normal Operating Altitude (ft)	Speed (knots)	Example
	at low-medium altitudes. They typically perform special purpose operations or routine operations within a specific set of restrictions. They are typically launched via catapult.				
Group 3	These operate at medium altitudes with medium-long range and endurance.	<1320	Under Flight level (FL) 180		Shadow (RQ-7B) Tier II / STUAS
Group 4	These are relatively large UASs that operate at medium-high altitudes and have extended range and endurance.	>1320		Any airspeed	Fire Scout (MQ-8B, RQ-8B) Predator (MQ-1A/B) Sky Warrior ERMP (MQ-1C)
Group 5	These are large systems that operate at medium-high altitudes and have the greatest range, endurance, and airspeed capabilities. Typically, these perform specialized missions such as broad area surveillance or penetrating attacks.		Over FL 180		Reaper (MQ-9A) Global Hawk (RQ-4) BAMS (RQ-4N)

USMC UAS requirements include the following: Marine Corps Tactical UAS (MCTUAS): RQ-7B Shadow, Small Tactical UAS (STUAS): MQ-21A Blackjack, and the Family of Small UAS (SUAS): RQ-11B Raven, RQ-20 Puma and Wasp IV (USMC, Unmanned Aircraft Systems (UAS) 2015).

The RQ-7B Shadow, a Group 3 asset, supports the Marine Expeditionary Force (MEF) and Marine Expeditionary Brigade (MEB) (USMC, Unmanned Aircraft Systems (UAS) 2015). The MQ-21A Small Tactical UAS, now formally named the "Blackjack," also a Group 3 asset, supports the Marine Expeditionary Unit (MEU) and infantry regiments (USMC, Unmanned Aircraft Systems (UAS) 2015). The MQ-21A system is designed to provide reconnaissance, surveillance, target acquisition, and communications relay, in support of the Ground Combat Element (GCE) (USMC, Unmanned Aircraft Systems (UAS) 2015). The remaining UASs are Group 1 assets. The RQ-11B Raven supports company level and above. The Raven provides day or night color FMV with an integrated laser pointer. Gaps in organic, small-unit ISR capability lead to procurement of the RQ-16 T-Hawk, the Wasp III & IV, and the Puma AE (USMC, Unmanned Aircraft Systems (UAS) 2015). This study will focus specifically on nano/micro UASs that can be allocated down to the platoon and squad levels operating in an urban environment.

Future wars will not always occur in the open field of battle as in the past. Current battles are in an urban setting where tFuture combat will be in the form of space combat and cyber warfare. However, there will always be a need for "boots on the ground" and fighting will conventional and unconventional.

Our UAS technology has continued to evolve to smaller units with similar or increased capabilities. These smaller units, nano/micro UASs, also known as "drones," have proliferated the public sector and have garnered the attention of the military. There are many types of nano/micro UASs. However, only a few will be considered in this study.

C. SUMMARY

The intelligence cycle consists of six phases. These phases describe the sequence of activities to develop information into intelligence. Military ISR assets provide that information that is transformed into intelligence.

Types of ISR assets, specifically UASs, range from Group 1 to Group 5. Figure 11 shows what is in the DoD inventory. The Marine Corps currently have UASs in several groups to support the MAGTF. The goal of this thesis is to demonstrate the need for each squad leader to have a nano/micro UAS capability.

The following chapter will provide scenarios and examine ways that smaller UASs can be modeled and approximate the use of smaller, lighter UASs, in a system of systems configuration.

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IV. ANALYSIS

This chapter, as outlined in Figure 12, provides the analysis and defines mission success. This chapter also presents case studies that will represent the detect, assess and engage construct. The following section will demonstrate the principles previously discussed.

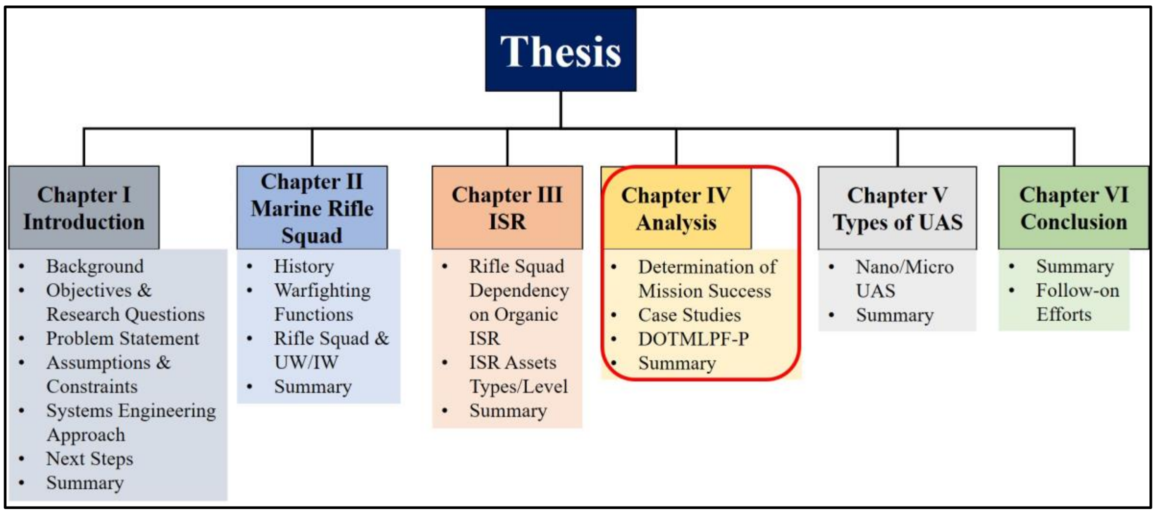

Figure 12. Chapter IV Outline

This chapter will show how mission success can improve with an increase in response time, thereby improving rifle squad effectiveness and efficiency. As depicted in the U.S. Army Unmanned Aircraft Systems Roadmap 2010–2035, Figure 13 points out smaller units tend to have higher risks with respect to lack of response time. Their reaction time is minimized because they are the closest to the fight and have the possibility of being overwhelmed and place in a reactionary mode. The response time refers to detection and reaction time, which have a direct relationship to the effectiveness and efficiency. From left to right, the smaller units risks are much greater for two reasons: first, they are closer to the fight and second, the response time is less. To combat this risk, smaller units should have their own ISR asset, which would allow more response time at longer ranges, which would help shape the battlespace and influence the fight.

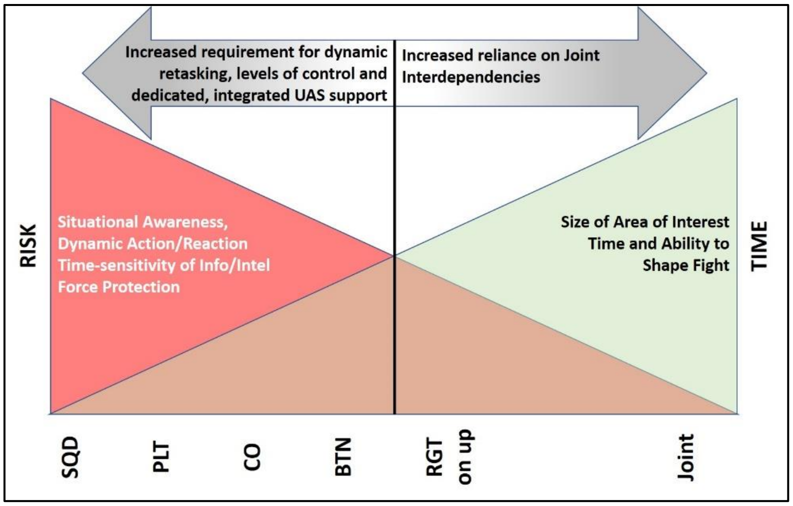

Figure 13. Time-Risk Relationship. Adapted from Dempsey (n.d.).

Smaller units, without ISR assets, have limited ability to shape the battlespace. As an example, the following steps are notional in the execution of a mission. A platoon is assigned a mission, who parses out tasks to squads. The squad, which is closest to the fight, executes its tasking. As the squad executes its tasking, the warriors may encounter the enemy, leaving them limited time to respond to the threat. Figure 13 shows that the response time is minimal and risk is greater for smaller units. The size of the area of interest is effectively decreased, and it does not allow smaller units the ability to influence the fight. This scenario could lead to mission failure.

Conversely, units with their own ISR assets can employ them to detect the enemy at longer ranges, which provides more response time to assess the situation and then engage in an appropriate manner. In other words, the units can shape the battlespace and influence the fight, which may lead to the desired state. This scenario effectively has an improved probability of mission success.

A. DETERMINATION OF MISSION SUCCESS

The basic functions of the rifle squad, detect, assess and engage, as shown in Figure 14, will be the basis of the model that will be used to assess efficiency and effectiveness of the squad. Effective is defined as "producing a decided, decisive, or desired effect" (*Merriam Webster* 2014). Efficient is defined as "capable of producing desired results with little or no waste" (*Merriam Webster* 2014). To help determine mission effectiveness, the use of a qualitative analysis approach that is probability based and kill chain based will be used.

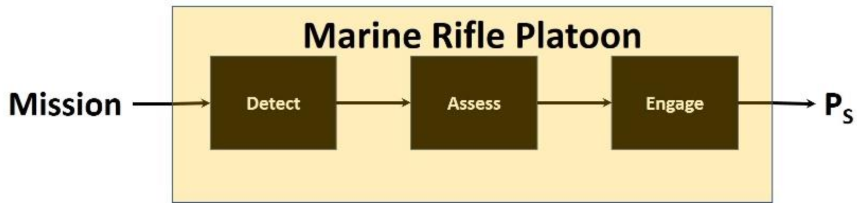

Figure 14. Basic functions for the Rifle Squad

Three cases in this chapter will explore how delays affect the ability of squad functions:

- the rifle squad with no ISR assets, relying on higher level assets
- the MRP with one ISR asset, and
- the rifle squads with their own ISR asset

Mission success is a function of detect, assess, and engage. These terms, defined shortly, refer to a sequence of events that lead to the gathering and assessing of data leading to the engagement of the threat.

Collected data must be available at the appropriate place and time and processed into useful information in order for the commander to make informed decisions. Information management procedures and techniques must have clearly identified information requirements and ensure timely, unimpeded flow of relevant information. Also, there must be an effective collection, reporting, and dissemination process in order for the information to get to the appropriate decision maker.

The decision maker uses two types of decision-making approaches, analytical or recognitional. Analytical decision-making is the most comprehensive and accurate type of decision-making. (Decision Making n.d.) Recognitional or "recognition-primed" decision-making "is a model of how people make quick, effective decisions when faced with complex situations." (Decision Making n.d.) Regardless of the approach, most people are hesitant to make a decision when the data is uncertain, vague, or contradictory. Planning and executing in uncertainty require understanding the variables commonly seen in decision-making. The variables are listed in Table 5.

Table 5. Common Decision-Making Variables.
Source: Decision Making (n.d.).

Chance	The absence of any cause of events that can be predicted, understood or controlled. No other human activity is subject to chance more than combat. It increases uncertainty and risk.
Risk	This is the expectation that the future holds the possibility of more than one result. It is inherent in every decision as well as indecision.
Information	The sum of all the inputs, often from multiple sources, in a given situation. We must learn to identify exactly how much information we need to make an effective decision. Too much information will slow down our processing time; too little information will cause unnecessary risk.
Time	A constraint imposed by either the mission or the enemy, requiring action to occur at a certain instant. It will often drive information accumulation and risk threshold.
Uncertainty	Decisions will never be made 'without doubt' or with complete protection from error. The goal is to attain the highest degree of precision, relative to the amount of information and the given time constraints.
Experience	Knowledge gained through exposure to an event or idea that has been stored in your memory. It drives information comparison and analysis. The larger experience database, the more we reduce risk, uncertainty, and the amount of information necessary to make a decision.
Human Factors	External factors that influence decision-making, often without the preconceived realization it is happening. We must learn to recognize these external factors and mitigate or control their influence in our decision-making process.

The cycle used during the analysis is known as the "OODA Loop." (Decision Making n.d.) OODA stands for the four elements: Observe, Orient, Decide, Act. (Decision Making n.d.) This cycle is quick and continuous, allowing for reaction to the changing environment quickly. An example of this process is once a unit is on location; they must first observe the situation. Secondly, they must orient themselves to shape the battlefield and influence the fight. Next, the unit must decide what to do and then act upon that decision. This must be accomplished quickly and continuously, as the enemy does not remain static. This OODA loop process falls in line with the detect, assess, and engage construct. Figure 15 is a modified version of the OODA loop that accounts for the dynamic nature of the rifle squad mission.

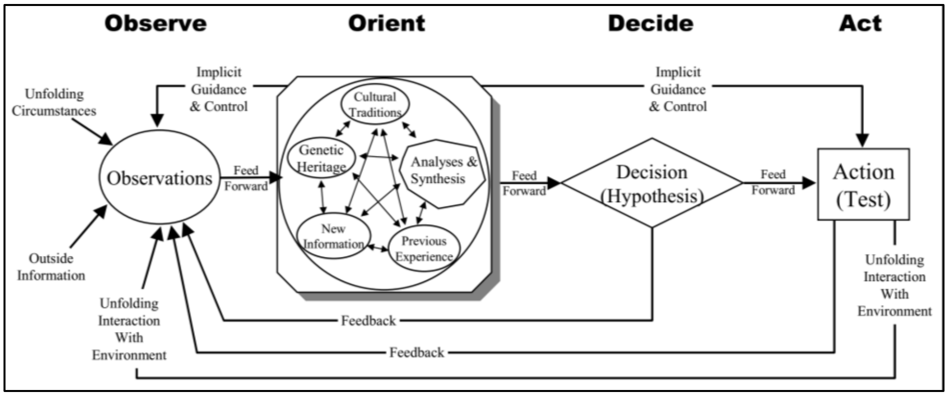

Figure 15. Modified OODA-Loop. Source: Brehmer (2005).

A way to improve the probability of success is to use the OODA loop process for each squad to operate independently in parallel, as shown in Figure 16

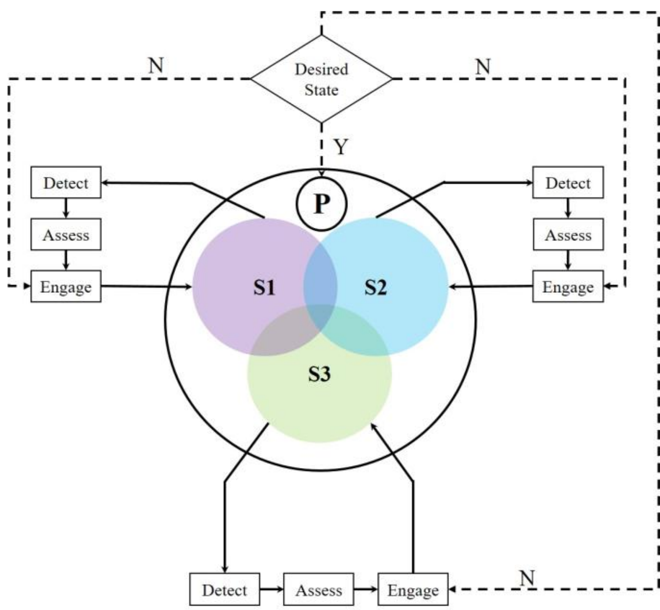

Figure 16. Squads Operating in Parallel

Table 6 provides a list of heights from 5.33 to 150 feet and distances from 2.82 to 14.94 miles. In terms of the OODA loop, as the height increases, the rifle squad can better observe the area of interest. This observation can help the squad better orient itself to engage the target. This orientation leads the squad leader to decide when and where to engage. The determination of when and where to engage leads to a more decisive action against the target. The heights are listed in columns 3, and 7 with the heading *h (ft)* and the distances are listed in columns 4 and 8 with the heading *d (mi)*. Using the approximate geometric formula for determining the distance at which a target can be detected is based on the height of the UAS. The equation is:

$$d \approx 1.22\sqrt{h} \text{ (from Horizon n.d.)} \qquad \text{Eq. 1}$$

where d = distance to the horizon and h = height of observer above sea level (ft).

Table 6. Distance versus Height

h (ft)	d (mi)		h (ft)	d (mi)		h (ft)	d (mi)
5.33	2.82		6.75	3.17		45.00	8.18
5.42	2.84		6.83	3.19		50.00	8.63
5.50	2.86		6.92	3.21		55.00	9.05
5.58	2.88		7.00	3.23		60.00	9.45
5.67	2.90		8.00	3.45		65.00	9.84
5.75	2.93		9.00	3.66		70.00	10.21
5.83	2.95		10.00	3.86		75.00	10.57
5.92	2.97		11.00	4.05		80.00	10.91
6.00	2.99		12.00	4.23		85.00	11.25
6.08	3.01		13.00	4.40		90.00	11.57
6.17	3.03		14.00	4.56		95.00	11.89
6.25	3.05		15.00	4.73		100.00	12.20
6.33	3.07		20.00	5.46		110.00	12.80
6.42	3.09		25.00	6.10		120.00	13.36
6.50	3.11		30.00	6.68		130.00	13.91
6.58	3.13		35.00	7.22		140.00	14.44
6.67	3.15		40.00	7.72		150.00	14.94

The starting point for determining the distance to a target will be based on the average height of a male, which is approximately 5.75 feet. In reviewing Table 6, the distance to a target is 2.93 miles. The issue is that if the platoon can see the target, the target can see the platoon. They both have equal response times. The goal is to detect the target without being detected and respond accordingly. Based on the assumptions, the platoon can use their resource more effectively to achieve the advantage necessary to complete the mission efficiently. Figure 17 shows a graph of the height versus the distance based on the data in Table 6. The red line depicts the baseline height from which a Marine can detect a threat with their own eyes.

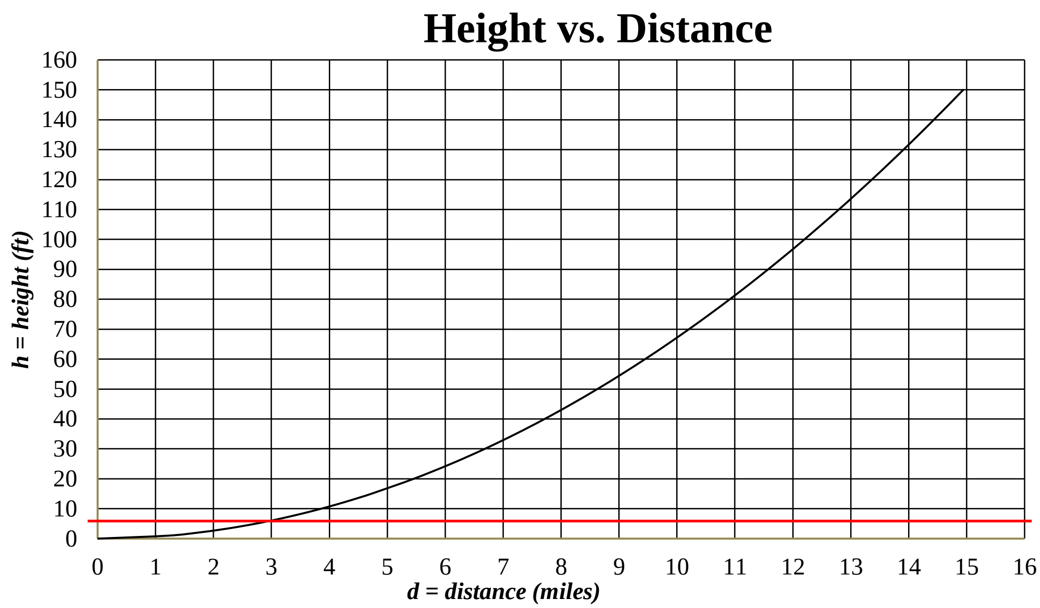

Figure 17. Height versus Distance

Figure 18 is a closer look from $d \approx 2.73 - 3.24$ miles and $h = 5 - 7$ feet tall, which is the range of humans. This height will be the baseline from which all observations occur. If a Marine can detect a threat, the potential exists for the threat can also detect the Marine. The objective is to gain an advantage. The advantage occurs when the Marine can detect a threat without being seen and have enough response time to act.

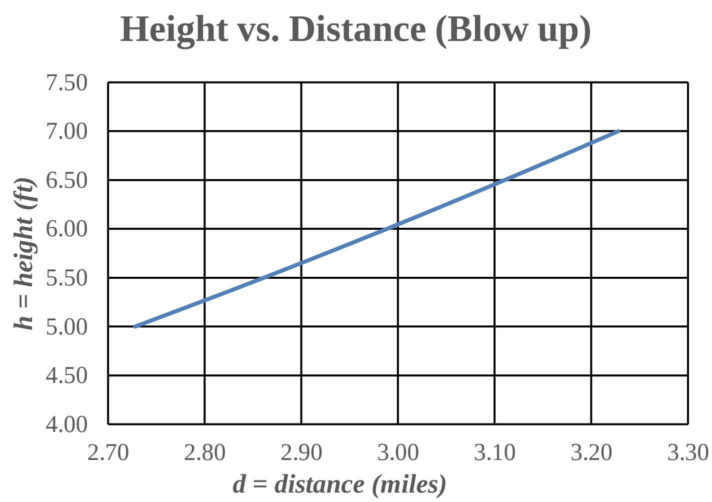

Figure 18. Height versus Distance (Magnified View)

The speed at which the commander receives the information allows more response time. Utilizing UAS assets at various heights increases the distance where potential threats can be identified. This increased distance provides the platoon commander more time to make decisions, thus giving the squads more time to adjust to a potentially dangerous situation. Figure 19 depicts a time-distance representation of this time versus distance concept, where t_1 and t_2 are the times when a target is detected with and without ISR assets, respectively. Likewise, d_1 and d_2 are the distances at which a target is detected at their respective times, with and without ISR assets, respectively. The additional time saved by the rifle squad is $\Delta t = |t_1 - t_2|$ and the additional distance gained is $\Delta d = |d_1 - d_2|$. This is possible if the rifle squad has its own ISR assets.

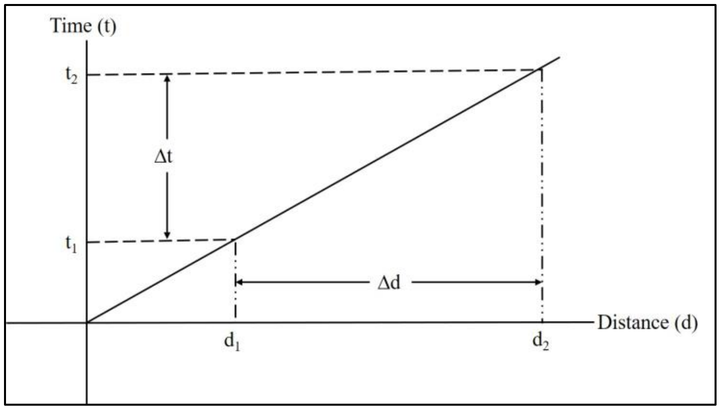

Figure 19. Time versus Distance Diagram

Understanding the time - distance concept can lead to a model to determine how effective and efficient the rifle squad can carry out its mission. The model can also help determine the probability of success for a particular mission using a certain configuration.

For this application, P(S) is given by the simplified kill chain in Equation 2:

$$P(S) = P(D) \times P(A) \times P(E) \qquad \text{Eq. 2}$$

where P(D) is the probability of detection of the threat, P(A) is the probability of assessing the situation correctly, and P(E) is the probability of a correct engagement decision/response to the threat.

In this thesis, equation two is applied qualitatively.The idea is to contrast P(D) with and without an ISR asset. The assumption is that the ISR asset results in more detections of the threat at a longer range. This implies that the result is improved reaction time and an improved assessment of the situation. This leads to an improved response to the threat.

As P(D) increases it results in an increase in P(A). As P(A) increases it leads to an increase in P(E). The overall result is an increase in P(S). A graphical representation looks like the following:

$$P(D) \uparrow \Rightarrow P(A) \uparrow \Rightarrow P(E) \uparrow \Rightarrow P(S)$$

The kill chain is a sequential process, so the overall P(S) is less than the lowest performing element. Addressing the issue of threat detection via an ISR asset improves the outcome. The case studies that follow illustrate this point

B. CASE STUDIES

Three case studies will be used to illustrate the impact of ISR asset on the various levels of the Marine Corps organization from battalion to the squad. A qualitative analysis using Equation 2 and the appropriate OODA loop

1. Case 1: Battalion UAS Support to the Squad

Figure 20 introduces Case 1, a scenario in which the battalion commander has assigned Mission X to Company Y. Company Y assigns a subset of Mission X, Mission Xa, to Platoon 2. Platoon 2 allocates task Xa-T to A Squad to execute in support of Mission Xa. This analysis will delve into the efficiency and effectiveness of Platoon 2 with respect to Mission Xa. The only echelon that has or control ISR assets is the battalion commander.

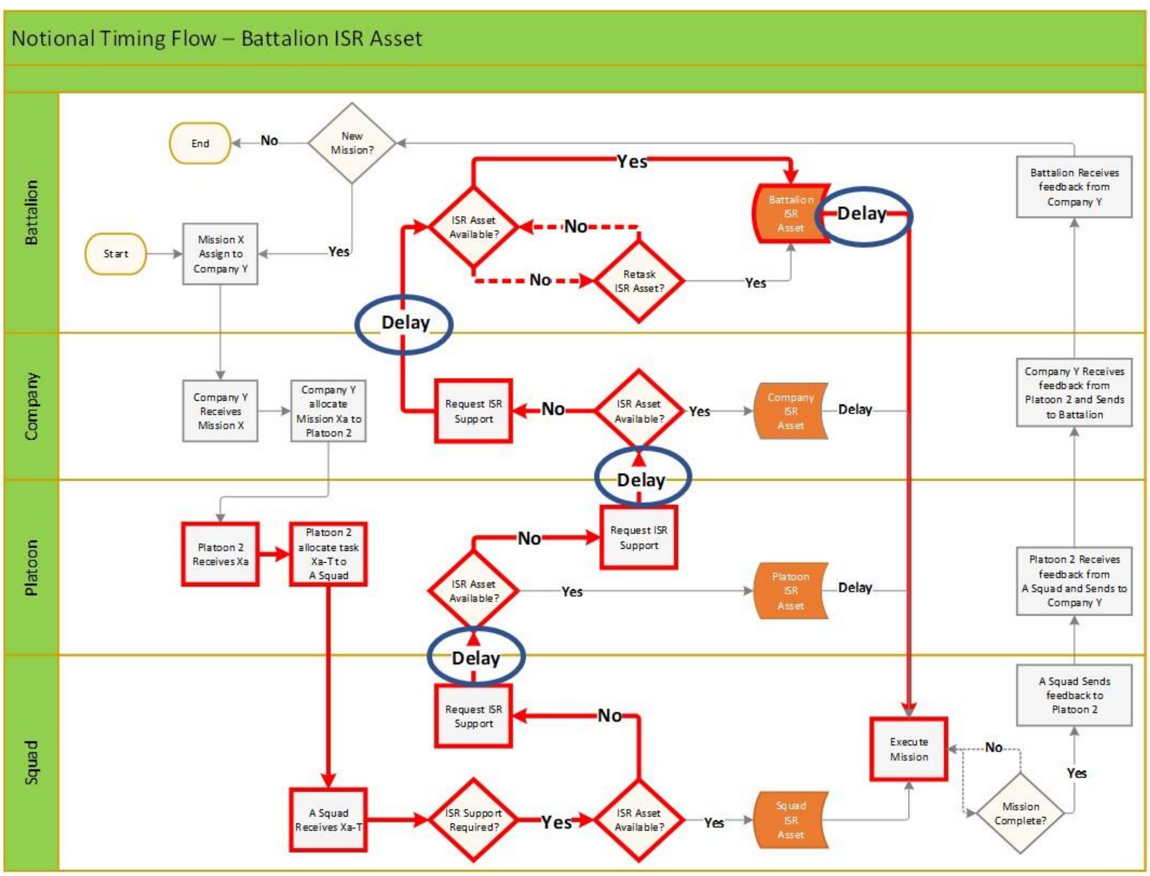

Figure 20. Notional Battalion ISR Asset OODA Loop

a. Assumptions

This scenario assumes that the target is stationary. The target area is known, but the exact target location is unknown. The units advance at an average pace of 3.4 miles per hour (mph) (Alpin-Gruppe 2009). The time, t=0, is the time at which the target is detected. The delay between the squad and the platoon and the platoon and the company and the company to the battalion is approximately 10 minutes each. The target area is approximately 6 miles away. These delays resulting in a 30-minute delay in obtaining an ISR asset from the battalion. Upon securing the ISR asset, it may take another 30 minutes to get on station and detect the target. The total delay is 60 minutes. Without knowing the enemy composition, the squad and subsequently, the rifle squad becomes reactionary with little to no time to shape the battlefield and influence the fight.

b. Discussion

Although the mission is at the platoon level, the resources at echelons above and below must be considered. For example, the battalion commander above owns and control the ISR assets and the squads below executes the tasks to support the mission. The squad requires ISR assets, which they do not have or control. The request for ISR asset support is forwarded from the squad to the platoon commander. This request introduces a delay and additional risk, which affects the efficiency of the squad executing its tasking.

The platoon commander does not have or control any ISR asset, therefore, the request proceeds further up the chain of command to the company commander. This request introduces another delay and more risk, which further affects the efficiency of the squad executing its tasking, as well as the platoon commander’s ability to effectively and efficiently accomplish Mission Xa.

The company commander does not have or control any ISR asset. Therefore, the request proceeds further up the chain of command to the battalion commander. This request introduces yet another delay and more risk. This additional delay further affects the efficiency of the squad executing its tasking, as well as the platoon commander’s ability to accomplish Mission Xa effectively and efficiently as well as the company commander’s ability to fulfill his Mission X.

The battalion commander, who does have and control ISR assets must decide if the priority of providing an ISR asset is a priority and if so, may have to re-task an asset. The squad and platoon commander are reliant on those assets to support the execution task Xa-T in support of mission Xa. Battalion priorities, however, may preclude providing support, in which the execution of task Xa-T and mission Xa will be less than optimal. On the other hand, if the priority does warrant the use of an ISR asset, the re-tasking will add delay as well as the transit of that asset to station. This additional delay along with the other delays could seriously jeopardize the success of task Xa-T, thus rendering mission Xa, in support mission X, less effective and efficient.

c. Results

The squad deploys without having knowledge of the exact enemy location. In reviewing Figure 21, it provides insight into the response time in which to engage the target. The figure also reveals that as the squad moves closer to the target, the delay severely hampers response time.

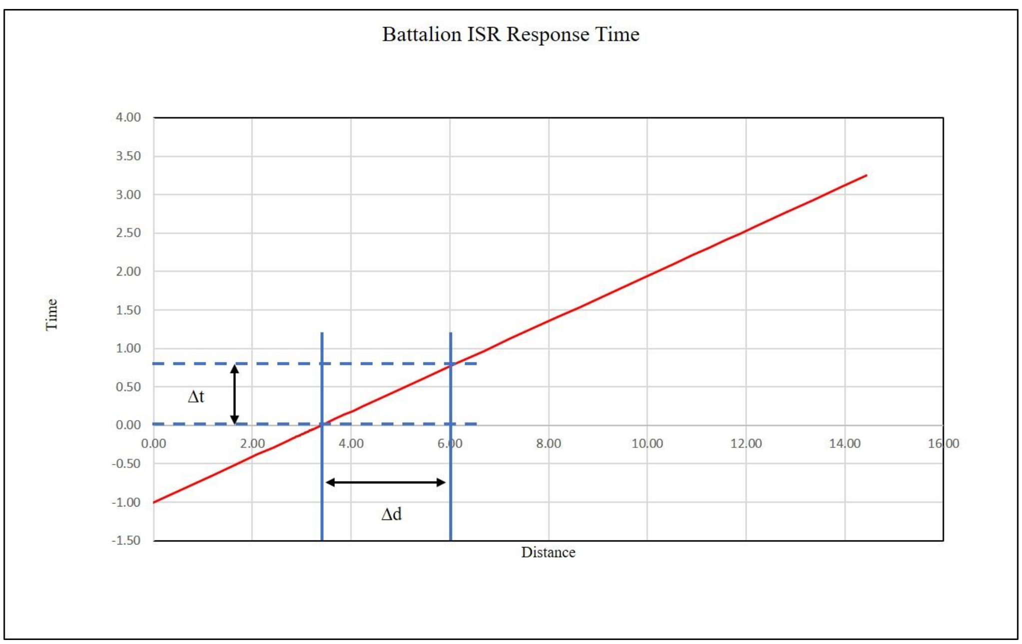

Figure 21. Battalion ISR Response Time

Due to the delay of 60 minutes to detect the target, the time to respond is Δt, approximately 48 minutes, could significantly affect mission success. As the rifle squad advances toward the target, the risk of detection increases while the response time decreases. The opportunity missed at engaging the target at a place and time of the rifle squad's choosing could lead an undesireable outcome.

2. Case 2: Platoon UAS support to Squad

Case 2 will use the same scenario as in Case 1. The difference is that the platoon commander has and control ISR assets, which can be deployed in support of the squad in the execution of task Xa-T, as shown in Figure 22. This request introduces further delay and more risk, which affects the efficiency of the squad, as well as the platoon commander's ability to accomplish Mission Xa effectively and efficiently.

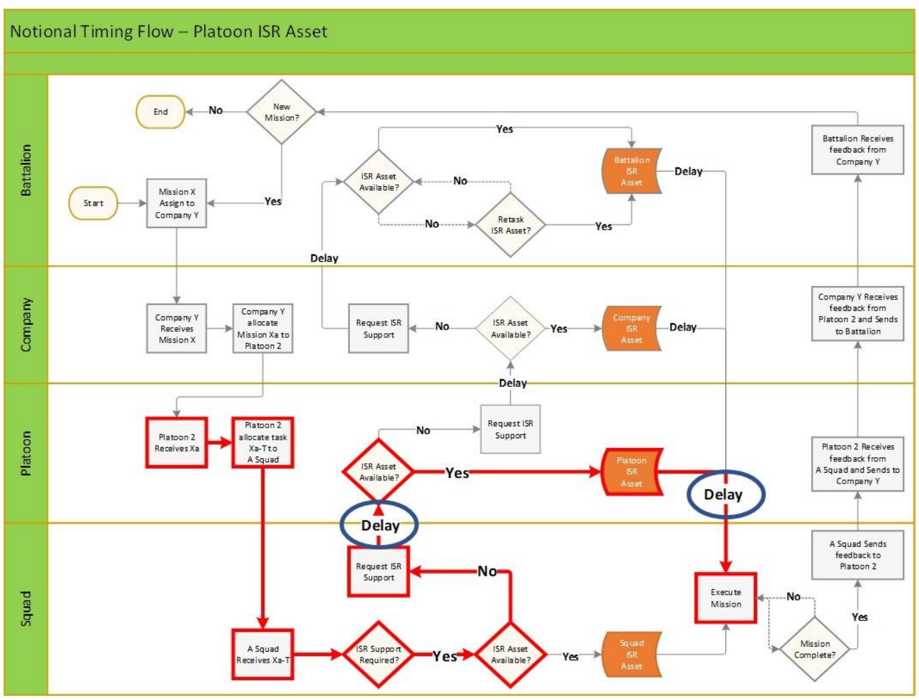

Figure 22. Notional Platoon ISR Asset OODA Loop

a. Assumptions

This scenario assumes that the target is stationary. The target area is known, but the exact target location is unknown. The units advance at an average pace of 3.4 miles per hour (mph) (Alpin-Gruppe 2009). The time, t=0, is the time at which the target is detected. The delay between the squad and the platoon is approximately 10 minutes each. The target area is approximately six miles away. Figure 25 is a graphical representation. Upon securing the ISR asset, it may take approximately 15 minutes to get on station and detect the target. The total delay is 25 minutes. Without knowing the enemy composition, the squad and subsequently, the rifle squad becomes reactionary with little to no time to shape the battlefield and influence the fight.

b. Discussion

As alluded to earlier, the platoon commander owns and controls the ISR assets and the squads below execute the tasks to support the mission. The squad requires ISR assets, which they do not have or control. As with Case 1, the request for ISR asset support is forwarded from the squad to the platoon commander, which is approximately 10 minutes. The deployment from the platoon to assist the squad in detecting the target is approximately 15 minutes, resulting in a total of 25 minutes. This request introduces a delay and additional risk, which affects the efficiency of the squad executing its tasking.

For example, a platoon has been given a specific mission, Mission X. That mission is then decomposed into various efforts, Effort $X_{1\ldots n}$, which are allocated to squads 1 through 3. The platoon commander controls the UAS to observe and direct the efforts of the squads (Figure 23).

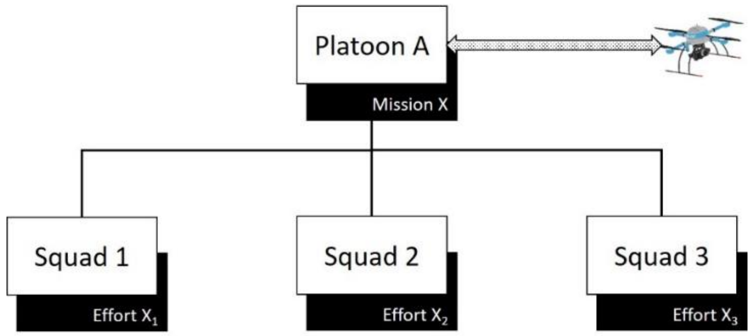

Figure 23. Mission Allocation - Platoon

The platoon can be more flexible when the UAS is controlled by the platoon commander. This configuration can improve effectiveness in that the platoon can be more agile in executing its mission. The agility would be based on information flow from the UAS versus information received from higher authority, which could possibly be invalid at that time. Although there are gaps in this configuration, the platoon commander can amass the squads where they can engage a target more efficiently and be more effective at achieving the goal of the platoon. Also, this configuration increases the platoon's footprint with respect to range r_1, as shown in Figure 24.

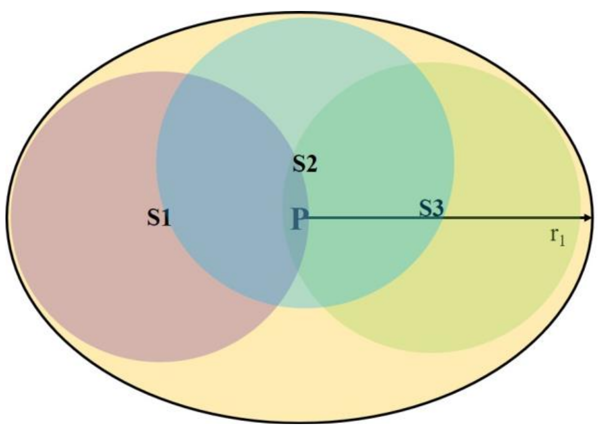

Figure 24. Platoon Footprint with Platoon Leader Control

c. Results

As with Case 1, the delays introduced poses a loss of opportunity of the rifle squad to engage at a time and place of their choosing, again leading to a less than desired outcome. The delay also introduces risks of the squad being compromised and becoming the target of the enemy, albeit less risky than that with Case 1. Once again, the rifle squad becomes reactionary with a little more time to shape the battlefield and influence the fight than that of Case 1.

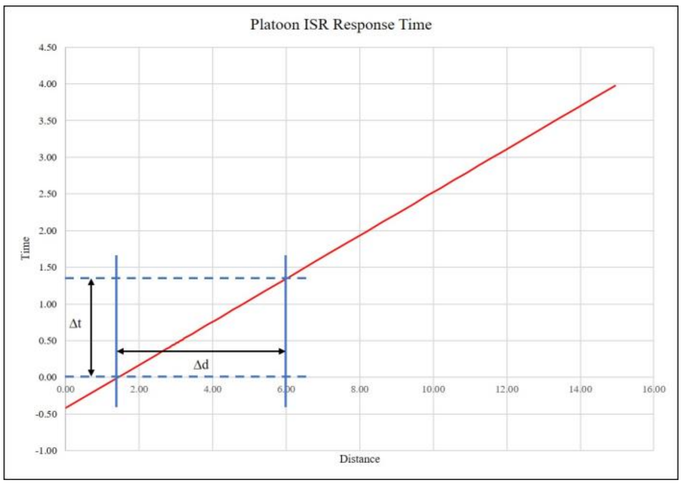

Figure 25. Platoon ISR Response Time

A delay of 25 minutes to detect the target, the time to respond is Δt, approximately 84 minutes, is greater than that of Case 1. However, mission success could be impacted. Engaging the target at a place and time of the rifle squad's choosing, may not be ideal but could lead to a satisfactory outcome.

3. Case 3: Squad owns/controls UASs

Case 3 will use the same scenario as in Case 1 with the difference being the squads have or control their own ISR asset, as shown in Figure 26. The squad requires ISR assets, which they have or control. The squads can deploy those assets in the execution of task Xa-T. There is no delay and minimal risk, which improves the efficiency of the squad, as well as the ability to accomplish Mission Xa effectively and efficiently by the platoon commander. The target can be detected at further ranges providing sufficient time to shape the battlefield and influence the fight.

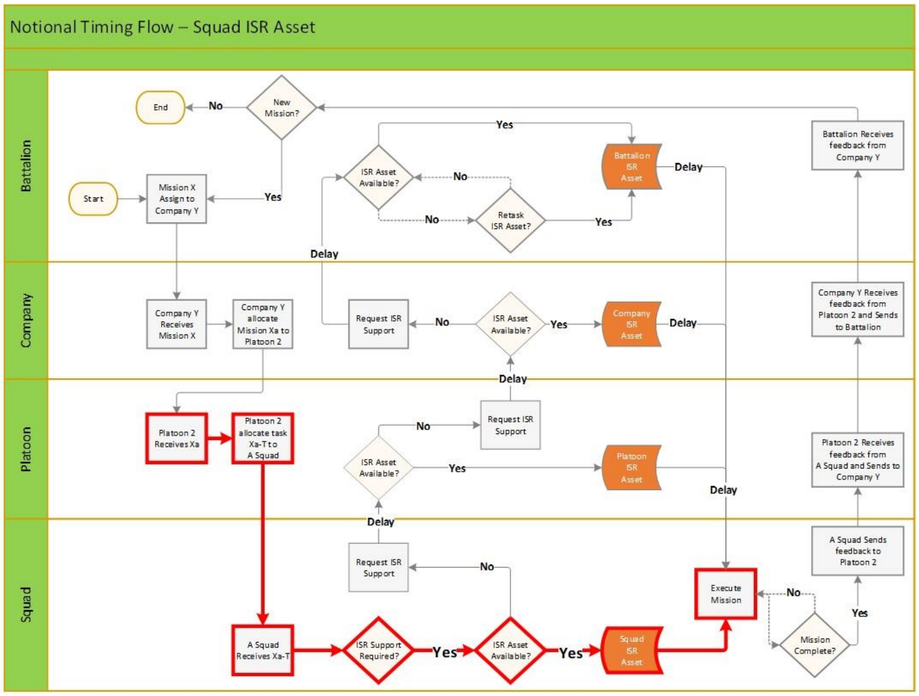

Figure 26. Notional Squad ISR Asset OODA Loop

a. Assumptions

This scenario assumes that the target is stationary. The target area is known, but the exact target location is unknown. The units advance at an average pace of 3.4 miles per hour (mph) (Alpin-Gruppe 2009). The time, t=0, is the time at which the target is detected. The target is six miles away.

b. Discussion

As a follow-on to Case 2, the squads, in the execution of its specific efforts, Effort $X_{1 \ldots n}$, have and control their own UAS (Figure 27). The squads, possibly dispersed in different sectors, can employ their UAS, which make the squads much more flexible and effective and efficient but also dramatically increases the squad's footprint and forward presence. This configuration allows the squad leaders to make decisions quicker, thus possibly engaging the target at opportune times, which is advantageous to the squad.

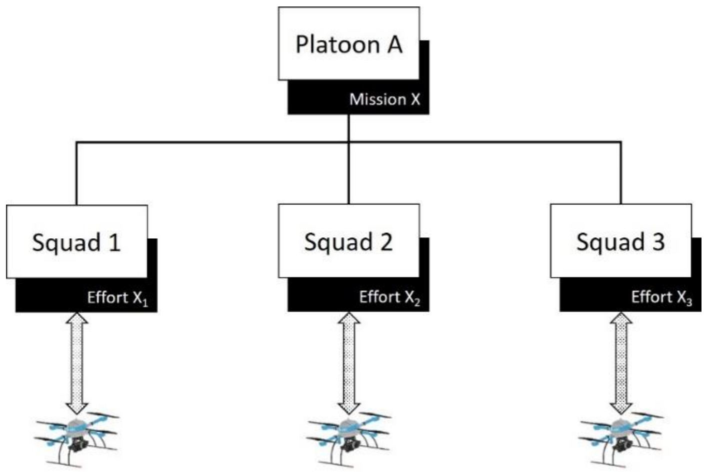

Figure 27. Mission Allocation – Squad

c. Results

There are minimal delays, thus minimizing the risk of the squad being compromised and becoming the target (see Figure 28). In this case, the squad can be more proactive in shaping the battlefield and influence the fight than that of Case 1 or Case 2, which are reactionary situations

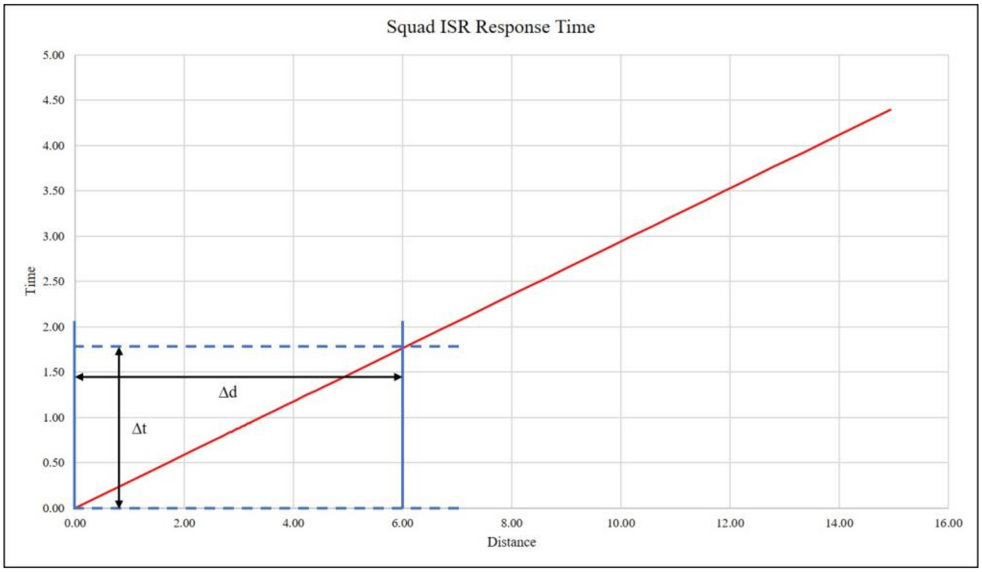

Figure 28. Squad ISR Response Time

With the target detected almost immediately, the time to respond, Δt, is at its maximum at approximately 108 minutes. The squad has the maximum opportunity to engage the target at a place and time of the squad's choosing. It may not be ideal but could lead to a satisfactory outcome.

Each squad can cover more ground and extend the range of the platoon. As the squads move in different sectors, they have their own UAS and can provide the squad leader with more accurate information from further distances, r_2, as depicted in Figure 35, effectively increasing the squad's footprint. Effectiveness and efficiency also increase because the squads can quickly act against a perceived threat, increasing the likelihood of mission success by the squad.

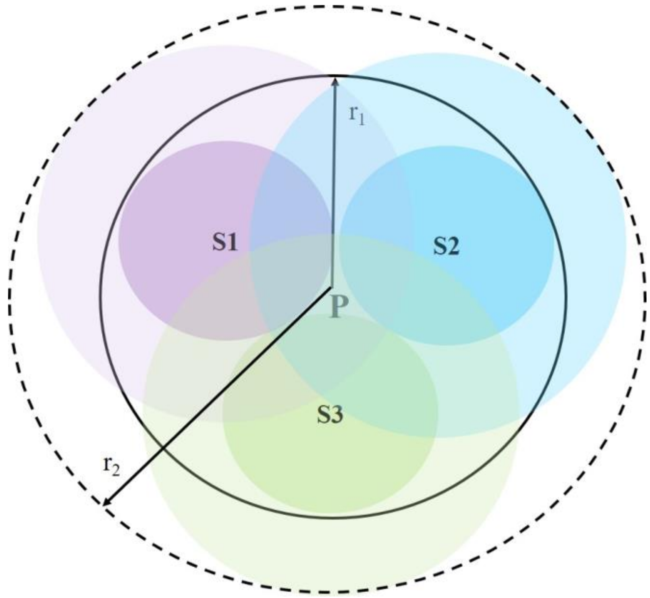

Figure 29. Platoon Footprint with Squad Leader Control

One advantage of having squad-organic UAS assets is the squad leader can deploy those assets more effectively to provide the necessary intelligence. Another advantage is an increase in engagement space and response time. As the detection distance increases, the adversary can be engaged at farther distances, at a time and place that is advantageous to the success of the mission. The total footprint increases from r_1, the platoon commander controlled UAS footprint, to r_2, the squad leader controlled UAS footprint.

"Marines operate in the spirit of and are guided by, the philosophy of maneuver warfare." as quoted by General James F. Amos, "The Marine Corps is America's Expeditionary Force in Readiness" (Amos 2010) exemplifies this philosophy in that the Marines can maneuver to any part of the world for any mission, from humanitarian to crisis intervention. Once the Marines are in location, the squad is that maneuver unit that can be ready to deploy quickly to perform specific missions as directed by their commanding officers. The efficiency and effectiveness of the squad can be enhanced by the use of organic mini/micro unmanned aerial systems (UASs). To reiterate the problem, the lack of organic ISR assets during operational deployment, the squad may be less effective and efficient in an unconventional or asymmetrical scenario, thus reducing overall mission effectiveness and efficiency. There are two assumptions that apply to all of the following potential vignettes: 1) the UAS must be under positive control at all times and 2) there is a clear line of sight from the user to the UAS.

C. DOTMLPF-P

The intent of this thesis to identify a capability that could help the Marine rifle squad become more effective and efficient. The previous statement implies a capability gap exists, as shown in Figure 5 in Chapter I. Therefore, an analysis is required to determine if a capability gap exists. The analysis that is most commonly used within the Department of Defense (DoD) is the Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) analysis. (DAU 2018)

To examine DOTMLPF-P further, each area is decomposed and analyzed to determine if it applies to the development of a new capability. According to the Defense Acquisition University Acquisition Encyclopedia, DOTMLPF-P analysis is defined in Table 7.

Table 7. DOTMLPF-P Summary. Source: DAU (2018).

Analysis Area	**Meaning**
Doctrine (D)	examines the way the military fights its conflicts with emphasis on maneuver warfare and combined air-ground campaigns to see if there is a better way that might solve a capability gap
Organization (O)	examines how a group is organized to fight; divisions, air wings, Marine-Air Ground Task Forces and other. It looks to see if there is a better organizational structure or capability that can be developed to solve a capability gap
Training (T)	examines how forces are prepared to fight tactically from basic training, advanced individual training, various types of unit training, joint exercises, and other ways to see if improvement can be made to offset capability gaps
Materiel (M)	examines all the necessary equipment and systems that are needed by forces to fight and operate effectively and if new systems are needed to fill a capability gap
Leadership and Education (L)	examine how leaders are prepared to lead the fight from squad leader to flag level and their overall professional development
Personnel (P)	examines availability of qualified people for peacetime, wartime, and various contingency operations to support a capability gap by restructuring
Facilities (F)	examines military property, installations and industrial facilities (e.g., government-owned ammunition production facilities) that support forces to see if they can be used to fill in a capability gap
Policy (P)	any DoD, interagency, or international policy issues that may prevent effective implementation of changes in the other seven DOTMLPF-P elemental areas

In the context of a system of systems, the rifle squad is one system and the ISR asset type identified in the following chapter would be another system within the system of systems. Performing a DOTMLPF-P analysis on the system of systems could provide opportunities for changes to one or more of the DOTMLPF-P elements.

The doctrine (D) for warfighting, Marine Corps Warfighting Publication (MCWP) 3–11.1, for the rifle squad should not change. The basic concept for the rifle squad is to defeat the enemy. MCWP 3–11.1 outline all the necessary functions in which the rifle squad should operate. If there is a change, it should address the asymmetric/unconventional warfare operations. Because of the way the adversary will fight in asymmetric/unconventional warfare, the rules of engagement should change.

The organization (O) has changed, per the CMC direction. The rifle squad has been changed to address the intelligence gap. The squad systems operator role will need to be identified. The CMC stated that "the systems operator will be the most tech-capable Marine in the formation" (Smith 2018). The role of the systems operator requires definition. A recommendation could be an intelligence-savvy Marine that has skills operation nano/micro UASs and can interpret the data.

The training (T) is covered within the existing warfighting publications. The training for the systems operator will need to be incorporated into the various tactics executed within the rifle squad. The CMC also stated the systems operator will come from the infantry ranks; no new Military Occupation Specialty (MOS) (Smith 2018). The systems operator will require training for the recommended nano/micro UAS and each particular system that will be used during a mission. Identification of the system operator role will clarify the requisite training needed for successful system employment.

The rifle squads are equipped with specific equipment, known in the acquisition community as materiel. The materiel (M) solution required for the new rifle squad to be successful needs to change. The CMC stated the material needs to be lighter (Smith 2018) because the squad may be smaller depending on the squad size determination. The recommendation of a nano/micro UAS as part of the materiel solution will require the systems operator to take control, maintain, and operate the unit.

The leadership and education (L) portion of DOTMLPF-P requires partial changes. The rifle squad is led by a sergeant, and that leadership part will not change, but the education part has to change. The sergeant will need to learn how to utilize the systems operator and the specific systems the rifle squad will employ.

The personnel (P) will change due to the employment of a systems operator. Identifying the most tech-capable personnel within the infantry can prove to be the most challenging. Depending on what systems employed by the rifle squad, the most qualified candidate might not be available to employ the system adequately. Defining the role of the systems operator would aid in the identification of the most capable Marine.

Exploring the facilities (F) requirements leads to the conclusion that no new facilities are required. Depending on the systems employed, particularly nano/micro UASs, there will be a need for space to store and repair systems, to include spares and spare parts at existing facilities.

As with any change in organizational changes, new policies (P) are usually developed to explain and outline the change. The development of a policy for the rifle squad changes is uncertain. Provided the requisite information is captured in the other elements of DOTMLPF, a new policy will not be required.

D. SUMMARY

The three cases above demonstrated how P_S improved as smaller units owned or controlled their own ISR assets. The rifle squad became more effective and efficient because units below, the squad level, became more effective and efficient. Utilizing the OODA Loop process with ISR assets increased situational awareness and minimized uncertainty, thus improving squad response time to act or react to a situation. Improving response time reduces risk, and potential casualties while increasing the probability of mission success.

Assuming the squad leaders always have positive control and a clear line of sight to the UAS, they can receive real-time or near real-time information as opposed to information provided by higher authority, which could be invalid at the time of mission execution. As a squad leader can orchestrate a mission via control of a UAS, the detection of a threat is increases, therefore increasing the squad footprint and the ability to detect more threats. Table 8 shows that the detection range increases with an increase in the height of the UAS.

Figure 30 shows how improved survivability and operational effectiveness are both dependent on and support the use of integrated ISR assets.

Figure 30. Impact of ISR on Survivability. Source Soh (2013).

The following chapter will identify several examples of nano/micro UAS systems, of which some have been deployed and used in real-world activities, while others are still in development.

V. TYPES OF NANO/MICRO UAS

This chapter, as outlined in Figure 31, provides a sample of available Nano/Micro UASs available in the market. Several have been used with law enforcement agencies as well as other governments.

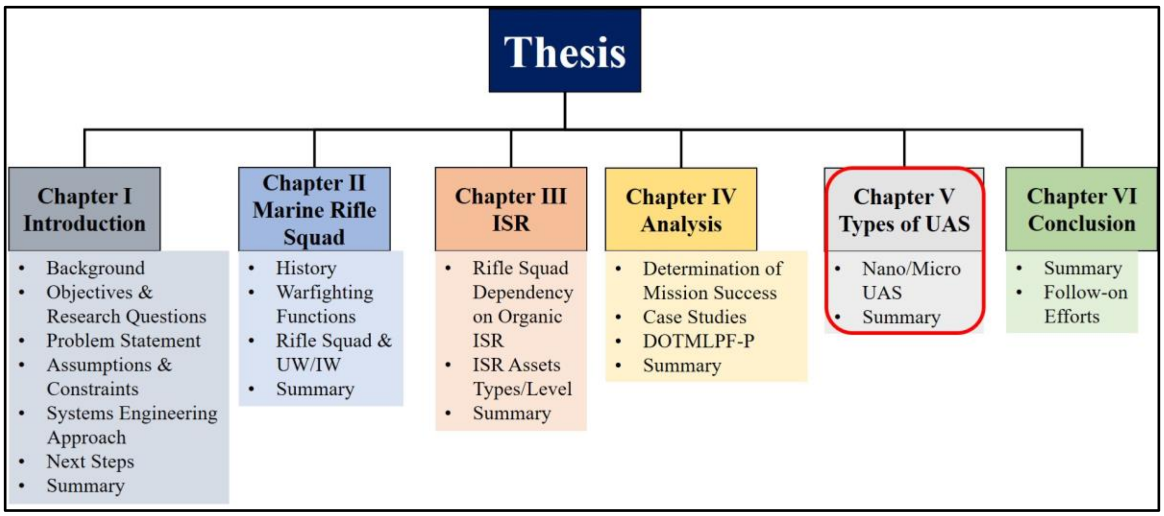

Figure 31. Chapter V Outline

This chapter will introduce potential solutions that could provide the rifle squad can improve with an increase in response time, thereby improving rifle squad effectiveness and efficiency.

A. NANO/MICRO UAS

1. Qube

The Qube, shown in Figure 32, “is a rugged and reliable small UAS primarily used for public safety purposes. This system can be easily stored and assembled within five minutes. It provides real-time video transmission to the operator and can carry out missions such as searching for suspects or missing persons, standoff or hostage situations, accident or crime scenes, fire-fighting support, disasters, and explosives or bomb disposal response” (Chua 2012, 4).

Figure 32. Qube UAS by Aerovironment. Source: Chua (2012).

2. PD-100

The PD-100, Figure 33, "is the first airborne and commercially available Personal Reconnaissance System. It provides end users with a highly mobile sensor system providing an immediate" ISR capability (PD-100 2017). The "Black Hornet 2 nano-sensors are inherently safe and pose virtually no risk to other air vehicles or personnel, allowing the system to be operated almost anywhere at any time" (PD-100 2017). "The Black Hornet's small size and electric motors make it virtually inaudible and invisible beyond short distances."

Figure 33. PD-100 Black Hornet PRS. Source: PD-100 (2017).

Table 8 provides the specifications of the PD-100, the types of missions, and the utility benefits.

Table 8. PD-100 Specification. Source: PD-100 (2017).

Specifications & Features	Types of Missions	Benefits
Rotor span – 120 mm	Search and rescue	Transportable—complete system fits inside a pocket
Mass – 18 g, including cameras	Reconnaissance in confined areas	Ready to fly—airborne within one minute
Maximum speed – 5 m/s	Look behind, between and below obstacles	Fly it anywhere—in confined areas and outdoors
Endurance – up to 25 min	Birds-eye view for situational awareness	Stealth—small and inaudible
Digital data link—beyond 1600 m line-of-sight	Object identification	Easy to operate—requires little training and no pilot experience
GPS navigation or visual navigation through video	Proximity surveillance	Safe—represents no risks to other aircraft or personnel
Autopilot w/autonomous and directed modes	Crowd control	Affordable—reusable or expendable
Hover & Stare, preplanned routes	Inspect nuclear installations	
Steerable EO cameras (pan/yaw and tilt)	Check chemical plants after incidents and accidents	
Live video and snapshot images		

3. Snipe

Another nano UAS is the Snipe system, as shown in Figure 34, manufactured by AeroVironment, which is designed to support close-range ISR missions. According to AeroVironment vice president, Kirk Flittie, "Snipe enables operators to spring into action quickly" (International 2017).

Figure 34. Snipe System. Source: International (2017).

"No assembly is required for the five-ounce (140-gram) nano UAS, which is designed to be worn by its operator so it can be deployed in less than a minute" (International 2017). Snipe is "equipped with electro-optical/infrared (EO/IR), low-light-capable and long-wave infrared (LWIR) sensors in an integrated tilt mechanism. Snipe can relay high-resolution images and record real-time video both day and night. Also, Snipe's integrated UHF radio provides for excellent non-line-of-sight operation" (International 2017). "Snipe is difficult to detect in operating environments with even minimal ambient noise" because of "its quiet electric motors, flight speeds exceeding 20 mph and more than one-kilometer range" (International 2017). The drone "is capable of operating under challenging environmental conditions—including winds of over 15 mph with gusts up to 20 mph" (International 2017). "Snipe is controlled using an app on a standard, ruggedized (MIL-STD 810) touch-screen controller" and has a useful feature of having the "ability to return to its operator automatically if it loses its radio link" (International 2017).

4. Dragonfly

Figure 35 shows the Dragonfly-inspired drone "being explored by the Ministry of Defence as part of a new defense initiative by the U.K. government. The Skeeter micro-drone was designed by Oxford-based startup Animal Dynamics to mimic the aerial abilities of dragonflies, complete with flapping wings for 'unparalleled levels of performance'" (Cuthbertson 2016). The Dragonfly is made of a "multifunctional composite structure with embedded smart electronics enabling autonomous flight" (Cuthbertson 2016). It uses technology that “enables day/night intel gathering and high-speed obstacle avoidance techniques” (Cuthbertson 2016).

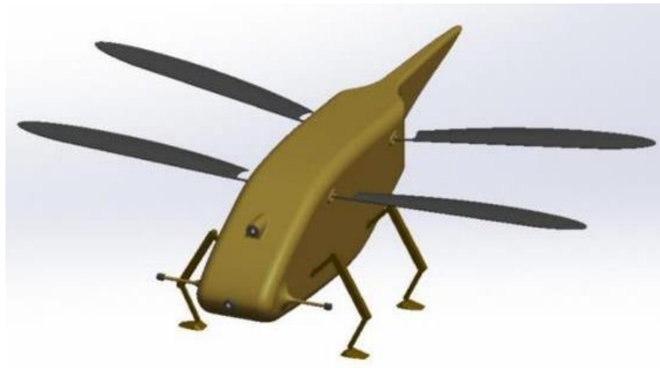

Figure 35. Dragonfly. Source: Cuthbertson (2016).

5. Draganflyer X6

The Draganflyer X6, Figure 36, “is small enough to fly indoors and has a unique design to maximize thrust which helps reduce the sound output to only 60 decibels. The UAV provides real-time video as well as telemetry to the operator. The system has multiple interchangeable camera modules, which include a thermal imaging camera. It also uses video goggles and a remote controller” (Chua 2012).

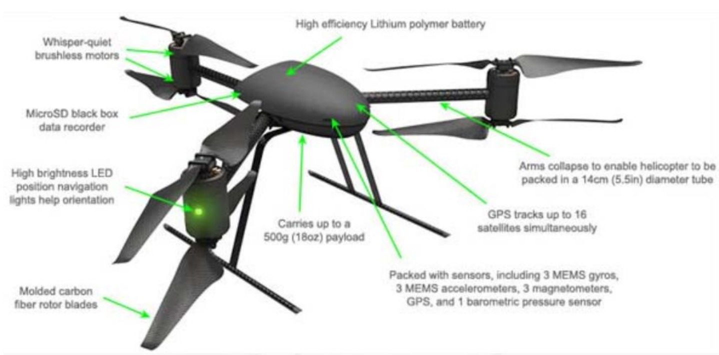

Figure 36. Draganflyer X6 by Draganfly Innovation, Inc. Source: Chua (2012).

6. Shrike

Chua has noted that the "Shrike VTOL system is designed for front-line day or night ISR missions, Figure 37. It can operate in hover-and-stare or perch-and-stare modes while transmitting real-time information to the common ground control station (GCS) via a digital data link. It weighs about 2.27 kg" and can hover up to 40 minutes. It also can "perch in discrete locations, from which it can transmit for several hours before returning to base" (Chua 2012).

Figure 37. Shrike by AeroVironment. Source: Chua (2012).

The aforementioned UASs, except the PD-100 and the Dragonfly units, have been deployed and used in real-world applications. The PD-100 has been tested and demonstrated by the Marines, and the Dragonfly is in development. All show great promise for the application envisioned within this thesis. The goal is to reduce the risk to Marines as well as increase the opportunity to act/react to enemy action.

B. SUMMARY

Technology has advanced and can provide tactical units with smaller, lighter UASs that can be deployed at the squad levels. Six of the many nano UASs, the Qube, the PD-100 Black Hornet, the Snipe system, the Dragonfly, the Draganflyer X6, and the Shrike VTOL have unique design and characteristics. However, they all can provide the requisite information to the squad leader. Some of these nano UASs have been used in real-world applications and proven to provide the necessary information that can be transformed into intelligence.

The following chapter will summarize the thesis and provide recommendations for follow-on efforts.

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VI. CONCLUSIONS

This chapter, as shown in Figure 38, summarizes the findings and provides recommendations for follow-on efforts.

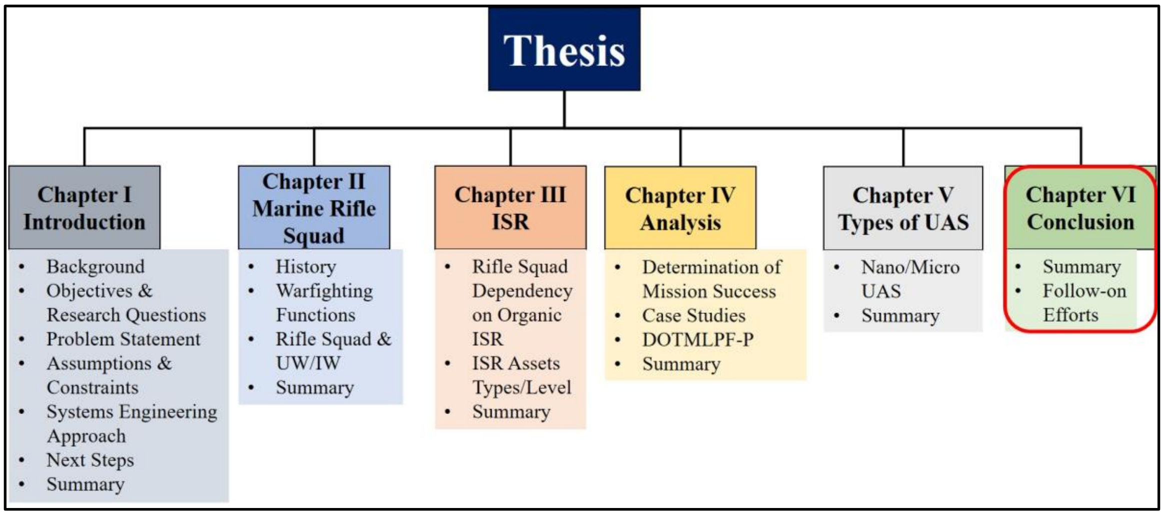

Figure 38. Chapter VI Outline

This chapter summarizes how mission success can improve with an increase in response time, thereby improving rifle squad effectiveness and efficiency. As depicted in the U.S. Army, “accurate, timely intelligence allowed coalition forces to be proactive rather than reactive, often disrupting the enemy during the planning or implementation phase of an operation” (Harris 2009).

A. SUMMARY

The purpose of this thesis was to examine how effective the Marine rifle squad is in unconventional warfare with the use of an ISR asset. Does the functional allocation within the rifle squad organization support organic ISR implementation, and what are the technological/organizational gaps to support organic ISR implementation?

With respect to the rifle squad effectiveness in unconventional warfare, the answer will depend on what policy changes will be required to account for the rules of engagement.

In unconventional warfare, the adversary is not the usual state actors, but non-state actors. The non-state actors do not operate the way state actors do, thus leading to the likelihood of different rules of engagement. Non-state actors are not affiliated with the country in which they operate. An example is a terrorist organization operating within a country that is not part of that country's government. The terrorist organization does not have to comply with any of the rules that govern how that government engages adversaries.

The use of an ISR asset could help the rifle squad become more effective because the employment of the ISR asset allows for early detection and an increase in reaction time. The data in Table 7 show how the detection range is based on the height of the ISR asset. Furthermore, as the detection range increase, so does the response time, as shown in Figure 34. The better the response time, the better the decisions by the squad leader.

The squad leader can decide where and when to engage an adversary, improving the effectiveness of the rifle squad. The more effective the rifle squad, the more effective the rifle platoon. The newly organized rifle squad has a systems operator to employ whatever system is required. The effectiveness will also depend on how effective the system operator can operate an ISR asset and interpret the data to provide to the squad leader.

The advent of a new role, systems operator, in the new rifle squad, support the functional allocation does support organic ISR implementation. The systems operator will provide the requisite functions to provide the necessary information to the squad leader. This information will allow the squad leader to make more informed decisions on how to disburse the fire teams. This information will also allow the squad to engage the adversary at a time and place of the leaders choosing. This engagement would and should be advantageous to the squad leading to a more effective and efficient campaign.

Originally, there was an organizational gap to support organic ISR implementation. However, that issue was resolved with the changes to the rifle squad. The CMC deemed it necessary to provide a more capable rifle squad with the addition of the systems operator. The role of the operator has not yet been defined. The CMC states that the systems operator will be the most tech-capable Marine and will come from the infantry. Being tech savvy does not equate to the ability to operate ISR assets. The training required may eventually lead to additional duties to a current technical MOS.

A DOTMLPF-P analysis was performed to determine the impact of the new rifle squad and nano/micro UAS integration. The overall view is that some areas require modifications to take full advantage of the implementation. For instance, the doctrine requires some modification to clarify the change to the rifle squad. The organization needs to clarify the role of the systems operator and to ensure there are qualified Marines to operate the recommended ISR assets. Training will be required to take full advantage of those Marines that are most tech-capable. The materiel solution will be the recommended nano/micro UAS. The leadership will not change; however, the education of the leader is required to understand how to employ the systems operator in the rifle squad's tactical operations. The personnel have changed with the addition of the systems operator and the number of Marines within the new rifle squad. No new facilities will be required. The current facilities will suffice. Lastly, no new policy will be required, provided that the other elements of DOTMLPF-P have been addressed.

B. CONCLUSION

This thesis concludes that an ISR capability needs to be at the squad level. The rationale is the fight is executed at the squad level via the fire teams. As the squads move toward a target, the threat should be identified as soon as possible. The squad leader needs the capability to adjust the teams to engage the threat using near real time data. Otherwise, the squad is at risk of moving into an unfavorable situation, which could lead to less than favorable results.

Changes in training, tactics and procedures are required to account for the new configuration within the rifle squad. Regardless of the outcome, each marine is still a rifleman.

C. POTENTIAL FOLLOW-ON EFFORTS

As technology continues to evolve, the nano/micro UAS capability will continue to improve. An investigation into a quieter UAS platform, be it the motor technology, the blade technology or some other means to make the unit quieter. The goal is to provide the rifle squad a capability that can detect a threat and not compromise their position.

Autonomous nano/micro UAS networks could be another follow-on effort. This capability would allow each squad's nano/micro UAS to automatically connect to another nano/micro UAS within the platoon. The network would allow the transfer of data, which could be transformed into information that would provide the platoon leader better situational awareness of the battlespace. This SA allows the platoon leader deploy the rifle squads at a time and place that is advantageous for a successful mission.

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