

ARMY, MARINE CORPS, NAVY, AIR FORCE



SPACE DEGRADED/ CONTESTED OPERATIONS STUDY

BY THE C2, SPACE,
CYBER
TEAM

03 FEBRUARY 2017

MULTI-SERVICE TACTICS, TECHNIQUES, AND PROCEDURES

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EXECUTIVE SUMMARY

SPACE DEGRADED/CONTESTED OPERATIONS STUDY

Chapter I Overview

Chapter I provides background information on the study, including its purpose, scope, historical perspective, problem statements, and research methodology.

Chapter II Findings

Chapter II describes what is in existence in current joint and Service doctrine and tactics, techniques, and procedures publications. It provides Service input by detailing subject matter expert perspectives on how to best solve the space degraded/contested operations problem.

Chapter III Conclusion

Chapter III gives recommendations. It also provides courses of action for Air Land Sea Application Center leaders' consideration.

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Chapter I OVERVIEW

1. Purpose

Air Land Sea Application (ALSA) Center action officers studied space degraded/contested operations to determine if a multi-Service tactics, techniques, and procedures (MTTP) gap exists across the Services. Subject matter experts (SMEs) provided input, interest, and concern for this study.

ALSA's research focused on understanding how each Service operates in a space degraded/contested environment, with associated doctrine, and how the joint force continues to operate when space access is unavailable. All the Services recognize internal challenges they face without space access, however, the multi-Service implications are still undeveloped.

2. Scope

The study was designed to help warfighters understand how to mitigate the tactics, techniques, and procedures (TTP) gap. Action officers did this by analyzing joint and Service doctrine and obtaining Service perspectives. Service perspectives were obtained from SMEs and are not official opinions of Service doctrine centers. ALSA determined this study should focus on the two major capabilities that tactical level warfighters depend on to operate in combat: position, navigation, and timing (PNT) and satellite communications (SATCOM).

3. Background and History

The United States (US) military depends on space capabilities to prosecute modern warfare. From the late 20th century to present day, the US military has maintained a technological dominance over its adversaries. However, changes in space technology have made a majority of space technology available to adversaries. Therefore, the US will face future threats that can reduce or negate its technological edge. Additionally, the next conflict the US faces may be against a near peer threat that can degrade or deny US access to space or destroy in-orbit space assets. The US military must train to detect and identify degraded space access, specifically for PNT and SATCOM, and be able to operate in degraded environments. Additionally, there must be documented TTP that provide the PNT or SATCOM user a means to restore, or request assistance to restore, degraded space technology-dependent systems.

4. Methodology

ALSA reviewed current joint and Service doctrine, queried joint and Service centers for lessons learned, attended training forums, and surveyed Service SMEs to determine existing doctrinal gaps and interoperability issues which would necessitate developing an MTTP titled, *Space Degraded/Contested Operations*. Early in the process, the ALSA action officers discovered there are no specific doctrinal references for operating in a space degraded/contested environment. However, there are United States Army Space and Missile Defense Command (USASMDC)/Army Forces Strategic Command (ARSTRAT) products that provide tactical-level users TTP to assist with determining if

they are in a degraded environment and how to mitigate the effects, but the publications do not address multi-Service integration.

As the research progressed, ALSA action officers found more studies, tests, and experiments. Each Service is attempting to understand the military space dependency risks and find solutions to, or create resiliency in, access to space. The action officers found, for instance, the threats that face the force are quickly evolving to take advantage of cheap and capable commercial off-the-shelf technology and military-grade capabilities that can have impact on US military operations.

Chapter II FINDINGS

1. Existing Doctrine and TTP Analysis

a. Overview. No joint or Service doctrine publication directly addresses the TTP related to fighting in a space degraded/contested environment. At a minimum, there are TTP that will directly affect the way the US Marine Corps and US Army conduct operations in a space degraded environment. A space degraded/contested operations MTTP publication will create a single-source, multi-Service document capable of informing US forces of steps to identify space degraded/contested environments and mitigate the degradation effects.

b. Joint Doctrine. Space degraded/contested operations are mentioned briefly in joint publications, but the publications fail to provide procedures for the joint force. Joint publication (JP) 3-14, *Space Operations*, refers to the challenges faced by the joint force during periods of limited space access and acknowledges the requirement to plan for imperfect space access. JP 3-13.1, *Electronic Warfare*, also discusses operations in a contested environment, but falls short of providing the TTP needed at the tactical and operational levels. The space degraded/contested operations MTTP will address the “how” the Services can identify issues, operate while degraded, and restore space access to continue joint operations. The following are some examples of the manner in which the joint publications address space.

(1) JP 3-14, *Space Operations*.

(a) Joint Force Planning. “The completed plan should describe how the commander will execute the plan in the event space capabilities are degraded, disrupted, or denied. Planning should consider mission assurance options such as requesting rapid restoration of space assets and leveraging allied, foreign, and/or commercial space and non-space capabilities to help assure mission success.”

(b) SATCOM. “Protected SATCOM provides scalable throughputs over a wide band of spectrum. In a hostile environment, where a wideband system could be degraded, protected SATCOM will allow survivable communication, but at a reduced data rate.”

(c) PNT. “Cryptologic systems and capabilities rely on precise time for synchronization of encrypted communications and information systems. Many communications networks use frequency hopping to improve security and increase resistance to jamming. Therefore, it is essential that planners allow for redundant timing capabilities in the event GPS [Global Positioning System] is disrupted or degraded.”

(d) Multinational Considerations. “Multinational space operations provide the joint force many opportunities, including increasing interoperability with, and extending, battlefield advantages to allies; demonstrating responsible behavior in space; and reassuring allies of our commitments to mutual defense. Partnerships can enhance collective security capabilities and can provide a deterrent effect against adversaries from attacking or interfering

with friendly space capabilities. Space capabilities derived from a mix of Department of Defense, commercial, multinational, and allied platforms enhance the resilience of our space enterprise and increase the ability of joint forces to operate effectively through a degraded, disrupted, or denied space environment.”

(2) JP 3-13.1, *Electronic Warfare*.

(a) “The use of the EMS [electromagnetic spectrum] is essential to control the OE [operational environment] during all military operations. The transfer of information from the collectors to the platforms will use the EMS. The EMS is constrained by both civil uses and adversary attempts to deny the use of the EMS—creating a congested and contested environment.”

(b) “Electronic Protection [EP]. EP refers to the division of EW [electronic warfare] involving actions taken to protect personnel, facilities, and equipment from any effects of friendly, neutral, or enemy use of the EMS, as well as naturally occurring phenomena that degrade, neutralize, or destroy friendly combat capability. EP focuses on system or process attributes or capabilities. Inherent hardware features minimize the impact of unplanned/undesired EM [electromagnetic] signals on an EM-dependent system’s operation. EP processes are designed to eliminate, reduce, or mitigate the impact of the same unplanned/undesired EM signals. These features and processes combine to allow friendly capabilities to continue to function, as intended, in contested and congested EMOEs [electromagnetic operational environments].”

(c) “Given the Army’s dependence on cyberspace, as well as the EMS, commanders must fully integrate cyberspace/electromagnetic activities within the overall operation. These activities employ a combined arms approach to operations in contested cyberspace and a congested EMS.”

c. Army Doctrine. Similar to joint doctrine, Army doctrine acknowledges the challenges with access to space, but does not address the interoperability lost and tactics to employ when space access is not available. Below are sections of the publications that address space degradation.”

(1) Field Manual (FM) 3-14, *Army Space Operations*.

(a) “In a memo to the Army Service component commands titled, *Unified Quest 2010 (UQ2010) Results and Implementation*, 27 July 2010, the Commander of Army Training and Doctrine Command stated, ‘The Army must prepare to fight in denied, degraded, and disrupted space operational environment.’”

(b) “Although focused on responding to man-made threats that can affect either terrestrial or space-based systems, such as GPS and SATCOM jammers, defensive space control actions may also safeguard assets from unintentional hazards, such as space debris, radio frequency interference, and other naturally occurring phenomena, such as radiation and weather. Space control provides encryption and protection of vital communications and information collection links necessary to support the force during normal and denied, degraded, and disrupted space operational environment.”

- (c) FM 3-14 addresses the potential for having to operate in a space degraded environment (e.g., terrain, space weather, and line of sight) but it does not provide the tactical-level user a means to identify degradation, steps to mitigate the degradation, and a way to support restoring access.
- (2) Graphic Training Aid(GTA). USASMDC/ARSTRAT authored a graphic training aid for the Army, GTA 40-01-001*Army Space Training Strategy Home Station Training Quick Reference Guide*. It provides a base for the TTP to identify space degraded operations and ways to mitigate the tactical effects of the losses.
- (3) Space Degraded/Contested Operations Scope. Provide TTP to address the use of existing multi-Service publications (e.g., *MTTP for Joint Application of Firepower* and *MTTP for Tactical Convoy Operations*) when space access is degraded or denied.
- d. US Marine Corps Doctrine. ALSA action officers found no doctrine that directly addressed the Marine Corps' use of space or the procedures to operate when space access is degraded/contested. The Marine Corps' space officers are using Army products to assist with training the force, but these publications are not official Marine Corps doctrine.
- (1) Marine Corps Order 5400.53, *Marine Corps Space Policy*. This order only addresses the Marine Corps' interest, as a joint partner, in using space to improve warfare. It assigns responsibilities to different departments within the Marine Corps for incorporating space into operations per the Department of Defense space policy.
- (2) Space Degraded/Contested Operations Scope. An MTTP would provide the Marine Corps approved doctrine that details the TTP to identify space degradation, mitigate the effects of it, and enable them to continue their mission.
- e. Navy Doctrine.
- (1) Navy Tactics, Techniques, and Procedures 3-14.1, *Space Tactics Manual*. This is a SECRET document which functions as an informational guide to what space is, how to use it, what space assets the enemy has, and what impacts space has on naval operations. The most current version is dated August 2004, however, there is a revision underway. ALSA action officers will remain engaged with the Navy Warfare Development Command (NWDC) to assess the updated version.
- (2) Space Degraded/Contested Operations Scope. The Navy has countermeasures and long-range communications that do not rely on space, therefore, space access is not a priority. However, an MTTP can include maritime TTP to identify space degradation early to allow a ships company to react and mitigate its effects when Navy forces act as part of a joint task force.
- f. US Air Force Doctrine. Air Force TTP publications address some challenges faced by pilots when space is degraded, but does not address interoperability. The following are excerpts or summations from publications that address varying levels of space use and access:
- (1) Air Force Policy Directive 13-6, *Space Policy*. "The Air Force will incorporate concepts for operating against an adversary enhanced by space capabilities, and

concepts for compensating for degraded space capabilities into its wargames, simulations, scenario development, experiments, and exercises at all organizational levels.” The Air Force acknowledges the potential for its force to operate in a space degraded environment.

(2) Tactical Bulletin 09-03, *A Day Without Space*. This SECRET document directly addresses the issues of operating without access to space. However, this publication is seven years old and there is no update scheduled. It would be a great starting point for a working group to understand the challenges faced by the Air Force and question units to confirm the TTP discussed in it are still accurate.

(3) The Focus. The majority of other space-related publications focus more on lifting and acquiring space assets than on the TTP to operate in a degraded environment.

(4) Space Degraded/Contested Operations Scope. The MTTP will include TTP for pilots and ground forces attempting to use close air support in a degraded environment.

2. Service SME Perspectives

a. US Army.

(1) The Army is using the Army Space Training Strategy Home Station Training Student Reference Guide USAMDC and ARSTRAT produced. These are products that provide the baseline for Army ground operations and directly translate to the Marine Corps for ground operations.

(2) The Army is interested in assured access to space and the resiliency of the systems in orbit. However, access is not guaranteed with the current threats in the world. The TTP from an ALSA Space Degraded/Contested Operations publication would fill this gap.

(3) The Army plans to publish ATP 3-14.3, which should provide updated space information specific to Army forces. ALSA will analyze it, after it is published, to prevent releasing redundant information.

(4) The National Training Center incorporates space degradation information in training unit rotations to assess their ability to identify degraded space access, report electromagnetic interference (EMI), and continue operating without space. The systems and techniques observed during ALSA’s research are detailed below.

(a) NAVWAR Electronic Attack Trainer (NEAT) is a commercial system that can jam the Global Positioning System (GPS) locally out to approximately one kilometer. This is a hand held device that provides several options to interfere with the GPS signals on L1 and L2. While it is around the size of the standard military GPS, it can also be vehicle mounted (OPFOR and other vehicles) to induce different reactions from the rotational training unit.



Figure 1. NEAT System

(b) Figure 2 shows the prototype system used to interfere with the GPS signal at NTC. The system is one of a kind, at this point, and provides amazing results at NTC. The system rack consists of a voltage regulator (top box), a signal generator (middle box), and a power amplifier (bottom box). The ALSA AOs were able to observe a test that demonstrated the system's ability to interrupt and prevent L1 and L2 signal connection or acquisition, respectively. During this test, the system successfully performed at a range of approximately 22 kilometers and also received requests from inflight civil air patrol assets to turn the system off as they were unable acquire a GPS fix. Additionally, Lizard Space, with OPFOR support, had also used the system from a different location in NTC's central valley (vicinity of the Sawtooth) and was able to range out to about 34 kilometers to the west. While these may not seem like overly large distances, this is enough to impact a training unit well before they are able to know that there is intentional interference. The main limiting factor to affecting larger areas is line of sight. This system uses either a direction focused antenna that adds additional power to the interference signal or a more open antenna that provides a wider area of affect, but at a lower power and thus, a slightly shorter range. Antennae immaterial, the terrain and weather will impact operations. This system, as seen in the left picture, is man-portable, however, it would take a larger team to carry the required support equipment (e.g., tripod, antenna, power source, etc.). As of now, the system is vehicle transported to a location and then the required system components are moved to the operation site.

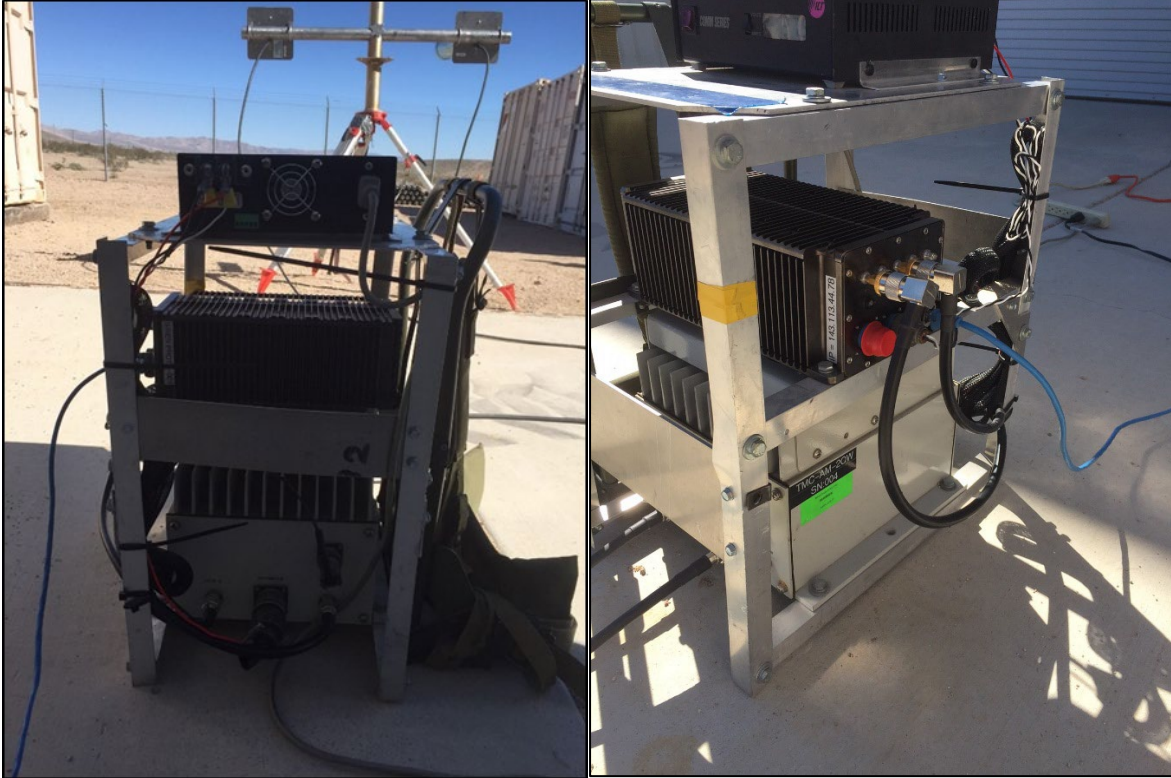


Figure 2. Prototype Electromagnetic Interference (EMI) Trainer (NOT the official name of the system)

(c) The final system discussed during this visit was the Warfighter Information Network-Tactical (WIN-T). WIN-T is the Army's system to provide connectivity down to the battalion level with services such as high speed data and voice communications. During the visit, this was the only artificial means of impacting the rotational training unit, however, the effects created are real and force a reaction. Basically, Lizard Space coordinates with the regional hub to "delete" the rotational training unit's systems from the network to deny them access to the WIN-T architecture. This prevents all organic brigade units (may include additional attached units as well) from being able to pass data via the "internet" over their primary communications systems. Lizard Space's goal is to have the unit submit an EMI report requesting assistance to isolate whether the issues are from internal errors or external factors/adversaries.

(5) ALSA observed Warfighter 16-3, an Army division-level exercise, to assess the mission command of the division commander and the staff. In this exercise, there was a space cell that injected space events into scenarios to generate a reaction. During this exercise the training audience struggled with identifying the space issues and failed to report the degradation up the chain of command.

b. US Marine Corps.

(1) The Marines fall in line with the Army, based on a shared ground force; but also will require maritime TTP from the Navy. The Marine space officers are using the same Army publications, previously listed, to train the force on how to

mitigate space degradation during operations. Currently, the Marines are not incorporating space degradation into exercises.

(2) The Marines have not officially adopted, as Marine doctrine, Army TTP for working in a space degraded environment. They have access to the publications to assist in their training, but the use seems to reside at the Marine space professional level.

(3) ALSA is working closely with NWDC, II Marine Expeditionary Force, and Pentagon space operations officers to ensure the proposed TTP is relevant to the Marine Corps. The Pentagon space officers are interested in assisting in joint working groups to provide the Marine Corps perspective to the MTTP.

c. US Navy.

(1) The Navy is revising its publication for maritime space operations. The Navy's use of SATCOM and PNT are critical because these are often the main communications and navigation resources to which ships have access while underway. This underscores the importance of documenting and learning TTP to use when space access is denied or degraded.

(2) ALSA action officers are working with NWDC and the Navy liaison officer (Navy space officer) to the US Air Force Space Education and Training Center to ensure the correct SMEs are consulted and TTP are documented.

d. US Air Force.

(1) The Air Force is interested in the command and control of air assets in a space degraded environment.

(a) ALSA is monitoring the Joint Air Operations Center Command and Control in a Contested Degraded Environment (JADC) Quick Reaction Test to record any tactical to operational level TTP. JADC working groups are ongoing.

(b) ALSA action officers participated in a US Air Force Lessons Learned research project. Participants in the project are working with Pacific Air Forces (PACAF) to determine how units throughout PACAF would react during a conflict where communications were severed with their air operations center. Initial research shows that no TTP exists that gives units direction when they are unable to receive an air tasking order.

(c) The Air Force is incorporating GPS degradation/denial into RED FLAG exercises. ALSA will remain in contact with the RED FLAG staff to ensure the TTP developed, documented, and validated are included in the MTTP.

(2) The joint terminal attack controller weapons school has TTP for degraded operations when controlling aircraft. ALSA is in contact with the school to record TTP and solicit SMEs.

e. Joint.

(1) ALSA monitored Valiant Shield 2016, a joint exercise in the Pacific theater. The joint community realized the importance of training for operations in a contested/degraded environment and incorporated PNT and communication

degradation/denial into the exercise. Participants found that many people do not understand the difference between equipment malfunctions and EMI.

(2) The Joint Navigation Warfare Center has conducted, and is conducting, tests to address shortfalls in unit training. These tests highlight the impacts of space degradation on the force, the training shortfalls in identifying when space access is degraded, and serve as forcing functions for units to seek TTP to fight in the degraded environment.

Chapter III CONCLUSION

1. Observations

The SMEs, with whom ALSA interacted, understood the importance of space access and recognized the shortfalls in the Services' ability to operate effectively in degraded/contested environments. However, each Service is still developing its own TTP to operate in the space degraded/contested environment. There are still Service specific tests, evaluations, and procedures that must occur prior to ALSA interacting to document and publish multi-Service interoperability TTP.

2. Recommended Course of Action

ALSA action officers recommend delaying an MTTP for space degraded/contested operations. ALSA action officers will remain in contact with the SMEs consulted during the research study, in the lessons learned forums, at the test centers, and at the training centers to stay abreast of the warfighter requirements to operate in a multi-Service space degraded/contested environment. The SMEs understand that space access is not guaranteed and as such, there are military-wide surges to update doctrine and develop Service-specific TTP to continue the fight. Once each Service understands its own limitations in this type of environment, ALSA can work with the Services' SMEs to document new TTP for conducting multi-Service operations where space is degraded/contested.

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REFERENCES

The following is a list of references used in this study.

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MARINE CORPS

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NAVY

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AIR FORCE

Air Force Policy Directive 13-6, *Space Policy*, 13 August 2013

Tactical Bulletin 09-03, *A Day Without Space*, 2009 (SECRET)

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GLOSSARY

PART I – ABBREVIATIONS AND ACRONYMS

ALSA	A, B, C, D Air Land Sea Application [Center]
ARSTRAT	Army Forces Strategic Command
ATP	Army techniques publication
EP	E electronic protection
EMOE	electromagnetic operational environment
EM	electromagnetic
EMI	electromagnetic interference
EMS	electromagnetic spectrum
EW	electronic warfare
FM	F field manual
GPS	G, H, I Global Positioning System
JADC	J, K, L Joint Air Operations Center Command and Control in a Contested Degraded Environment
JP	joint publication
MEF	M Marine expeditionary force
MTTP	multi-Service tactics, techniques, and procedures
NWDC	N Navy Warfare Development Command
OE	O operational environment
PACAF	P, Q Pacific Air Forces
PNT	position, navigation, and timing
SATCOM	S satellite communications

SME	subject matter expert
	T
TTP	tactics, techniques, and procedures
	U, V, W, X, Y, Z
US	United States
USASMDC/ARSTRAT	United States Army Space and Missile Defense Command/Army Forces Strategic Command

PART II – TERMS AND DEFINITIONS

Global Positioning System—A satellite-based radio navigation system operated by the Department of Defense to provide all military, civil, and commercial users with precise positioning, navigation, and timing. (DOD Dictionary)