Degraded Space Mitigation Strategy

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1. Introduction.

a. Purpose. This purpose of this report is to recommend Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) actions necessary to prepare the Army to be able to mitigate operational issues resulting from operations under conditions of degraded or denied Space Force Enhancement (SFE) areas of: (1) Satellite Communications (SATCOM); (2) Intelligence, Surveillance, and Reconnaissance (ISR); (3) Positioning, Navigation and Timing (PNT); (4) Missile Warning (MW); and (5) Environmental Monitoring (EM). This report also describes the approach used to identify these actions which address the requirements of all six Army Warfighting Functions (WfFs).

b. Background.

(1) Advances in information technologies have given warfighters sophisticated tools for gathering, sharing, disseminating, storing and displaying information. One result of these advances is that the Army has transitioned from being supported by space-based capabilities to being truly enabled by and reliant upon them. Space capabilities are now integral to the conduct of military operations. Current doctrine and the Army's future concept of Integrated Distributed Operations (IDO), as well as the Joint concept of Globally Integrated Operations (GIO) continue this reliance on SFE. Both of these concepts are extensions of the Army's current operating concept of Unified Land Operations (ULO). Envisioned are agile, responsive combined arms teams guided by Mission Command/Joint Command and Control, enabled by a collaborative network of systems to achieve decisions by creating advantages over adversaries through the deliberate use of physical separation and mutually supporting independent tactical actions. Through SFE, the network is expected to provide near real-time situational awareness (SA), allowing the force to rapidly adapt to changes in the operational environment; achieve cross domain synergy; present adversaries with multiple simultaneous dilemmas; cause a disaggregated adversary to re-aggregate while friendly forces mass the effects of combat power, from distributed locations, to defeat or destroy them. Concurrently, adversaries have recognized our reliance on SFE and have developed or begun development on methods to deny SFE to U.S. forces.

(2) On 5 June 2012, the Army Space Council (ASC) identified the need for the Army to develop a “Strategic Level” DOTMLPF assessment of denied or degraded space capabilities and a strategy to employ mitigation techniques at the tactical level. MG Bartell, Deputy Director of the U.S. Army Capabilities Integration Center (ARCIC), stated ARCIC would take the lead in conducting this assessment. On 12 October 2012, the U.S. Army Training and Doctrine Command (TRADOC) G33 issued TRADOC task order (TASKORD) IN122865 Subject: Degraded Space DOTMLPF Review, (S//NF), which tasked the Army’s Combined Arms Center (CAC) and the Mission Command (MC) Center of Excellence (CoE) to identify and incorporate into the MC Capabilities Based Assessment (CBA) operational mitigation actions associated with denial or degradation of space-based capabilities. This TASKORD gave CAC tasking authority over organizations in support for the purpose of the TASKORD. Each CoE was tasked to support this review within the scope of their respective WfF with the MC CoE, as the lead for the MC CBA ‘13, having the responsibility for leading the effort.

(3) On 7 November 2012, fragmentary order (FRAGO) 1 to the base task order was issued and, on 28 November 2012, FRAGO 2 to the base task order was issued, modifying execution timelines and responsibilities. The MC CBA 13 Functional Solutions Analysis (FSA) completion was extended to 31 October 2013 in order to accommodate the conduct and completion of the Degraded Space Review.

c. Bottom Line Up Front (BLUF): Operationally, a robust, beyond line-of-sight data network, capable of transporting, at the minimum, voice communications and situational awareness data in near real time is required in order for the Army to operate in accordance with its current doctrine and future concepts. If the network cannot provide the required information to the commander when he needs it, that commander must use alternative means to get that information. Short of having such a network available, Commanders must choose between significantly changing the way we operate or accept the risk associated with having forces operating autonomously with little to no communications, and therefore without situational awareness, between subordinates, adjacent units, and higher headquarters. At the Soldier and system level, many of the skills, tactics, techniques, and procedures which can be employed to mitigate denied or degraded SFE are already taught in the Army's formalized training venues and in the professional education system. These skills are not, however, maintained to a level of proficiency which would allow operations to successfully take place under those conditions. This can only be remedied by ensuring units train under denied or degraded SFE conditions. Additionally, planners at all levels must weigh the risk of SFE denial or degradation and adjust task organizations and schemes of maneuver within Operation Plans (OPLANS) and Contingency Plans as necessary. To achieve this, a doctrinal base for conducting operations in an SFE denied environment must first be developed and taught to leaders at all levels. This report identifies 16 DOTMLPF-P actions for the Army's consideration.

2. Approach.

a. Constraints, Limitations, and Assumptions. The Degraded Space Mitigation Strategy was developed with the following constraints, limitations and assumptions:

(1) Constraints:

(a) The study team was constrained by time and resources available at each CoE.

(b) The analysis was constrained by consideration of only one scenario, the Corps Division Scenario (CDS) Integrated Security Construct-B (ISC-B) scenario as directed by the TASKORD.

(2) Limitations.

(a) The analysis of potential mitigation actions was limited to the use of subject matter experts (SME), professional military judgment (PMJ), and qualitative analysis due to the lack of certified modeling and simulation tools capable of fully representing the effects of degraded space conditions.

(b) Potential mitigation actions nominated by the CoEs for inclusion in the mitigation strategy were limited to those which met selection criteria which included its level of contribution to operational risk mitigation; feasibility, acceptability and suitability(FAS); and non-excessive cost.

(c) The mitigation strategy was limited to those actions which can mitigate the risks associated with conducting Army operations in a degraded space environment and does not include actions which could protect space-based assets from degradation.

(3) Assumptions. The following assumptions were made upon initiation of the review and were subsequently determined to be valid.

(a) The loss of one particular space-based capability (e.g. SATCOM) does not necessarily mean the loss of other space-based capabilities (e.g. Environmental Monitoring, PNT, ISR).

(b) The Army force structure was likely to decrease due to budget constraints, but this would not result in any significant changes to Army required capabilities.

(c) The operational environment defined by TRADOC G2's Operational Environments to 2028: The Strategic Environment for Unified Land Operations adequately represents the timeframe of the Degraded Space Review.

(d) All non space-based systems included as part of the capability baseline (fielded or in the POM with a Management Decision Document (MDD)) would be fielded on schedule and with the capabilities specified in their approved requirement documentation.

b. Scope. The Degraded Space Review scope includes the following:

(1) The review examines operations as executed by Army echelons from Company (either within a Brigade Combat Team or, in some cases, companies, troops and batteries within the Maneuver BN Formation) through Theater Army/Army Service Component Command (ASCC) level.

(2) This review addressed capabilities and vulnerabilities for Army units operating with Unified Action Partners and organizations.

(3) This review addressed all Army tasks of decisive action, across all domains and the electromagnetic spectrum (EMS).

(4) This review included consideration of an operational capability baseline provided by currently fielded, or being fielded (Capability Set 13) systems, and by systems which are considered "program of record" systems (in the POM and having reached Milestone B) with initial operational capability (IOC) scheduled by 2020 or earlier. The operational capability baseline for the Degraded Space Review, however, did not include space capabilities.

(5) This review addressed required capabilities which are considered scenario independent (required in any scenario), as well as unique requirements derived from consideration of the ISC-B scenario.

c. Methodology. The methodology executed to develop this Degraded Space Mitigation Strategy involved 3 steps:

(1) CoE Assessments. Each CoE conducted an assessment of the effects of degraded or denied SFE on their respective WfFs. These assessments were conducted within the context of the CDS ISC-B scenario. The purpose of these assessments was to identify operational issues caused by degraded or denied SFE and potential actions to mitigate those issues.

(2) Compare and Consolidate Mitigating Actions. After each CoE identified potential mitigating actions to their issues, the mitigating actions were consolidated and discussed at a VTC conducted with the study teams from each CoE. Similar potential mitigating actions were combined.

(3) Identify DOTMLPF-P Solutions. After identifying potential mitigating actions, the ICDT identified any DOTMLPF-P solutions which would be required to give the Army the capability to execute the mitigating actions identified in the previous step. As with a CBA, materiel solutions will be proposed only if non-materiel solutions across the DOTMLPF-P domains will not mitigate the operational issue. The list of DOTMLPF-P solutions are in Appendix A, DOTMLPF-P Solutions.

d. Scenario Overview. In accordance with TRADOC guidance and the associated task orders, the Corps Division Scenario (CDS) Integrated Security Construct-B (ISC-B) scenario was used to establish the conditions and context for conducting the Degraded Space Review.

(1) Summary: CDS ISC-B depicts a U.S. force conducting Joint Forcible Entry Operations (JFEOs) in 2020. The base scenario involves Phase 0 through V operations. Phases II and III include airborne and amphibious assaults to seize ports of entry and the insertion of combat aviation, armor, Stryker, and infantry brigade combat teams to defeat threat capabilities. Desired end-state conditions are restoration of freedoms of navigation and commerce, defeating threat capabilities adversely influencing the region to include attacks against regional critical infrastructure, increased regional partner capacity to defend against future threat efforts, and to deter the threat from taking further destabilizing actions. U.S. forces are postured to ensure freedoms of navigation and commerce and to deter further threat aggression.

(2) Characteristics:

(a) Scenario Classification: SECRET/NOFORN

(b) Terrain: Arid climate, coastal marshland and plains transitioning inland into foothills then rugged mountainous terrain.

(c) Operation: A phase 0-V joint scenario with a corps-led JFEO, to include a U.S. Army Division and a MEF conducting decisive offensive operations supported predominantly by sea-based joint fires and sustainment.

(d) Opposing forces: Conventional and paramilitary forces provide an OE-compliant scenario with an adaptive, learning threat. This thread is assumed to possess the means, either organic or through 3rd party support, to deny and/or degrade U.S. Space Force Enhancement (SFE) capabilities.

(e) Duration: Years (phase 0-V) with approximately a 60-day period focused on phase II and phase III operations.

(f) Features: JFEOs in an environment with significant logistics challenges, extended lines of communication, joint fires and missile defense challenges.

3. Summary of Centers of Excellence Assessments. Each CoE conducted an independent assessment of the effects of degraded or denied SFE on their respective WfFs. These assessments were conducted within the context of the CDS ISC-B scenario. The purpose of these assessments was to identify operational issues caused by degraded or denied SFE and potential actions to mitigate those issues. The individual CoE reports are Annexes I – VIII.

a. The operational issues identified by the individual CoEs centered on the loss or reduction of capabilities provided by the 5 SFEs.

(1) SATCOM. The loss of SATCOM brought the transfer of data to a halt. Systems no longer received or sent updates to other systems and had to be updated manually as information became available. This resulted in significant latency in updating the situation and the loss of a Common Operating Picture (COP) across the force. The COP became more confused in a degraded environment when systems would update with information that was older than information which had been manually entered. Collaboration and synchronization between organizations dispersed beyond line-of-sight distances became extremely limited. Assets had to be repurposed to form additional RETRANS vehicles and teams to man them in order to maintain control in battalion areas. The division headquarters and BCT command posts became isolated from their subordinates, adjacent units, and higher headquarters. Long-term loss of SATCOM virtually eliminated the Army's ability to execute mission command over the distances required in the scenario and envisioned by our doctrine and our future concepts. Long-term loss or degradation forced a significant change to the scheme of maneuver by forcing units to within LOS range of subordinate and adjacent units. Loss of SATCOM also caused a significant reduction in OPTEMPO as information flow to commanders at all echelons was reduced.

(2) Intelligence, Surveillance, and Reconnaissance (ISR) SFE. Loss of ISR forced the repurposing of combat power for use as reconnaissance forces and a change to the scheme of maneuver. The repurposed combat power caused a change to the force ratios, requiring additional forces to achieve the same force ratio throughout the operation. The scheme of maneuver and OPTEMPO of the operation were significantly reduced as the operation became a movement to contact against an unknown enemy.

(3) Positioning, Navigation, and Timing (PNT). Loss of PNT caused a significant reduction in commanders' ability to track their own forces and reduced OPTEMPO as units were forced to navigate manually. Information and communication systems lost the ability to communicate as communications systems' timing became de-synchronized, or drifted. GPS guided precision fires were unavailable, causing a change to logistics planning as more non-guided munitions were required. Tactical and operational UASs will be degraded or non-mission capable due to inability to track geographic signal while landing and taking off.

(4) Early Warning. Loss of early warning reduced the reaction time of forces to ballistic missile attack and limited the ability to respond to launches.

(5) Environmental Monitoring (EM). Loss of EM prevented the timely reporting of weather conditions to the force.

b. There were 74 mitigating actions identified by the CoEs. These mitigating actions include actions units can employ on the battlefield, actions taken prior to operations in anticipation of denied or degraded SFE, and DOTMLPF-P actions to help prepare the force to operate in an SFE denied or degraded environment. The list of these actions as submitted by the CoEs is found in Appendix C, Centers of Excellence Mitigating Actions.

4. Summary of Consolidation of Mitigating Actions. Many of the 74 mitigating actions identified by the CoEs were duplicative or very similar. Through working meetings with the ICDT, these 74 mitigating actions were consolidated down to 25 unique mitigating actions. The list of the final mitigating actions is found in Appendix B, Mitigating Actions.

5. Summary of Identification of DOTMLPF-P Solutions. Based on the mitigating actions identified during the Degraded Space DOTMLPF Assessments conducted by the various Centers of Excellence within TRADOC , 16 DOTMLPF-P solutions are recommended in order to prepare the force for operations in a denied or degraded SFE environment. Preeminent among these is the development of an Army policy requiring units to train under these conditions. While many of the skills necessary to continue operations under SFE denied or degraded conditions are already taught in training conducted at the various Army schools and professional education courses, these skills are not maintained in units to a sufficient level to ensure proficiency when operating under those conditions. The 16 DOTMLPF-P solutions identified are listed by DOTMLPF-P domain below, with details provided in Appendix A, DOTMLPF-P Solutions.

DOCTRINE:

(1) Develop overarching and WfF-specific doctrine on operating in a denied or degraded SFE environment

(2) Develop ATPs for operating systems in a disconnected environment

(3) Develop ATPs for prioritizing / limiting digital traffic

(4) Modify concepts to include operations in a SFE denied or degraded environment

(5) Continue development of the JALN concept

ORGANIZATION – None

TRAINING

(6) Train system operators to operate systems in a disconnected environment

MATERIEL / materiel

(7) Multi-Payload Capability for UAS

(8) Update IPADS

(9) Develop a Terrestrial Layer Network Capability

(10) Develop a GPS Surrogate

(11) Develop Persistence Platforms

LEADERSHIP & EDUCATION

(12) Include operations in SFE denied / degraded environment in professional education at all levels

PERSONNEL – None

FACILITIES – None

POLICY

(13) Change policy to require training in SFE denied / degraded conditions

(14) Change policy to require OPLANS to consider operations in a SFE denied or degraded environment

(15) Change policy to maintain national map production capabilities

(16) Modify MOA/Statement of Requirement with Air Force to Provide Weather Support

6. Mitigation Strategy

a. Introduction. The ICDT considered two basic levels of mitigation when discussing the loss or degradation of Space Force Enhancement: the Soldier / system level and the tactical / operational level.

(1) The Soldier / system level focuses on how we will operate our systems and perform basic functions when services provided by SFE are degraded to an unacceptable level or denied completely. This level of mitigation ignores the issue of how to provide the force with the information and dataflow normally provided by SFE and, instead, focuses on how Soldiers operate their systems when information is provided to them via other means. Examples of this level of mitigation include land navigation with map and compass and manually populating systems normally updated by the network. Many of the skills necessary to provide this level of mitigation are already present in formal Army training.

(2) The tactical / operational level of mitigation focuses on actions which must be taken to enable the force to provide itself with the information and capabilities normally provided by SFE. This level is significantly more difficult to mitigate than the Soldier / system level. Short of an alternative means of providing the capabilities currently provided by SFE, commanders will have to make decisions on how the force is going to conduct or continue its operations when SFE is denied or degraded. Inherent to making these decisions, the commander must have information on the cause, likely duration, and scope of the SFE disruption. Dependent on these and other factors, mitigating actions may include changes to the scheme of maneuver, repositioning of forces on the battlefield, and repurposing available assets to provide capability normally provided by SFE.

b. Implementation:

(1) Doctrine, Training, and Leader and Education solutions can be executed by TRADOC. In order to ensure a synchronized effort across these domains, a work group composed of CAC-T, CADD, CAL, corresponding activities from each CoE, and representatives from FORSCOM should be formed to further develop those solutions into comprehensive Degraded Space doctrine and training.

(2) Army policy solutions (solutions 13 & 14) can be executed by DA G-3/5/7 in coordination with appropriate subordinate organizations.

(3) Extra-Army policies (solutions 15 & 16) must be proposed to DoD by the Army. Again, DA G-3/5/7 is the lead organization.

(4) In order for materiel solutions to be developed, there must be a valid requirement for the capability provided by the solution in an Initial Capabilities Document (ICD). ICDs generally result from a Capabilities Based Assessment (CBA) or other analytically rigorous study and are approved by either the Army Requirements Oversight Committee (AROC) or Joint Requirements Oversight Committee (JROC). If the requirement for multi-payload capabilities for unmanned aerial systems or an updated IPADS (solutions 7 & 8) are not currently found in an ICD, a CBA or similar study identifying the capability gap and potential solutions must be conducted. If the study validates the requirements, either a new ICD must be written or an existing ICD modified to document the requirement. In either case, the ICD will require AROC or JROC approval. Once the requirement is documented and approved, other JCIDS documents such as Capabilities Development Documents (CDD) and Capabilities Production Documents (CPD) can be developed.

(5) Materiel solutions 9 – 11 all propose alternative methods of providing network capability. While an alternative method of providing beyond-line-of-sight network capability would provide a high degree of mitigation to the loss of SFE, it is not likely the Army can afford it. Before these solutions can be recommended, the Signal Center of Excellence must perform the necessary analysis and recommend to the Army the best alternative means of providing the network to users beyond line-of-sight. Only then can supporting systems be developed.

7. Conclusions.

a. The difference between denial and degradation of SFE to the operational force is not a function of bandwidth or throughput – it is a matter of meeting the commander's needs. If SFE does not provide the commander with the necessary communications, information, SA, or positioning, navigation and timing (PNT) which is timely, accurate, and reliable enough to execute the mission, then that commander must utilize alternate means and, most likely, expend additional resources to regain at least some of that capability.

b. The Army must ensure units plan and train for the contingency of denied or degraded SFE. The likelihood of an adversary developing the ability to deny or significantly degrade our SFE capabilities continues to increase. They recognize both our reliance on SFE and the advantages SFE provides our forces.

c. Doctrine, Training, and Leadership and Education solutions can be executed within TRADOC but must be coordinated across the Warfighting Functions. This will require a comprehensive effort, led by TRADOC, to ensure the synchronization of those solutions and that they are consistent with each other.

d. Alternative network enhancements providing much of the same capability currently provided by SFE is the best mitigation, but are not likely to be achieved in the current fiscal environment.

Appendix A, DOTMLPF-P Solutions, to the Degraded Space Mitigation Strategy

This appendix lists recommended Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) solutions for preparing the Army to conduct operations under denied or degraded space conditions.

DOCTRINE:

1. Develop Overarching and WfF-Specific Doctrine on Operating in a Denied or Degraded SFE Environment

Description: Modify or create doctrine at all levels and in all WfFs to address the changes necessary to successfully conduct operations in an environment where SFE is denied or degraded. Included will be discussions on when to implement various actions to mitigate the loss or degradation of SFE as well as planning considerations in operations where adversaries pose a threat to SFE. Doctrine must include mitigating actions such as recognizing denied or degraded SFE conditions, increasing the use of LOS communications, increasing the air defense posture, repurposing and reprioritizing available assets, deploying alternate command posts, using manual reporting procedures, reducing the OPTEMPO of operations, reducing the distance between units to LOS ranges, increasing the use of graphic control measures, and any WfF-specific actions or considerations appropriate to the anticipated conditions. It must also discuss factors for leaders to consider when making decisions to implement mitigating actions

2. Develop ATPs for Operating Systems in a Disconnected Environment

Description: Develop Army Techniques Publications (ATPs) which assist leaders and system operators to manually update systems and operate those systems while disconnected from the network or a portion of the network. Systems must be capable of receiving manual updates.

3. Develop ATPs for Prioritizing / Limiting Digital Traffic

Description: Develop ATPs which help Commanders limit data transmission to only that data deemed important to them. This may include the total shutdown of some systems to prevent them from calling for data from the network.

4. Modify Concepts to Include Operations in a SFE Denied or Degraded Environment

Description: Expand Army and Joint Operating Concepts to include Degraded/Denied Space Annexes. Current and future Operating Concepts warn and advise the force to train and be prepared for "worst case" denied space scenarios, but these concepts lack the necessary specificity of how the force will operate under those conditions.

5. Continue Development of the JALN Concept

Description: Continue to develop the Joint Aerial Layered Network (JALN) concept to provide extended range voice and data communications. The JALN concept calls for bridging disparate radio systems to relay voice and data communications, create communication conference patches between radios and common phone systems, provide Link 16 and SADL access, and integrate Naval Automatic Identification System (AIS) data.

ORGANIZATION – None

TRAINING

6. Train System Operators to Operate Systems in a Disconnected Environment

Description: Train system operators to manually update systems and operate those systems while disconnected from the network or a portion of the network. They must also know how to limit or eliminate data transfer from their systems.

MATERIEL / materiel

7. Multi-Payload Capability for UAS

Description: Ensure appropriate low-level, Army owned UASs are capable of carrying multiple payloads to include RETRANS, HNR (or similar capability) and other systems so they may be repurposed to mitigate loss, denial, or degradation of SFE.

8. Update IPADS

Description: Update the Improved Position Azimuth Determining System (IPADS) to be more compact and maintain accuracy standards. Mount the IPADS on unit leader vehicles. This will allow Platoon Leaders and up to create their own Survey Control Points (SCPs). The SCPs can be shared with other units.

9. Develop a Terrestrial Layer Network Capability

Description: Develop a High Bandwidth Networking Radio (HNR) - like capability and deploy at echelons down to company level. This terrestrial based, LOS system must be capable of handling the bandwidth requirements necessary for synchronized operations for units within LOS distances of other units.

10. Develop a GPS Surrogate

Description: Develop a GPS surrogate compatible with current GPS receivers. A GPS surrogate can overpower the weaker signal from the constellation in space. Since it is closer to the earth and has a

stronger emitting signal than a satellite in space, a surrogate will mitigate some of the effects of GPS jamming or spoofing.

11. Develop Persistence Platforms

Description: Develop and field persistence platforms capable of carrying systems which replicate SFE system capabilities. There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms will be able to provide communication extension, expansion and intelligence collection for direct support.

LEADERSHIP & EDUCATION

12. Include Operations in SFE Denied / Degraded Environment in Professional Education at All Levels

Description: Include the operations process (plan, prepare, execute, assess) under denied or degraded SFE conditions in all levels of PME for all WfFs.

PERSONNEL – None

FACILITIES – None

POLICY

13. Change Policy to Require Training in SFE Denied / Degraded Conditions

Description: Change Operating and Generating Force Training policy to require all formations to train under SFE denied / degraded conditions. Units must plan, prepare, execute and assess operations using manual Mission Command TTPs.

14. Change Policy to Require OPLANS to Consider Operations in an SFE Denied or Degraded Environment

Description: Change policy to require the review and, as needed, modification of existing OPLANS and CONPLANS to account for actions which may be necessary to mitigate the loss, denial, or degradation of SFE. Many "immediate action" mitigation actions involve the repurposing and / or reprioritizing of assets to mitigate the loss of SFE or the restriction of units to within LOS distances. Planners can anticipate these requirements by reviewing OPLANS and modifying them as necessary to include planning factors which address denied and degraded SFE environments, as well as by identifying what additional assets or task organization would be required to accomplish the mission under those conditions.

15. Change Policy to Maintain National Map Production Capabilities

Description: Maintain National Map Production Capabilities with Capability to Surge Production and Reproduction as Required. Soldiers are routinely trained in the use of paper maps for navigation, position location and reporting. However, recent policy decisions will make the availability of hardcopy maps extremely limited. Conducting manual land navigation on a screen size likely to be carried by troops is not feasible. Additionally, this policy would allow units to continue operations in an environment where the systems themselves have been compromised or rendered inoperable.

16. Modify MOA/Statement of Requirement with Air Force to Provide Weather Support

Description: Modify agreement with Air Force to ensure weather personnel are adequately trained on "single station analysis" processes/techniques. The Army receives weather reports from the Air Force IAW an agreement which is updated every 2 years. This agreement must be updated to indicate the requirement to utilize single station analysis processes and techniques.

Appendix B, Consolidated Mitigating Actions, to the Degraded Space Mitigation Strategy

The mitigating actions found in this appendix are the result of the consolidation of the mitigating actions submitted by the CoEs as found in Appendix C. To consolidate the actions, similar or duplicative actions were combined. Under each of the numbered mitigating actions are the CoE mitigating actions (from Appendix C) which were consolidated into it. Some of the mitigating actions submitted by CoEs are linked to more than one of the consolidated mitigating actions.

1. Increase Use of LOS Communications

Description: Units at all echelons will increase reliance on LOS Comms. LOS networks include capabilities such as the Warfighter Information Network-Tactical (WIN-T), HNR, Troposcatter Wideband Radio, JTRS, and SINCGARS. Included is the RETRANS capability of LOS networks.

MCCoE 1 – Increase Use of LOS Communications
ICoE 7 – Alternate Communications Pathways
ICoE 9 – Utilization of Terrestrial Signal Assets
MSCoE 1 – Alternative Communications Package
MSCoE 3 – TTPs for Increased Use of LOS Communications
MSCoE 4 – Transmit over theater communications assets
AvCoE 4 – Use of HAVEQUICK, SINGARS, LINK=16, SRW, WNW and/or dedicated communications relay
AvCoE 5 – Use of dedicated LOC communications links to operate UAS

2. Increase Air Defense Posture

Description: Increase in manning/operating timelines. Issues will be to identify scheduled maintenance impacts and TTPs developed in the event of space-based denial. Due to the anticipated reduction in probability of kill (PK), additional ADA assets should be considered for force packages.

MC CoE 2 – Increase Air Defense Posture
FCoE 2 – Increase Air Defense Posture

3. Operate Systems in a Disconnected Environment

Description: System operators must be capable of manually updating systems and operating those systems while disconnected from the network or a portion of the network. Systems must be capable of receiving manual updates.

MCCoE 3 – Operate Systems in a Disconnected Environment
MCoE 3 – CPs to battle tracking using paper maps
ICoE 6 – Prophet Operator Training
ICoE 8 – TS-II operators using manual actions to operate the GPS & ACC
ICoE 10 – Cross-level intelligence date through courier and disk-to-disk data transfers
FCoE 3 – Revert to firing standard MET for all missions
MSCoE 2 – Manual population of the COP
MSCoE 8 – Use stored and replicated map data
SCoE 5 – Sustainment movement tracking systems operations
SCoE 6 – Automated sustainment business systems operations
SCoE 7 – Sustainment Mission Command System
AvCoE 3 – Fall back on use of HAVEQUICK, SINCGARS, LINK-16 etc which have autonomous clocks

4. Navigate Using Map and Compass

Description: Soldiers navigate using map and compass.

MCCoE 4 – Navigate Using Map and Compass

MCoE 2 – Training without GPS and BFT

MSCoE 5 – Terrain navigation with map and compass w/training at BCT and below

MSCoE 6 – Navigation Training

MCoE 4 – Soldiers require increased training in land navigation tasks and map reading; Watercraft operators maintain skills in celestial navigation, radio positioning, and dead reckoning

FCoE 6 – Use of Inertial Navigation and Dead Reckoning

AvCoE 1 – Alternative Navigation solutions

5. Prioritize Traffic & Communications

Description: Commanders limit data transmission to only that data deemed important to them. This may include the total shutdown of some systems to prevent them from calling for data from the network.

MCCoE 5 – Prioritize Traffic & Communications

SigCoE 1 – TTPs within the Signal units will mitigate connectivity issues

MSCoE 4 – Transmit over theater communications assets

6. Recognize Denied / Degraded SFE Conditions

Description: Operators and/or systems must be capable of recognizing denied or degraded SFE conditions. Staffs must be able to identify the causes of SFE degradation or denial and provide commanders with an estimate of the duration of the event.

MCCoE 6 – Recognize Denied / Degraded SFE Conditions

MCoE 1 – Leader training and Awareness

SigCoE 1 – TTPs within the Signal units will mitigate connectivity issues

7. Repurpose Available Assets

Description: Repurpose assets under the commander's control to fill a more critical need no longer being provided by SFE. Examples include utilizing platforms (aerial and vehicle) as retrans or tasking forces to perform reconnaissance missions.

MCCoE 7 – Repurpose Available Assets

MCoE 5 – Use of maneuver forces for reconnaissance

MCoE 6 – Devote UAVs to retrans missions

ICoE 1 – Utilization of Intelligence Platforms as Re-Trans Platforms

MSCoE 9 – Use manned and unmanned aerial vehicles to augment satellite terrain imagery production

SigCoE 2 – Using aerial layer networking capabilities

8. Deploy Alternate Command Posts

Description: Equip commanders and principal battle staff officers with the means to rapidly form and displace mobile and survivable tactical command posts to facilitate mission command at forward locations.

MCCoE 8 – Deploy Alternate Command Posts

9. Transfer Data & Information Manually or Verbally
Description: Data and information are passed via voice means or using storage media, written reports, etc. Increased reliance on spot reports, unit status reports, etc will be required.

MCCoE 9 – Transfer Data & Information Manually or Verbally

ICoE 10 – Cross-level intelligence date through courier and disk-to-disk data transfers

10. Reduce OPTEMPO of the Operation
Description: Loss of information and rapid dissemination provided by SFE will require operations to be conducted at a more deliberate pace.

MCCoE 10 – Reduce OPTEMPO of the Operations

11. Reduce Distance Between Units
Description: Units reposition to be within LOS communications distances.

MCCoE 11 – Reduce distance between units

12. Increase Use of Graphic Control Measures
Description: Increase the number of graphic control measures (phase lines, coordination points, fire control measures, etc) used in operations to facilitate position reporting and situational awareness as well as maintaining control of the operation.

MCCoE 12 – Increase Use of Graphic Control Measures

13. Incorporate Loss of SFE Into Concepts
Description: Expand Army and Joint Operating Concepts to include Degraded/Denied Space Annexes. Current and future Operating Concepts warn and advise the force to train and be prepared for "worst case" denied space scenarios, but these concepts lack the necessary specificity of how the force will operate under those conditions.

MCCoE 13 – Incorporate Loss of SFE into Concepts

14. Maintain National Map Production Capabilities
Description: Maintain National Map Production Capabilities with Capability to Surge Production and Reproduction as Required. Soldiers are routinely trained in the use of paper maps for navigation and position location and reporting.

MCCoE 14 – Maintain National Map Production Capabilities

MSCoE 7 – Maintain National Map Production

15. Review / Modify OPLANS
Description: Review and, as needed, modify existing OPLANS and CONPLANS to account for actions which may be necessary to mitigate the loss or degradation of SFE. Many "immediate action" mitigation actions involve the repurposing of assets to mitigate the loss of SFE or the constriction of units to LOS distances. Planners can anticipate these requirements by reviewing OPLANS in an SFE degraded or denied environment and identify what additional assets or actions, such as fielding Geo-spatial Engineer Teams, deploying databases and analytic capability forward, changes to the scheme of maneuver or scheme of support, or adjusting task organization, would be required to accomplish the mission under those conditions.

MCCoE 15 – Review / Modify OPLANS
MCoE 7 – Attach more UAVs to the deployed forces
ICoE 2 – Deployment of Databases & Analytic Capability Forward in Support of Operations
ICoE 5 – Provide centralization of weather support within LOS footprint
ICoE 11 – Multi-Int and persistent surveillance in aerial Intelligence Collection Layer
ICoE 12 – Airborne Intelligence Collection support to BCT and below
FCoE 5 – Additional survey teams from non-deployed units
SCoE 1 – Push vs Pull philosophy set in place
SCoE 2 – The Brigade Sustainment Automation Support Management Officer (SASMO) Planning
SCoE 3 – SCOE3-The Brigade Support Operations (SPO) and SASMO develop a Theater Support Plan.

16. Modify Training Policy
Description: Modify Operating and Generating Force Training Policy to require all formations participating in CTC or MCTP exercises conduct, as a minimum, one mission where the training audience must collectively plan, prepare, execute and assess an operation using manual Mission Command TTPs.
MCCoE 16 – Modify Training Policy

17. Continue to Develop the JALN Concept
Description: Continue to develop the Joint Aerial Layered Network (JALN) concept to provide extended range voice and data communications. The JALN concept calls for bridging disparate radio systems to relay voice and data communications, create communication conference patches between radios and common phone systems, provide Link 16 and SADL access, and integrate Naval Automatic Identification System (AIS) data.
MCCoE 17 – Continue to develop the JALN Concept

18. Modify MOA/Statement of Requirement with Air Force to Provide Weather Support
Description: Ensure that AFW provides adequate "single-station analysis" training for forecasters assigned to support Army operations. The Army receives weather support from AFW IAW a Statement of Requirements (SOR) which is updated every 2 years or so. This agreement must describe to AFW the Army's need for weather support personnel training on these important procedures. Requesting this support is no guarantee that the AF is willing/able to do such. However, the SOR is the vehicle to initiate this requirement from AFW.
MCCoE 18 – Modify MOA/Statement of Requirement with Air Force to Provide Weather Support
ICoE 4 – Adequate training of AF weather support personnel on "single station analysis" processes / techniques

19. Develop a Terrestrial Layer Network Capability
Description: Develop a High Bandwidth Networking Radio (HNR) - like capability and deploy at echelons down to company level. This terrestrial based, LOS system is capable of handling the bandwidth requirements necessary for synchronized operations for units within LOS distances of other units.
MCCoE 19 – Develop a Terrestrial Layer Network Capability

20. Multi-Payload Capability for UASs

Description: Ensure appropriate low-level, Army owned UASs are capable of carrying multiple payloads to include RETRANS, HNR (or similar capability) and other systems so they may be repurposed to mitigate loss or degradation of SFE.

MCCoE 20 – Multi-payload Capability for UASs

MCoE 6 – Devote UAVs to retrans mission

21. Develop a GPS Surrogate

Description: Develop a GPS surrogate compatible with current GPS receivers. A GPS surrogate can overpower the weaker signal from the constellation in space. Since it is closer to the earth and has stronger emitting signal than a satellite in space, a surrogate will mitigate some of the effects of GPS jamming or spoofing.

MCCoE 22 – Develop a GPS Surrogate

MCoE 4 – GPS surrogate

FCoE 4 – Network GPS

FCoE 6 – Use of Inertial Navigation and Dead Reckoning

AvCoE 1 – Alternate Navigation solutions

AvCoE 2 – Alternate Position Solutions

22. Develop Persistence Platforms

Description: Develop and field persistence platforms capable of carrying systems which replicate SFE system capabilities. There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms will be able to provide communication extension, expansion and Intelligence Collection for direct support.

MCCoE 21 – Develop Aerostats

MCCoE 23 – Develop Persistence Platforms

ICoE 11 – Multi-Int and persistent surveillance in aerial Intelligence Collection Layer

ICoE 12 – Airborne Intelligence Collection support to BCT and below

ICoE 13 – Persistence Platform

SigCoE 2 – Using aerial layer networking capabilities

23. Update IPADS

Description: Update the Improved Position Azimuth Determining System (IPADS) to be more compact and maintain accuracy standards. Mount the IPADS on unit leader vehicles. This will allow Platoon Leaders and up to create their own Survey Control Points (SCPs). The SCPs can be shared with other units.

MCCoE 24 – Update IPADS

FCoE 7 – Update IPADS to be more compact and maintain accuracy standards

24. Requirement to Confirm Long Range Fires (BDAR) by Visual Means

Description: Fires currently rely on other resources to provide deep targeting BDA. Lack of Space ISR and the ability to forward that information that will impact Fires ability to sense, assess, and disseminate

engagement results. Results would impact timeliness of BDA and re-engagement of targets. Fires Cell would request "eyes on" resources through the supported and joint units.

FCoE 1 – Requirement to confirm long range fires (BDAR) by visual means

25. Using Aerial Layer Networking Capabilities

Description: Aerial layer networking capabilities allow for greater distances between units, and can provide the network infrastructure required to route information from a degraded space environment to point where SATCOM can be accessed. The Commander must remember more UAS dedication to network support means fewer UAS available to support the other missions. However, degraded or denied PNT adversely effects the operation of UASs, possibly to the point of making them non-mission capable. SigCoE 2 – Using aerial layer networking capabilities

ICoE 7 – Alternate Communications Pathways

MSCoE 4 – Transmit over theater communications assets

Appendix C, Centers of Excellence Mitigating Actions, to the Degraded Space Mitigation Strategy

This appendix lists the mitigating actions as submitted by the Centers of Excellence in their individual reports (Annexes I – VIII). These mitigating actions were consolidated into the list found in Appendix B.

Mission Command CoE

1. Increase Use of LOS Communications
Description: Units at all echelons will increase reliance on LOS communications. LOS networks include capabilities such as the Warfighter Information Network-Tactical (WIN-T) HNR, Troposcatter Wideband Radio, JTRS, and SINCGARS. Included is the RETRANS capability of LOS networks.

2. Increase Air Defense Posture
Description: Increase in manning/operating timelines. Issues will be to identify scheduled maintenance impacts; and, TTP's are developed in the event of space based denial. Due to the anticipated reduction in PK, additional ADA assets should be considered for force packages.

3. Operate Systems in a Disconnected Environment
Description: System operators must be capable of manually updating systems and operating those systems while disconnected from the network or a portion of the network.
Systems must be capable of receiving manual updates.

4. Navigate Using Map and Compass
Description: Soldiers navigate using map and compass.

5. Prioritize Traffic & Communications
Description: Commanders' limit data transmission to only that data deemed important to them. This may include the total shutdown of some systems to prevent them from calling for data from the network.

6. Recognize Denied / Degraded SFE Conditions
Description: Operators and/or systems must be capable of recognizing denied or degraded SFE conditions. Staffs must be able to identify the causes of SFE degradation or denial and provide commanders with an estimate of the duration of the event.

7. Repurpose Available Assets
Description: Repurpose assets under the commander's control to fill a more critical need no longer being provided by SFE. Examples include utilizing platforms (aerial and vehicle) as retrans or tasking forces to perform reconnaissance missions.

8. Deploy Alternate Command Posts
Description: Equip commanders and principal battle staff officers with the means to rapidly form and displace mobile and survivable tactical command posts to facilitate mission command at forward locations.

9. Transfer Data & Information Manually or Verbally
Description: Data and information are passed via voice means or using storage media, written reports, etc. Increased reliance on spot reports, unit status reports, etc will be required.

10. Reduce OPTEMPO of the Operation
Description: Loss of information and rapid dissemination provided by SFE will require operations to be conducted at a more deliberate pace.

11. Reduce Distance Between Units
Description: Units reposition to be within LOS communications distances.

12. Increase Use of Graphic Control Measures
Description: Increase the number of graphic control measures (phase lines, coordination points, fire control measures, etc) used in operations to facilitate position reporting and situational awareness as well as maintaining control of the operation.

13. Incorporate Loss of SFE into Concepts
Description: Expand Army and Joint Operating Concepts to include Degraded/Denied Space Annexes. Current and future Operating Concepts warn and advise the force to train and be prepared for "worst case" denied space scenarios, but these concepts lack the necessary specificity of how the force will operate under those conditions.

14. Maintain National Map Production Capabilities
Description: Maintain National Map Production Capabilities with Capability to Surge Production and Reproduction as Required. Soldiers are routinely trained in the use of paper maps for navigation and position location and reporting.

15. Review / Modify OPLANS
Description: Review and, as needed, modify existing OPLANS and CONPLANS to account for actions which may be necessary to mitigate the loss or degradation of SFE. Many "immediate action" mitigation actions involve the repurposing of assets to mitigate the loss of SFE or the constriction of units to LOS distances. Planners can anticipate these requirements by reviewing OPLANS and modifying them as necessary to include planning factors which address denied and degraded SFE environments, as well as by identify what additional assets or actions, such as fielding Geo-spatial Engineer Teams, deploying databases and analytic capability forward or adjusting task organization, would be required to accomplish the mission under those conditions.

16. Modify Training Policy
Description: Modify Operating and Generating Force Training Policy to require all formations participating in CTC or MCTP exercises conduct, as a minimum, one mission where the training audience must collectively plan, prepare, execute and assess an operation using manual Mission Command TTPs.

17. Continue to Develop the JALN Concept
Description: Continue to develop the Joint Aerial Layered Network (JALN) concept to provide extended range voice and data communications. The JALN concept calls for bridging disparate radio systems to relay voice and data communications, create communication conference patches between radios and common phone systems, provide Link 16 and SADL access, and integrate Naval Automatic Identification System (AIS) data.

18. Modify MOA/Statement of Requirement with Air Force to Provide Weather Support
Description: Modify agreement with Air Force to ensure weather personnel are adequately trained on "single station analysis" processes/techniques. The Army receives weather report from the Air Force IAW an agreement which is updated every 2 years. This agreement must be updated to indicate the requirement to utilize single station analysis processes and techniques.

19. Develop a Terrestrial Layer Network Capability
Description: Develop a High Bandwidth Networking Radio (HNR) - like capability and deploy at echelons down to company level. This terrestrial based, LOS system capable of handling the bandwidth requirements necessary for synchronized operations for units within LOS distances of other units.

20. Multi-Payload Capability for UASs
Description: Ensure appropriate low-level, Army owned UASs are capable of carrying multiple payloads to include RETRANS, HNR (or similar capability) and other systems so they may be repurposed to mitigate loss or degradation of SFE.

21. Develop Aerostats
Description: Develop and field aerostat blimps capable of carrying systems which replicate SFE system capabilities.

22. Develop a GPS Surrogate
Description: Develop a GPS surrogate compatible with current GPS receivers. A GPS surrogate can overpower the weaker signal from the constellation in space. Since it is closer to the earth and has a stronger emitting signal than a satellite in space, a surrogate will mitigate some of the effects of GPS jamming or spoofing.

23. Develop Persistence Platforms
Description: Develop and field persistence platforms capable of carrying systems which replicate SFE system capabilities. There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms will be able to provide communication extension, expansion and Intelligence Collection for direct support.

24. Update IPADS
Description: Update the Improved Position Azimuth Determining System (IPADS) to be more compact and maintain accuracy standards. Mount the IPADS on unit leader vehicles. This will allow Platoon Leaders and up to create their own Survey Control Points (SCPs). The SCPs can be shared with other units.

Appendix C, Centers of Excellence Mitigating Actions, to the Degraded Space Mitigation Strategy

Maneuver CoE

1. Leader training and awareness
Description: Leaders need to understand the potential vulnerabilities to space systems our Army has grown accustomed to. They need to understand near-peer and regional hegemon adversaries have the capability to negate or deny space based capabilities we have relied on during previous conflicts.

2. Training without GPS and BFT
Description: Commanders need to train their units in scenarios where GPS is not available. Units should train using map and compass in mounted and dismounted navigation. Land navigation is a perishable skill. The more training unit's receive the more proficient they will become and the less of a learning curve to overcome in the event the unit deploys to a contingency where GPS can be denied. There may be an aversion to this training. However, of all the space capabilities that can be denied GPS signals can be jammed or spoofed locally by a savvy adversary using off the shelf technology.

3. CPs to battle tracking using paper maps
Description: BFT feeds and auto populating COPs are dependant of GPS signal to populate location of icons on COPs. If COPs cannot auto populate, then they cannot be used to battle track.

4. GPS surrogate
Description: The Army needs to look at possibly having a GPS surrogate ready to deploy to an area where the potential of GPS denial can occur. The technology for a surrogate already exists. However, this would require an aerial platform or high altitude platform to mount these surrogates in and around the area of operation. Aerial platforms will be vulnerable to enemy air defenses. A high altitude platform would be safer since it can fly above the reach of enemy ADA assets.

5. Use of maneuver forces for reconnaissance
Description: Because some PIRs could not be collected against due to National constellations failure to contribute to the intelligence picture and UAVs not conducting efficient reconnaissance due to lack of PNT. Since more maneuver forces would need to be devoted to the reconnaissance effort, these maneuver units will be taken away from the close fight. However with current BCT 2020 redesign, particularly the additions of a third CAB in ABCT and IBCT, this makes the option a possibility. Not optimum or desired, but these new redesigned formations could be better suited to operate in a scenario where our ISR will be degraded and maneuver units will need to be devoted to collect PIR.

6. Devote UASs to Retrans mission
Description: However, that UAS will not be able to perform ISR if fitted with the communications relay package.

7. Attach more UASs to the deployed force
Description: To compensate for UASs devoted to a Retrans mission, more UASs may be necessary if we know a force can deploy to a contingency where the denial of SATCOM can occur. A detachment of additional UASs could be part of a deployable contingency package.

Appendix C, Centers of Excellence Mitigating Actions, to the Degraded Space Mitigation Strategy

Intelligence CoE

1. Utilization of Intelligence Platforms as Retrans Platforms

Description: Shadow TUASs currently have the ability to deploy with Retrans capability and have been used in that capacity in Iraq and/or Afghanistan. Currently, there are 4 Shadow TUAVs in a BCT and a BCT is generally able (in terms of personnel and logistical support) to deploy 2 air frames simultaneously to support operations. Utilizing Shadows as Retrans platforms rather than ISR platforms reduces the ability of the BCT to conduct effective reconnaissance--unless Shadow platoons are augmented with personnel and additional air frames. Adding additional personnel and TUAS systems to formations allows formations to continue to collect intelligence at current levels of capacity in addition to conducting communications Retrans missions. This facilitates full-spectrum offensive and defensive operations. Tactical and operational UASs will be degraded or non-mission capable due to inability to track geographic signal while landing and taking off.

2. Deployment of Databases & Analytic Capability Forward in Support of Operations

Description: A variety of agencies participate in the translation, development, and analytic process of turning raw data into intelligence. These agencies typically deploy personnel and equipment forward in support of the GWOT, even though, in some cases, a large part of the analytic and technical work is still done in CONUS. This recommendation moves a sufficient number of analysts forward, along with databasing capability, and physical equipment to support the intelligence requirements of forward-deployed U.S. forces. This requirement would change based not just on U.S. force deployment size and requirements, but also in terms of mission requirements by phase of operation (in terms of SIGINT, IMINT, and biometrically-enabled intelligence). If this capability is deployed forward, U.S. forces could "reach-back" utilizing either LOS capability or re-transmitted communications. If this capability remains back in the U.S. while satellites are down, U.S. forces will lack access to large portions of several important forms of intelligence.

3. Adequate training of AF weather support personnel on "single station analysis" processes/ techniques

Description: Denied weather satellite imagery cannot be replaced/augmented by any other means. Baseline weather satellite imagery provides comprehensive , near real-time SA over the AO. Fully utilized imagery and atmospheric sounding also assists in producing more accurate weather forecasters in support of all Army operations. Army aviation operations are especially vulnerable to weather conditions (winds, visibility, ceiling height, etc). Without reliable satellite imagery and data, forecasting these weather parameters becomes less reliable. Also, reliability of forecasting severe weather (thunderstorms, dust storms, tornadoes, etc) is noticeably degraded without weather satellite imagery. Result: -- Weather satellite "denied" -- Operational forecast accuracy decreased by 30%, weather support mission overwatch capabilities decreased by 40% (Div and below operations)
-- Weather satellite "degraded" -- -- Operational forecast accuracy decreased by 15%, weather support mission overwatch capabilities decreased by 20% (Div and below operations). Without replacement of imagery capabilities, environmental SA/SU will certainly suffer. Weather forecast accuracy will decrease along with the ability to provide effective mission watch (difficult or impossible to monitor military operations environmental conditions during the course of mission execution). This training recommendation is only a partial fix (approximately 15% of lost satellite capabilities mitigated).

4. Provide centralization of weather support within LOS footprint

Description: Create augmented weather support cell(s) at Corps/Division/CAB level /Naval or theater-level that have line-of-sight communications with deployed operational, lower echelon units. These augmented weather cells will produce centralized weather products for all deployed units, and disseminate weather support products utilizing the LOS communications capability. This mitigation recommendation assumes that any newly formed, centralized weather support cell(s) can somehow receive updated weather data from within theater to process into weather support products that support all deployed operations (i.e., Naval Oceanographic Command [Naval] support to land based operations from afloat). Centralized weather support cells, especially in smaller or environmentally consistent regions, can distribute effective weather updates to lower levels via LOS communications.

5. Prophet Operator Training

Description: Operator training must stress "Operation under unusual conditions", particularly, training the Prophet Sensor & Control operators to establish voice & data links without PNT. The recommendation is to train Prophet Control operators to manually acquire satellite link. TTPs must be developed and rehearsed to ensure operators are proficient on tasks and steps to take if data/voice or satellite communications are disrupted. System set-up, employment and pre-mission checks will require more time to complete in a denied/degraded PNT environment due to additional steps being required. Doctrine exists to mitigate this issue, but it is not currently stressed at the "schoolhouse". Manual synchronization, especially with more emphasis on these procedures, will mitigate implications of time de-synchronization issues.

6. Alternate Communications Pathways

Description: Operation under unusual conditions will have to stress using alternate communications/ networking routes to access TDNs 1-3. The Prophet Control has the capability to tie into alternate network access points via LAN cables. Signal Corps assets must provide some sort of terrestrial access to SIPRNET, JWICS, and NSANET. Once the Prophet Control is connected to the networks, the Control and Sensors can operate as normal. Instead of being self-reliant for access to TDNs 1-3, the Prophet Control must rely on Signal Corps assets to establish communications paths. This will slow down SIGINT reporting and analysis until Signal Corps can build a robust enough terrestrial network.

7. TS-II operators using manual actions ("crew drills") to operate the GPS & ACC (antenna control system)

Description: Operator training must stress "Operation under unusual conditions". Particularly, training the TS-II operators to manually acquire satellite link. TTPs must be developed and rehearsed to ensure operators are proficient on tasks and steps to take if PNT is denied/degraded. This shouldn't add more than 10-15 minutes extra time to an initial set-up if the crew is proficient on their set-up drills. System set-up, employment and pre-mission checks will require more time to complete in a denied/degraded PNT environment due to the additional steps required.

8. Utilization of terrestrial SIGNAL assets

Description: TS II operators will be trained in procedures to connect through the Corps/Div/BfSB WIN-T (Signal Corps) assets of the supported elements for reach back to access to SIPRNET, JWICS and NSANET. This will be the standard operating procedures as WIN-T increments 2 &3 are fielded to all

units. This will slow down all Intelligence reporting and analysis until Signal Corps can build a robust terrestrial network.

9. Cross-leveled intelligence data through courier services and disk-to-disk data transfers. However, convoy operations in forward areas will experience slowed or restricted support due to a change in the overall OPTEMPO

Description: The BAT-A and handheld variants currently used in theater can write data to, and read data from, standard computer disks. These disks are then shared with other collection systems. One or more couriers are needed to conduct operations up and down the chains to the nearest theater repository or communications access to the national (DoD) data repository. This process is currently utilized in theater in areas that lack LOS communications and/or ready access to a SIPR connection. This is manual sharing of data.

10. Multi-INT and persistent surveillance in aerial Intelligence Collection layer

Description: Develop concepts, doctrine, and TTP that address the introduction of multi-INT and persistent surveillance capabilities of the Aerial Intelligence Collection layer. This includes manned and unmanned teaming focused on find, fix, finish, exploit, analyze, and disseminate (F3EAD). This alleviates the over dependence on National level systems and establishes concepts, doctrine, and TTP that address the introduction of multi-INT and persistent surveillance capabilities of Aerial Intelligence Collection not currently optimized for CAM and WAS.

11. Airborne Intelligence Collection support to BCT and below

Description: Revise affected ICoE and MCOE doctrine (FMs, TCs, TTPs) to reflect current and projected changes to the employment of Airborne Intelligence Collection assets (traditional and non-traditional) in direct support to Brigade Combat Teams and subordinate units. Common doctrinal inputs and language must evolve whenever possible in multiple documents. Additional inputs to augment base information will be developed and included as needed. The focus of the new doctrine will be on implementation of the U.S. Army Aerial Layer Platform and Sensors (ALPS) Strategy and Joint Direct Airborne Intelligence, Surveillance and Reconnaissance (JDSAISR) Initial Capabilities Document (ICD) in support of overall Intelligence Collection operations.

12. Persistence Platform

Description: There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms are able to provide communication extension, expansion and Intelligence Collection for direct support to the tactical user.

Fires CoE

1. Requirement to confirm long range fires (BDAR) by visual means

Description: Fires currently rely on other resources to provide deep targeting BDA. Lack of Space ISR and the ability to forward that information will impact Fires ability to sense, assess, and disseminate engagement results. Results would impact timeliness of BDA and re-engagement of targets. Fires Cell would request “eyes on” resources through the supported and joint units.

2. Increased Air Defense posture

Description: Increase in manning/operating timelines. Issues will be to identify scheduled maintenance impacts. TTP's are developed in the event of space based denial.

3. Revert to firing standard MET for all missions

Description: This is a standard MET. Weather conditions from firing platform to target are not factored into a firing solution. This provides FA units the ability to provide quick/timely fire support; however, corrections due to weather may be required.

4. Network GPS

Description: Requires a node/location other than the firing point (FP) to have connection to GPS (no distance restrictions). The precision round can be initialized and fired. The assumption is the round will pass to an area that can receive GPS signals; Increases the number of precision rounds that could be fired, assuming GPS denial is localized and pin-pointed at firing units.

5. Additional survey teams from non-deployed units

Description: Supplementing existing survey teams with those from non-deployed units would assist in ensuring firing units have accurate firing point location. This supplement probably would not assist the dismounted observers in a quickly moving situation to more accurately locate themselves or their targets. If this capability is deployed forward, U.S. forces could "reach back" utilizing either LOS capability or re-transmitted communications. If this capability remains back in the U.S. while satellites are down, U.S. forces will lack access to large portions

6. Use of Inertial Navigation and Dead Reckoning

Description: Most of the Field Artillery Systems firing vehicles, radars, and mounted observers have inertial navigation systems with known error rates. Accuracy degrades over distance travelled at known rates. This does provide reliability for precision fires over dead-reckoning or map spots, at least initially from a Survey Control Point. Survey is still required, but not for each position.

7. Update the Improved Position Azimuth Determining System (PADS) to be more compact and maintain accuracy standards

Description: Mount the IPADS on unit leader vehicles. This will allow Platoon Leaders and up to create their own Survey Control Points (SCPs). The SCPs can be shared with other units. SCP can be established at firing unit and radar locations without having to be brought forward from distant locations.

<u>Maneuver Support CoE</u>

1. Alternative Communications Package

Description: Maneuver Support & Protection **(**MSP) units will have to access alternative communications packages, such as WIN-T (Inc 2) for voice and data connectivity for reachback to technical centers of expertise from theater to CONUS during denied/degraded SATCOM conditions. Although WIN-T (Inc 2) systems will be more jam resistant than current systems, they still will not be

entirely jam-proof. This will delay operations (slow OPTEMPO) as they will have to leave their location, travel to an access point either at the MEB, BCT, other functional Bde, ESB, or DIV/Corps TOC, conduct their collaboration with the technical agency, and continue with their mission. This action will provide an alternate means of communications with technical agencies using existing/programmed solutions.

2. Manual population of the COP (Command Post of the Future-CPOF)

Description: MSP units will be required to send critical populace control information to higher headquarters by voice communications over shorter range systems for updates to the COP during denied/degraded SATCOM conditions. This will delay the timely flow of information between units, and limit the timeliness of situation awareness updates for units that may be impacted by the presence of civilian population in and along the areas of maneuver. Doctrinal manuals will have to be updated to describe the manual process of updating the COP and for units sending information to their higher headquarters during denied/degraded SATCOM. Units will be required to provide an alternate method of sending updates to the COP when in a denied/degraded SATCOM environment.

3. Tactics, Techniques, and Procedures (TTPs) for increased use of LOS communications

Description: MSP units will send and receive critical populace control information with higher headquarters, adjacent and supported units, and host nation agencies over organic assigned communications equipment during denied/degraded SATCOM environment. This mitigation will enable communication between units, but will reduce the range and OPTEMPO of operations. Doctrinal manuals will have to be updated to describe TTPs for operating within limitations of using LOS communications during denied/degraded SATCOM conditions. This provides an alternate method of sending and receiving information with higher headquarters, adjacent and supported units, and host nation officials when in a denied/degraded SATCOM environment.

4. Transmit over theater communication assets

Description: Transmit all standard and sharable geospatial foundation (SSGF) updates and production using theater communication assets. The operational impact of using terrestrial communication assets to transmit data is considered to be low. Terrain updates are typically small, and are not anticipated to introduce a significant additional load demand on terrestrial signal operations.

5. Terrain navigation with map and compass w/training at BCT and below

Description: MSP units conducting clearance operations will have to conduct manual navigation during a denied/degraded PNT environment. Doctrine will need to be updated describing the requirement to conduct manual navigation, institutional training will need to place emphasis on training Soldiers and leaders to use map and compass to identify location and navigate point-to-point, and units will need to train during exercises in anticipation that automated navigational aids would not be available or degraded in future operations. This action will provide an alternate method to identify location, and navigate from point-to-point along routes while conducting clearance to support mobility of friendly forces. Manual navigation will slow the OPTEMPO.

6. Navigation training

Description: Add navigation training/emphasis to existing training during Initial Military Training and Leader Development courses, and incorporate at the unit level through individual and unit training, and training exercises. New training and emphasis on training will focus on identifying current location, location of enemy/points of interest, maintaining map boards, and navigating from point-to-point. Action will increase proficiency of Soldiers and leaders in positioning and navigation in order to conduct operations, navigate in a timely and safe manner, to track locations of units and personnel, and identify enemy locations and activities, in order to increase OPTEMPO in a safe and confident manner when digital capabilities are not available or are degraded.

7. Maintain national map production

Description: To provide hardcopy maps for this capability requires that the National Geospatial-Intelligence Agency (NGA) maintain its hardcopy map production capability. Planned reduction of hardcopy map production by NGA must be maintained with the capability to surge production and reproduction, as required. Using hardcopy maps is more time consuming, and lacks the accuracy of GPS systems, but all Soldiers are routinely trained in map use for navigation and position location and reporting. Supplementing electronic systems with standardized hardcopy maps and charts provides users an established means to determine and report their location.

8. Use stored and replicated map data

Description: Use stored and replicated map data and implement other position determination techniques. Using non-GPS surveying techniques, and using stored and replicated data will provide Standard and Shareable Geospatial Foundation (SSGF) capable location information. Survey processes provide highly accurate location data for targeted locations, and dead-reckoning navigation processes provide an alternative to GPS navigation and location services. This will create a surge requirement for hardcopy maps that may exceed current production capabilities and logistical planning factors. NGA has announced its intent to reduce/eliminate reproduction of hardcopy maps. This mitigation requires the capability to produce and/or reproduce maps in bulk quantities. Tactical Geospatial Engineers do not have this capability.

9. Use manned and unmanned aerial vehicles (UAV) to augment satellite terrain imagery production

Description: The use of manned and unmanned aerial platforms to perform aerial mapping operations provides ideal platforms for all requirements to include standard, multi-spectral, Light Detection and Ranging (LIDAR), and nonstandard products (Buckeye). Both helicopters and fixed wing aircraft can be used for aerial mapping, but the higher altitude and speed capabilities of UAVs or fixed wing aircraft make them a more desirable platform. Currently, aviation assets are used for high resolution imagery and special missions. Greater terrain coverage by aerial assets will be required which will indirectly limit those assets for use in other mission sets.

Sustainment CoE

1. Push versus Pull philosophy set in place

Description: The use of an effective "Logistics Pull" system requires uninterrupted communications to ensure effectiveness. The key mitigation for the Sustainment community would be to adopt a "Logistics Push" paradigm. Used to forecast consumables, this will not be as efficient or materially economical, but will provide supplies and stock based on staff planning data from operational histories, estimates and SOPs. Other commodities such as repair parts will require a different method of ordering and that too will be inefficient.

2. The Brigade Sustainment Automation Support Management Officer (SASMO) Planning

Description: The SASMO plans for hostile interference toward the Tactical Sustainment Network i.e. Combat Service Support Very Small Aperture Terminal (CSS-VSAT). Planning includes: Reviewing and implementing applicable preventive measures; Providing immediate counter actions and troubleshooting upon discovery of hostile actions; Reporting hostile actions to the network manager and chain of command; Providing procedures for transitioning automated sustainment operations into Network Enterprise Center (NEC) Active Directory Organizational Unit (AD OU) capability. In an immature theater, Providing procedures for transitioning automated sustainment operations into WIN-T as a redundant network.

3. The Brigade Support Operations (SPO) and SASMO develops a Theater Support Plan

Description: The SASMO includes Tactical Sustainment Network force protection measures, responses to hostile interference, and response procedures in his theater support plan.

4. Soldiers require increased training in land navigation tasks and map reading; Watercraft operators maintain skills in celestial navigation, radio positioning, and dead reckoning

Description: DARPA has made progress with development of a timing & inertial measurement unit (TIMU) that contains everything needed to aid navigation when GPS is temporarily unavailable. The single chip TIMU prototype contains a six axis IMU (three gyroscopes and three accelerometers) and integrates a highly-accurate master clock into a single miniature system, smaller than the size of a penny. This chip integrates breakthrough devices (clocks, gyroscopes and accelerometers), materials and designs from DARPA's Micro-Technology for Positioning, Navigation and Timing (Micro-PNT) program. Additionally, other technical strategies such as Pseudolites, RF-based systems, and Multi-sensor devices are under development.

5. Sustainment movement tracking systems operations

Description: Unit level training may be required to ensure operators understand the implications and functionality of tracking system operations. Increased training in HF radio (such as SINCGARS) is needed to communicate with organic HQs and coordinate with convoy/SSA/Harbor control activities and with supported units.

6. Automated sustainment business systems operations

Description: Soldiers require increased training in radio relay procedures, preparation of paper versions of documents for couriers, increased reliance on localized reference databases or SOPs for such disparate functions as medical diagnosis and/or vehicle cannibalization procedures.

7. Sustainment Mission Command System (Battle Command Sustainment Support System BCS3)

Description: Soldiers require increased training in radio relay procedures, preparation of paper versions of documents for couriers, increased reliance on localized references, databases or SOPs. Use manual procedures and hard copy documents. Leaders must consider both the individual and collective training requirements in planning, preparing and executing unit training plans.

Aviation CoE

1. Alternative Navigation solutions i.e. INS or terrain flight navigation

Description: Use onboard Inertial Navigation System (INS) and/or Terrain flight navigation. DOTMLPF implications are in the training domain. Training for Inertial Navigation System and Terrain flight navigation is conducted in flight school. Alternative navigation solutions are INS and/or terrain flight navigation. INS is an onboard navigation system which is integrated with GPS.

2. Alternative position solutions (i.e. INS)

Description: Use onboard INS. DOTMLPF implications are in the training domain. Presently, training for INS is conducted in flight school. Alternative position solutions are INS-related. INS is an onboard navigating system which is currently integrated with GPS.

3. Fall back on use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization

Description: Fall back on use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW. DOTMLPF implications are in the training domain. Presently training for Communications is part of flight school POI. Mitigation is through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization. Additional coordination is required to ensure synchronization with other elements.

4. Use of HAVEQUICK, SINCGARS, LINK-16, SRW, WNW and/or dedicated communications relay

Description: HAVEQUICK, SINCGARS, LINK-16, SRW and WNW. DOTMLPF implications are in the training domain. Communications training is part of flight school program of instruction (POI). Mitigation is through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW.

5. Use of dedicated LOS communication links to operate UAS

Description: Use Line of Sight (LOS) communication links to operate UAS. DOTMLPF implications are in the training domain. Using LOS communication links to operate UASs is part of training. Mitigation is through the use of LOS links to operate UAS.

Signal CoE

1. TTPs within the Signal units will mitigate connectivity issues

Description: Directing traffic typically routed over SATCOM to the terrestrial LOS/aerial layer capabilities will provide connectivity. Commanders will have to prioritize traffic so that network planners can ensure that critical information is still delivered in a timely manner.

2. Using aerial layer networking capabilities

Description: Aerial layer networking capabilities allow for greater distances between units, and can provide the network infrastructure required to route information from a degraded space environment to a point where SATCOM can be accessed. The Commander must remember more UAS dedication to network support means fewer UAS available to support the other missions.

Annex I, Mission Command Center of Excellence Degraded Space Assessment, to the Degraded Space Mitigation Strategy

Army Mission Command

Degraded Space Assessment

16 August 2013

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Annex I, Mission Command Center of Excellence Degraded Space Assessment, to the Degraded Space Mitigation Strategy

1. Introduction.

a. Purpose. The purpose of this report is to describe the approach and results of the Mission Command Degraded Space Review which identifies failed mission command tasks, operational issues, and potential mitigating actions resulting from the loss or degradation of Space Force Enhancement (SFE) to the operational force. This report will be combined with results from similar reviews conducted by each of Army Training and Doctrine Command's (TRADOC) Centers of Excellence (CoE) into an overall Degraded Space Review final report. That report will be subsequently integrated into the on-going Mission Command Capability Based Assessment (MC CBA 13) as an extension of that assessment.

b. Background.

(1) Advances in information technologies have given warfighters sophisticated tools for gathering, sharing, disseminating, storing and displaying information. One result of these advances is that the Army operations process has transitioned from being supported by space-based capabilities to being truly enabled by and reliant upon them. Space capabilities are now integral to the conduct of military operations. Current doctrine and the Army's future concept of Integrated Distributed Operations (IDO), as well as the Joint concept of Globally Integrated Operations (GIO) continue this reliance on SFE. Both of these concepts are extensions of the Army's current operating concept of Unified Land Operations (ULO). Envisioned are agile, responsive combined arms teams guided by Mission Command/Joint Command and Control, enabled by a collaborative network of systems to achieve decisions by creating advantages over adversaries through the deliberate use of physical separation and mutually supporting independent tactical actions. Through SFE, the network is expected to provide near real-time situational awareness (SA), allowing the force to rapidly adapt to changes in the operational environment; achieve cross domain synergy; present adversaries with multiple simultaneous dilemmas; cause a disaggregated adversary to re-aggregate while friendly forces mass the effects of combat power, from distributed locations, to defeat or destroy them. Concurrently, adversaries have recognized our reliance on SFE and have developed or begun development on methods to deny SFE to U.S. forces.

(2) On 5 June 2012, the Senior Army Space Council (ASC) identified the need for the Army to develop a "Strategic Level" DOTMLPF assessment of denied or degraded space capabilities and a strategy to employ mitigation techniques at the tactical level. MG Bartell, TRADOC ARCIC, stated that TRADOC ARCIC would take the lead in conducting this assessment. On 12 October 2012, the TRADOC G33 issued TRADOC TASKORD IN122865 Subject: Degraded Space DOTMLPF Review, (S//NF), which tasked CAC and the MCCoE to identify and incorporate into the MC CBA 13 operational mitigation actions associated with denial or degradation of space-based capabilities. This TASKORD gave CAC tasking authority over organizations in support for the purpose of the TASKORD. Each CoE was tasked to support this review within the scope of their respective Warfighting Function (WfF) with the MC CoE, as the lead for the MC CBA 13, having the responsibility for leading the effort.

(3) On 7 November 2012, FRAGO 1 to the base task order was issued and, on 28 November 2012, FRAGO 2 to the base task order was issued, modifying execution timelines and responsibilities. The MC CBA 13 FSA completion was extended to 31 October 2013 in order to accommodate the conduct and completion of this Degraded Space Review.

c. Bottom Line Up Front (BLUF): Denied or significantly degraded satellite communications (SATCOM) is a point of failure for the Army's ability to conduct Mission Command, a foundation of the Army's Capstone Concept of Unified Land Operations. While the other elements of SFE contribute to the overall picture and the commander's SA, it is SATCOM's ability to provide a beyond line-of-sight (BLOS) network which ultimately enables Mission Command as envisioned by doctrine and future concepts. The loss or significant degradation of SFE, in particular SATCOM, undermines the Army's ability to execute integrated distributed operations (IDO), a key to the future operating concepts (ACC and Capstone Concept for Joint Operations) executed within the scenario studied. This loss of capability is not readily mitigated by actions which units can take themselves. Because of this, planners must take into account the possibility of operating within SFE degraded or denied environments and adjust plans accordingly.

2. Approach.

a. Constraints, Limitations, and Assumptions. The Degraded Space Review was conducted under the following constraints, limitations and assumptions:

(1) Constraints:

(a) Completion dates for the Degraded Space Review were fixed by the Tasking Order, so the study team was constrained by the time available.

(b) The time available for the conduct of the review constrained consideration of scenarios to the ISC-B scenario specified in the Tasking Order.

(2) Limitations.

(a) A certified modeling and simulation (M&S) tool capable of fully modeling impacts of degraded space capabilities on the conduct of mission command does not exist. This limited the review to the use of subject matter experts (SME), professional military judgment (PMJ), and qualitative analysis approaches.

(b) The availability of critical SME support was limited by their participation in multiple or parallel CBAs and other studies in related and supporting areas, to include the Capability Needs Assessment (CNA) process.

(c) Consideration of classified scenarios and addressing classified aspects of space-based capabilities limited the efficiency of the conduct of the analysis by the study team.

(3) Assumptions. The following assumptions were made upon initiation of the review and were subsequently determined to be valid.

(a) Any updates to the Army Functional Concept for Mission Command, or to other Army functional concepts, during 2013 would not be so significant as to require the study team to redo major portions of its review.

(b) The Army force structure was likely to decrease due to budget constraints, but this would not result in any significant changes to Army required capabilities.

(c) The operational environment defined by TRADOC G2's Operational Environments to 2028: The Strategic Environment for Unified Land Operations adequately represents the timeframe of the Degraded Space Review.

(d) All non space-based systems included as part of the capability baseline (fielded or in the POM with a Management Decision Document (MDD)) would be fielded on schedule and with the capabilities specified in their approved requirement documentation.

b. Scope. The Degraded Space Review is scoped similar to that of the MC CBA. This includes the following:

(1) The review examines Mission Command as executed by Army echelons from Company (either within a Brigade Combat Team or, in some cases, companies, troops and batteries within the Maneuver BN Formation) through Theater Army/Army Service Component Command (ASCC) level.

(2) This review addressed capabilities and vulnerabilities for Army units operating with Unified Action Partners and organizations.

(3) This review addressed all Army tasks of decisive action, across all domains and the electromagnetic spectrum (EMS).

(4) This review included consideration of an operational capability baseline provided by currently fielded, or being fielded (Capability Set 13) systems, and by systems which are considered "program of record" systems (in the POM and having reached Milestone B) with initial operational capability (IOC) scheduled by 2020 or earlier. The operational capability baseline for the Degraded Space Review, however, did not include space capabilities.

(5) This review addressed required capabilities which are considered scenario independent (required in any scenario), as well as unique requirements derived from consideration of the ISC-B scenario.

c. Methodology. The methodology executed for the Degraded Space involved identifying SFE dependencies within the Mission Command Warfighting Function (WfF), executing a map exercise (MAPEX - a type of wargame) using the Corps and Division Scenario Integrated Security Construct-B (CDS ISC-B) scenario (described below) under SFE enabled and SFE denied conditions to identify failed tasks and issues, and then identifying actions to mitigate those issues. This methodology consisted of four tasks as follows:

(1) Identify SFE Dependencies. The Mission Command Working Group (MCWG), consisting of representatives from each CoE, identified the mission command systems and processes with SFE dependencies. This was done by examining MC systems to identify data sources and how data was passed from the source to the system. Any dependency on SFE was identified. Systems identified in this step are located in Appendix A (Systems With SFE Dependencies) of this report.

(2) Identify Failed Tasks. For this step in the process, the MCWG conducted a MAPEX using the CDS ISC-B scenario under SFE enabled and SFE denied conditions. Given the systems with SFE dependencies, the MCWG identified MC tasks from the on-going MC CBA which would fail in an SFE

denied environment. Those tasks which were assessed as not being able to be conducted to standard were designated as “failed tasks”. These tasks, along with specific rationale for being identified as a failed task, are documented in Appendix B (Failed Tasks Under Degraded/Denied SFE Conditions). Tasks which failed due to lack of other capabilities (non-space capabilities) are not included for the purpose of this study.

(3) Identify Issues. In addition to using the MAPEX to identify failed tasks, operational issues arising under SFE denied conditions were identified and examined to verify they were the result of the loss of SFE. The issues were then staffed with the Mission Command Integrated Capability Development Team (ICDT) and any comments from ICDT members adjudicated and applied to issue definitions. These issues are described in operational terms and documented in paragraph 3.b.(2) of this report. The resulting operational issues identified in this MC review will be integrated with operational issues identified by the other CoEs as part of the overall Degraded Space Review.

(4) Identify Mitigating Actions. For this step in the process, the MCWG researched and solicited from the MC ICDT potential actions to mitigate the operational issues identified in the previous step. These include actions which can be executed prior to or during an operation, as well as those which must be executed over time during the standard Joint Capabilities Integration and Development System (JCIDS) process. All potential actions proposed are documented in Appendix D (Potential Mitigating Actions). As with a CBA, materiel solutions will be proposed only if other non-materiel actions will not mitigate the operational issue. As with issues, mitigating actions identified in this MC review will be integrated with the mitigating actions identified by the other CoEs and subsequently prioritized as part of the overall Degraded Space Review.

d. Scenario Overview. In accordance with TRADOC guidance and associated task orders, the MCWG utilized the CDS ISC-B scenario to establish the conditions and context for conducting the Degraded Space Review.

(1) Summary: CDS ISC-B depicts a U.S. force conducting Joint Forcible Entry Operations (JFEOs) in 2020. The base scenario involves Phase 0 through V operations. Phases II and III include airborne and amphibious assaults to seize ports of entry and the insertion of combat aviation, armor, Stryker, and infantry brigade combat teams to defeat threat capabilities. Desired end-state conditions are restoration of freedoms of navigation and commerce, defeating threat capabilities adversely influencing the region to include attacks against regional critical infrastructure. Regional partner capacity is increased to defend against future threat efforts and to deter the threat from taking further destabilizing actions. U.S. forces are postured to ensure freedoms of navigation and commerce and to deter further threat aggression.

(2) Characteristics:

(a) Scenario Classification: SECRET/NOFORN

(b) Terrain: Arid climate, coastal marshland and plains transitioning inland into foothills then rugged mountainous terrain.

(c) Operation: A phase 0-V joint scenario with a corps-led JFEO, to include a U.S. Army Division and a MEF conducting decisive offensive operations supported predominantly by sea-based joint fires and sustainment.

(d) Opposing forces: Conventional and paramilitary forces provide an OE-compliant scenario with an adaptive, learning threat. (Threat capabilities are assumed to possess the means, either organic or through 3rd party support, to deny and/or degrade U.S. Space Force Enhancement (SFE) areas of: (1) Satellite Communications (SATCOM); (2) Intelligence, Surveillance, and Reconnaissance (ISR); (3) Positioning, Navigation and Timing (PNT); (4) Missile Warning (MW); and (5) Environmental Monitoring (EM).

(e) Duration: Years (phase 0-V) with approximately a 60-day period focused on phase II and phase III operations.

(f) Features: JFEOs in an environment with significant logistics challenges, extended lines of communication, joint fires and missile defense challenges.

e. MAPEX. The ICDT conducted a MAPEX executing the CDS ISC-B scenario with SFE intact and again with SFE denied as a worst case scenario to identify issues. In wargaming the scenario, the ICDT focused on phase II (Seize the Initiative) and phase III (Dominate) operations. Three key events within these phases were analyzed in detail: the initial entry operations and expansion of the lodgment, the main body executing the approach march from the lodgment area to assault positions, and seizing of the final objective. The following synopsis describes these three phases of the operation.

(1) Initial Entry Operations and Expansion of the Lodgment. Key tasks included the seizure of a semi-remote coastal airfield by an Airborne Brigade Combat Team (BCT) and simultaneous amphibious assault by a Marine Expeditionary Brigade to seize a nearby port facility. Forces were dispersed over a 40-square kilometer area that included urban areas, littoral marshlands, coastal plains, and inland foothills. Mission Command was executed by a controlling Division Headquarters located over 100 kilometers away at the Initial Staging Base (ISB).

(2) Approach March from Lodgment to Assault Positions. Mission Command was exercised over a 170 kilometer approach march with Armor and Stryker BCTs attacking abreast over an axis of advance 30 to 60 kilometers wide and the Airborne BCT left in the initial lodgment. The Division Headquarters remained in the Initial Staging Base over 100 kilometers from the Airborne BCT and over 200 kilometers from the Armor and Stryker BCTs. During the approach march, numerous small towns and villages were bypassed, with follow-on forces securing these areas along two principal routes resulting in pockets of friendly forces isolated along the 170km route. Air assault forces seized key chokepoints throughout the depth of the rugged, mountainous terrain, resulting in further dispersal of forces beyond line-of-sight communications ranges.

(3) Seizing the Final Objective. The decisive operation involved the Armor and Stryker BCTs seizing key terrain in and around a medium size built-up area. Lines of communication between the division and brigade command posts were over 200 kilometers, and in certain cases, up to 100 kilometers between brigade and battalion command posts. Company teams routinely operated 30 to 40 kilometers away from battalion command posts

Annex I, Mission Command Center of Excellence Degraded Space Assessment, to the Degraded Space Mitigation Strategy

3. Results

a. Results With SFE Enabled. The following synopsis recaps the MAPEX results with SFE intact for each decisive point.

(1) Decisive Point #1 (Initial Entry Operations and Expansion of the Lodgment). Through SFE ISR, SATCOM and PNT, the forced entry operation was rapidly executed with near-real time friendly and threat situational awareness, enabling dispersed forces to quickly mass fires and defeat threat attempts to counter the entry operation.

(2) Decisive Point #2 (Approach March from Lodgment to Assault Positions). Through the LandWarNet, enhanced logistical situational awareness enabled timely evacuation of friendly casualties, and through automated tracking of Class I, III, IV and V expenditures, the companies were supplied and readied before the threat could re-attack. SATCOM enabled coordinated, synchronized operations despite forces being beyond line-of-sight communications range from their controlling command post and each other. Through persistent reconnaissance and surveillance coverage to support information collection, friendly position location, a shared vision/COP and collaborative decision-making, the battalions and brigade controlling the air assault forces were able to make effective and efficient execution and adjustment decisions to rapidly mass Army and Joint fires. This agility enabled isolated company teams to defeat or destroy attacking enemy brigade size and larger formations. The result was a secure flank and sustainment base, an unimpeded approach march and arrival of the main body at their assault positions.

(3) Decisive Point #3 (Seizing the Final Objective). Given the high operating tempo (OPTEMPO) and distributed application of friendly combat power, the enemy was quickly overwhelmed by multiple simultaneous dilemmas. Units leveraged shared situational awareness and the ability to quickly bring precision Army and Joint fires at critical times and places on the battlefield. The result was an enemy unable to coordinate an effective defense, and friendly forces meeting limited resistance in seizing the final objective. The network-enabled mission command system provided the means for effective control of a reinforced division size unit over a 240 kilometer deep, and 60 kilometer wide area in urban, mountainous and open terrain.

b. Results With SFE Denied or Degraded.

(1) Degraded vs Denied SFE. The difference between denial and degradation of SFE to the operational force was not a function of bandwidth or throughput – it was a matter of meeting the commander's needs. When SFE did not provide the commander with the necessary communications, information, SA, or PNT necessary to execute the mission, that commander had to utilize alternative means and expend additional resources to regain at least some of that capability. This also applies when only part of the force was in a denied or degraded SFE environment – affected commanders still had to utilize alternate means and expend additional resources to regain the capability / information lost and their ability to provide information to the rest of the force was compromised.

(2) The issues identified throughout the operation were similar and are summarized below for the SFE which most contributed to the issue. See Appendix C (Operational Issues Under Degraded/Denied SFE Conditions) for a more detailed description of the issues.

(a) SATCOM. The loss of SATCOM brought the transfer of data to a halt. Systems no longer received or sent updates to other systems and had to be updated manually as information became available. This resulted in significant latency in updating the situation and the loss of a Common Operating Picture (COP) across the force. This became more confused in a degraded environment when systems would update with information that was older than information which had been manually entered. Collaboration and synchronization between organizations dispersed beyond line-of-sight distances became extremely limited. Assets had to be repurposed to form additional RETRANS vehicles and teams to man them in order to maintain control in battalion areas. The division headquarters and BCT command posts became isolated from their subordinates, adjacent units, and higher headquarters. Long-term loss of SATCOM virtually eliminated the Army's ability to execute mission command over the distances required in the scenario and envisioned by our doctrine and our future concepts. Long-term loss or degradation forced a significant change to the scheme of maneuver by forcing units to within LOS range of subordinate and adjacent units as well as a significant reduction in OPTEMPO as information flow to commanders at all echelons was reduced.

(b) Intelligence, Surveillance, and Reconnaissance (ISR) SFE. Loss of ISR forced the repurposing of combat power for use as reconnaissance forces and a change to the scheme of maneuver. The repurposed combat power caused a change to the force ratios, requiring additional forces to achieve the same force ratio throughout the operation. The scheme of maneuver and OPTEMPO were significantly reduced as the operation became a movement to contact against an unknown enemy.

(c) Positioning, Navigation, and Timing (PNT). Loss of PNT caused a significant reduction in commanders' ability to track their own forces as well as reducing OPTEMPO as units were forced to navigate manually. Information and communication systems lost the ability to communicate as communication systems' timing became de-synchronized, or drifted. GPS guided precision fires were unavailable, causing a change to logistics planning as more non-guided munitions were required.

(d) Early Warning. Loss of early warning reduced the reaction time of forces to ballistic missile attack and limited the ability to respond to launches.

(e) Environmental Monitoring (EM). Loss of EM prevented the timely reporting of weather conditions to the force.

(3) Given the impacts of denied or degraded SFE, the loss of SATCOM proved most difficult for the force to overcome while executing the CDS ISC-B scenario. The preparation and communication of orders and directives proved inefficient and untimely. The lack of long-range communications resulted in extended periods where subordinates operated out of contact with one another. The inability to collaborate and the lack of force-wide situational awareness resulted in uncoordinated, independent actions, versus achieving mass through the synergistic effects of an organized team operating in concert with one another, the force applied combat power in a piecemeal manner. OPTEMPO was significantly reduced, giving the enemy time to identify and counter the friendly scheme of maneuver. Friendly losses in personnel and equipment were high. These losses, combined with widespread collateral damage and loss of civilian life, created negative perceptions both at home and abroad, generating world-wide demands to cease hostilities short of strategic objectives.

(4) The above MAPEX/wargame outcomes are symptomatic of a Mission Command system that has grown so reliant on SFE that without it, the Army's ability to conduct Unified Land Operations, much less Integrated Distributed Operations, is seriously undermined. The operations process was reduced to the manual/analog techniques and procedures of the "Air-Land Battle" Army of the 1980s and early 90s. While those manual/non-digital techniques and procedures are still viable, the force is not trained or equipped to apply them in an era of assumed assured digital connectivity.

4. Mitigation Actions. Given the impacts of operating in a denied or degraded space environment, the ICDT identified four lines of effort (LOE) for mitigating the loss of SFE. The first LOE addresses those immediate actions that a deployed force can employ, given resources currently on-hand as part of the force deployment package, to minimize the impacts of degraded space and continue the mission. The second LOE identifies operational adjustments which units can execute if the commander deems them to be necessary. The third LOE involves policy and contingency planning to prepare for operations in an SFE denied or degraded environment. The fourth line of effort entails the development of materiel solutions in the aerial and terrestrial layers. Details for the mitigating actions can be found in Appendix D.

a. LOE #1 (Immediate Actions): The ICDT MAPEX/wargame identified immediate actions that the deployed force could take, assuming no additional resources are available, to mitigate the loss or degradation of SFE and continue the mission. It must be noted that while these are actions which units take in an operational environment, the Army must develop doctrine and conduct training for forces expected to carry out these actions. This doctrine development and training must occur before undertaking operations where SFE is at risk. The actions identified, in no particular priority, are as follows:

(1) Increase Use of LOS Communications

(2) Increase Air Defense Posture

(3) Operate systems in a Disconnected Environment

(4) Navigate Using Map and Compass

(5) Prioritize Communications Traffic

(6) Recognize Denied / Degraded SFE Conditions

b. LOE #2 (Operational Adjustments): In addition to actions which units can take immediately, there are actions which units can take which can help mitigate long-term loss or degradation of SFE. These adjustments require a commander’s decision to make adjustments which affect the operation such as the reallocation of assets or the repositioning of units. The trade-off is the time required to implement as these actions require adjustments that will take hours or even days to implement.

(1) Repurpose Available Assets

(2) Deploy Alternate Command Posts

(3) Transfer data and Information Manually or Verbally

(4) Reduce OPTEMPO of the Operation

(5) Reduce Distance Between Units

(6) Increase Use of Graphic Control Measures

c. LOE #3 (Policy and Contingency Planning): There were several deficiencies identified which could be mitigated with changes to the OPLAN such as allocating additional resources, or which could be mitigated by changes to policy.

(1) Incorporate Loss of SFE into Concepts

(2) Maintain National Map Production Capabilities

(3) Review / Modify OPLANS

(4) Modify Training Policy

(5) Continue to Develop the JALN Concept

(6) Modify MOA/Statement of Requirements (SOR) with Air Force to Provide Weather Support

d. LOE #4 (Materiel Solutions): Materiel solutions can, in general, mitigate some part of the capability which would be lost by replicating some part of the network, or by providing an alternative means of providing a service. In general, only high-altitude, persistence platforms which replicate area coverage provided by satellites can mitigate the loss of an SFE provided capability to the point where operations can be conducted in accordance with current concepts.

(1) Develop a Terrestrial Layer Network Capability

(2) Multi-Payload Capability for UASs

(3) Develop Aerostats

(4) Develop a GPS Surrogate

(5) Develop Persistence Platforms

(6) Update IPADS

5. Conclusions.

a. The execution of Mission Command in the ISC-B scenario is dependent upon Space Force Enhancements, particularly satellite communications. The scenario's emphasis on coordinated, synchronized action between widely dispersed forces and headquarters operating in non-contiguous areas of operations requires a voice and data communications system capable of operating beyond line-of-sight with the capacity necessary to meet the various commanders' needs. This is currently only

achievable with SATCOM. While the other elements of SFE contribute to the overall picture and the commander's SA, it is SATCOM which ultimately enables Mission Command. The loss or significant degradation of SFE, in particular SATCOM, undermines the Army's ability to execute integrated distributed operations (IDO), a key to the future operating concepts (ACC and Capstone Concept for Joint Operations). Degraded or denied satellite communications (SATCOM) is a point of failure for network-enabled MC, a foundation of the Army's Capstone Concept of Unified Land Operations.

b. The difference between denial and degradation of SFE to the operational force is not a function of bandwidth or throughput – it is a matter of meeting the commander's needs. If SFE does not provide the commander with the necessary communications, information, SA, or positioning, navigation and timing (PNT) which is timely, accurate, and reliable enough to execute the mission, then that commander must utilize alternate means and, most likely, expend additional resources to regain at least some of that capability.

c. The loss of most SFE is not readily mitigated by actions which units can take themselves, particularly for short-term outages. While it is possible to manually update most of the various Mission Command systems, it is the transfer of the data needed to update them which is problematic when SFE is denied or degraded. Units do not own communications systems capable of beyond line-of-sight communications (outside of those enabled by SFE) and the operational changes required to mitigate the loss of SFE, such as deploying additional RETRANS, couriers, or LNOs, are time consuming and not effective at mitigating short-term outages.

d. Actions which units can take to mitigate the loss of SFE only provide a fraction of the capability lost. Regardless of what actions are taken to communicate with higher headquarters, subordinate, and adjacent organizations, the ability to pass data in time to meet commander's needs throughout the force cannot be re-created. While manual (map and compass) navigation can be done, it does not automatically report positioning throughout the force, nor does it provide the timing which allows systems to synchronize with one another.

e. Units must plan and train for the contingency of denied or degraded SFE. The likelihood of an adversary developing the ability to deny or significantly degrade our SFE capabilities continues to increase. They recognize both our reliance on SFE and the advantages SFE provides our forces.

Appendix A (Systems with SFE Dependencies) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

The purpose of this appendix is to provide a list of the Mission Command or Mission Command-related systems, utilized within the context of the ISC-B scenario, that are either directly or indirectly dependant on Space Force Enhancement (SFE) in order to perform their functions. Loss or degradation of SFE can cause the system to no longer function adequately to meet commanders' / users' needs and may require alternative means to perform the functions normally performed by these systems.

- Advanced Field Artillery Tactical Data System (AFATDS)
- Air Defense Systems Integrator (ADSI)
- Air/Missile Defense Planning and Control System (AMDPCS)
- Army Human Resource Systems (AHRS)
- Army Missile Defense Warning System (AMDWS)
- Aviation Mission Planning System (AMPS)
- Battle Command Sustainment Support System (BCS3)
- Blue Force Tracker (BFT)
- Combat Service Support Automated Information Systems Interface/Very Small Aperture Terminal (CAISI/VSAT)
- Command Post of the Future (CPOF)
- Computerized Movement Planning and Status System
- Defense Readiness and Reporting System-Army (DRRS-A)
- Digital Fire Control System (DFCS)
- Distributed Common Ground System - Army/ Digital Topographic Support System (DCGS-A / DTSS)
- Effects Management Tool (EMT)
- Enhanced Medium Altitude Reconnaissance and Surveillance System (EMARSS)
- Fire Control Computer (FCC)
- Force XXI Battle Command, Brigade-and-Below (FBCB2)
- Forward Area Air Defense Command and Control (FAADC2)
- Global Combat Support System-Army (GCSS-A)
- Global Command & Control System – Army (GCCS-A)
- GPS-guided Precision Munitions
- Guardrail Common Sensor (GRCS)
- Gun Display Unit-Replacement (GDU-R)
- GPS-guided Unmanned Aircraft System (UAS), Tactical Unmanned Aircraft System (TUAS), and Tactical Unmanned Aerial Vehicles (TUAV)
- Integrated C4ISR System Framework (ICSF)/ Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)
- Joint Battle Command-Platform (JBC-P)
- Joint Automated Deep Operations Coordination System (JADOCS)
- Joint Planning and Execution System (JOPES)
- Joint Worldwide Intelligence Communications System (JWICS)
- Maneuver Control System (MCS)
- Medical Communications for Combat Casualty Care (MC4)
- Nett Warrior

Appendix A (Systems with SFE Dependencies) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

- Non-classified Internet Protocol (IP) Router Network (NIPRNET)
- Paladin Digital Fire Control System (PDFCS)
- Property Book Unit Supply Enhanced (PBUSE)
- PROPHET
- Secret Internet Protocol Router Network (SIPRNET)
- Standard Army Ammunition System (SAAS)
- Standard Army Maintenance System (SAMS)
- Standard Army Management Information System (STAMIS)
- Standard Army Retail Supply System (SARSS)
- Tactical Airspace Integration System (TAIS)
- Tactical Ground Reporting System (TIGR)
- Theater Army Medical Management Information System (TAMMIS)
- Unit Level Logistics System (ULLS)
- Universal Fire Control System (UFCS)

Appendix B (Failed Tasks Under Degraded / Denied SFE Conditions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

The purpose of this appendix is to provide a list of the Mission Command (MC) tasks the MC Working Group (MCWG) identified and assessed as failed tasks. These MC tasks were identified during execution of the Corps and Division Scenario Integrated Security Construct-B (CDS ISC-B) by Army echelons; and, they could not be conducted to standard in a Space Force Enhancement denied or degraded environment. The conditions during assessment are noted in the CDS ISC-B scenario. These failed tasks contributed to the development of the operational issues noted in Appendix C, Operational Issues Under Degraded/Denied SFE Conditions. The MC tasks are noted below with their number designation, task title and description, and the specific rationale for identification as failed tasks.

Task # 13.1 **Task Title:** Conduct the Operations Process

Task Description: The operations process consists of the major mission command activities performed during operations: planning, preparing, executing and continuously assessing the operation. The commander drives the operations process through understanding, visualizing, describing, directing, leading, and assessing operations. The activities of the operations process may be sequential or simultaneous. They are usually not discrete; they overlap and recur as circumstances demand.

Why Task Failed. Task failed due to failure of tasks 13.1.1, 13.1.2, 13.1.3, and 13.1.4, all of which are key component tasks.

Task # 13.1.1 **Task Title:** Plan Operations

Task Description: Planning is the art and science of understanding a situation, envisioning a desired future, and laying out effective ways of bringing that future about. Planning helps commanders create and communicate a common vision between commanders, their staffs, subordinate commanders, and unified action partners. Planning results in a plan and orders that synchronize the action of forces in time, space, and purpose to achieve objectives and accomplish missions. Methodologies that assist commanders and staffs with planning include the Army design methodology, the military decision-making process (MDMP), and troop leading procedures (TLP).

Why Task Failed. Units are unable, in the time available, to gather necessary information from, collaborate with, or disseminate information and orders to units that are beyond the range of line-of-sight communications and operating in non-contiguous areas of operations.

Task # 13.1.2 **Task Title:** Prepare for Operations

Task Description: Preparation consists of those activities performed by units and Soldiers to improve their ability to execute an operation. Preparation creates conditions that improve friendly forces' opportunities for success. It requires commander, staff, unit, and Soldier actions to ensure the force is trained, equipped, and ready to execute operations. Preparation activities help commanders, staffs, and Soldiers understand a situation and their roles in upcoming operations.

Why Task Failed. Units are unable to collect information necessary to answer commanders' CCIR. Units are unable to track status of units beyond line-of-sight communications range. Units are unable to conduct virtual rehearsals.

Appendix B (Failed Tasks Under Degraded / Denied SFE Conditions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Task # 13.1.3 **Task Title:** Execute Operations

Task Description: Execution is putting a plan into action by applying combat power to accomplish the mission.

Why Task Failed. Units are unable to synchronize operations with subordinate and adjacent units operating outside of line-of-sight range, especially in non-contiguous areas of operation. Commanders' are unable to maintain an accurate assessment of the situation, both friendly and enemy.

Task # 13.1.4 **Task Title:** Assess the Situation and Operational Progress

Task Description: Assessment is the determination of the progress toward accomplishing a task, creating an effect, or achieving an objective. Assessment precedes and guides the other activities of the operations process. Assessment involves deliberately comparing forecasted outcomes with actual events to determine the overall effectiveness of force employment. More specifically, assessment helps the commander determine progress toward attaining the desired end state, achieving objectives, and performing tasks. It also involves continuously monitoring and evaluating the operational environment to determine what changes might affect the conduct of operations.

Why Task Failed. The force is unable to maintain a Common Operating Picture. Units are unable to effectively monitor the situation. Commanders are unable to accurately evaluate the situation. Staffs are unable to maintain accurate running estimates.

Task # 13.2 **Task Title:** Organize Mission Command System (Personnel, Network, Info Systems, Processes and Procedures, Facilities and Equip)

Task Description: Apply knowledge management to support the commander in organizing the mission command system. At every echelon, commanders use knowledge management to configure and organize their mission command system to support their ability to make decisions and communicate. The mission command system is the arrangement of personnel, LandWarNet, information systems, processes and procedures, and facilities and equipment that enable commanders to conduct operations. Knowledge management is embedded into all underlying processes and activities. Commanders apply knowledge management to tailor and organize their mission command systems to achieve a qualitative information advantage to ensure tactical and operational success.

Why Task Failed. Task failed due to failure of task 13.2.2, a key component task.

Task # 13.2.2 **Task Title:** Conduct Information Management

Task Description: Information Management is the science of using procedures and information systems to collect, process, store, display, disseminate, and protect data, information, and knowledge products. Information Management supports, underpins and enables Knowledge Management. The two are linked for a common purpose that is to facilitate shared situational understanding and decision making. Information management procedures and information systems go beyond technical control of data flowing across networks.

Appendix B (Failed Tasks Under Degraded / Denied SFE Conditions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Why Task Failed. Units are unable to disseminate FFIR beyond line-of-sight distances in non-contiguous areas of operation. Unit is unable to establish communications connectivity with component intelligence agencies, combatant command and national intelligence agencies. Unit is unable to pass information in time to meet operational requirements. Unit is unable to disseminate COP and execution information.

Task # 13.3 **Task Title:** Conduct Inform and Influence Activities

Task Description: Units/staffs integrate designated information-related capabilities in order to synchronize themes, messages, and actions with operations to inform United States and global audiences, influence foreign audiences, and affect adversary and enemy decision-making. As a primary staff task under mission command, conduct inform and influence activities aids the commander to inform domestic and friendly audiences. It enables the commander to develop and maintain relationships with partners and influence adversary and enemy decision-making to gain an operational advantage.

Why Task Failed. Task failed due to failure of task 13.3.1, a key component task.

Task # 13.3.1 **Task Title:** Conduct Inform and Influence Activities (IIA) within the Operations Process

Task Description: The unit/staff plans the concept of Inform and Influence Activities; develop, coordinate and synchronize an IIA plan in accordance with the higher headquarters warning order, operations plan, operations order or fragmentary order and the Commander's guidance. Employ allocated information-related capabilities (IRCs) to best exploit their capabilities. The unit/staff is able to support operations in accordance with the commander's intent, the IIA paragraph, and the IIA annex (with overlay). Develop associated staff products and incorporate them into plans and orders including the high payoff target list, IIA effects tasks, and the target selection standard. Able to disseminate all support plans and staff products to higher, adjacent, subordinate, and supporting Unit/staff.

Why Task Failed. Units are unable to coordinate and synchronize IIA activities across the force. Units are unable to distribute IIA targeting information in a timely manner.

Appendix C (Operational Issues Under Degraded / Denied SFE Conditions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

1. Introduction. The purpose of this appendix is to document the operational issues under degraded/denied SFE conditions the Mission Command Work Group (MCWG) identified during execution of the Corps and Division Scenario Integrated Security Construct-B (CDS ISC-B) by Army echelons. The MCWG examined operational issues arising under SFE-denied conditions, and verified the issues were the result of the loss of SFE. The Mission Command (MC) Integrated Capability Development Team (ICDT), ICDT members' staffing comments were adjudicated, and applied to issue definitions. These issues are described in operational terms, and documented below under each Space Force Enhancement (SFE) as the effect(s) of the loss or degradation of that SFE.

2. The Operational Issues with each SFE.

a. Loss or degradation of SATCOM

(1) The lack of beyond line-of-sight voice and data transport eliminated the force's ability to effectively communicate, collaborate, and exchange relevant intelligence and information in a timely manner. This issue also applied to battalion and above command posts which were within line-of-sight due to all data transport and telephone communications between tactical CPs going through satellite.

(2) The loss of a global broadcast capability to provide internet protocol services denied the use of Microsoft Internet Explorer (MSIE) and Outlook for intra- and extra-theater Secret Internet Protocol Router Network (SIPRNET) and Non-classified Internet Protocol (IP) Router Network (NIPRNET) exchanges. Affected was the ability to reach-back and access both data repositories locally and at the COCOM and national agency levels.

(3) Without a network for data transfer, Command Post of the Future (CPOF), Maneuver Control System (MCS), Force XXI Battle Command, Brigade-and-Below (FBCB2), Blue Force Tracker (BFT), Tactical Ground Reporting System (TIGR), Joint Battle Command-Platform (JBC-P), Nett Warrior and other technical maneuver systems were denied the ability to portray and populate the common operational picture (COP); pass fire support messages, overlays, send status reports and orders; free text, or send tactical email.

(4) Advanced Field Artillery Tactical Data System (AFATDS), Joint Automated Deep Operations Coordination System (JADOCS), Tactical Airspace Integration System (TAIS), Aviation Mission Planning System (AMPS), and Effects Management Tool (EMT) were unavailable to coordinate, synchronize, and control Army and Joint fires, or provide fires SA and COP. The lack of Universal Fire Control System (UFCS), Digital Fire Control System (DFCS), Gun Display Unit-Replacement (GDU-R), Paladin Digital Fire Control System (PDFCS) and Fire Control Computer (FCC) all impacted the control and development of firing solutions for High-Mobility Artillery Rocket System (HIMARS), Multiple Launch Rocket System (MLRS), and cannon artillery systems. Firefinder and Lightweight Counter Mortar Radar (LCMR) systems were equally affected, denying the force responsive counter fire and counter mortar capabilities.

(5) Airspace management and situational awareness were lost due to the absence of the Air/Missile Defense Planning and Control System (AMDPCS), Forward Area Air Defense Command and Control (FAADC2), Air Defense Systems Integrator (ADSI), Army Missile Defense Warning System (AMDWS), and the TAIS systems. The loss of Sentinel sensor cueing to provide Identification Friend or

Foe (IFF) early warning prevented proactive Patriot, Terminal High Altitude Area Defense (THAAD) and Avenger airborne threat engagements and increased the risk of fratricide.

(6) Logistics was significantly impacted to the point of near paralysis. The Sustainment Communications Network, Combat Service Support Automated Information Systems Interface/Very Small Aperture Terminal (CAISI/VSAT), Battle Command Sustainment Support System (BCS3) and the Global Combat Support System-Army (GCSS-A) were unavailable to provide required support to the force including supply, maintenance, property accounting, logistics SA and common operational picture. In the maintenance area in particular our sophisticated weapon systems derive approximately 70% of required repair parts directly from national sources unavailable during extended communications outages. The entire suite of Standard Army Management Information System (STAMIS), to include the Global Combat Support System-Army (GCSS-A); the Medical Communications for Combat Casualty Care (MC4) system; the Standard Army Maintenance System (SAMS); the Standard Army Ammunition System (SAAS); the Standard Army Retail Supply System (SARSS); the Army Human Resource Systems (AHRS); the Property Book Unit Supply Enhanced (PBUSE); the Theater Army Medical Management Information System (TAMMIS); and Unit Level Logistics System (ULLS), were all unavailable to include a host of financial management and human resource sustainment systems.

(7) Loss of Distributed Common Ground System – Army / Digital Topographic Support System (DCGS-A / DTSS) prevented the timely updating and exchange of geospatial products and data. GCCS-A and access to the Defense Readiness and Reporting System-Army (DRRS-A) system; the Integrated C4ISR System Framework (ICSF)/ Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); the Joint Planning and Execution System (JOPES); and the Computerized Movement Planning and Status system all contributed to the lack of a "Top COP".

b. Loss or degradation of Positioning, Navigation & Timing (PNT)

(1) GPS enhanced air and ground navigation support was unavailable, slowing movement and reducing accuracy of position information.

(2) Differential timing capabilities that provide universal timing signals to synchronize information systems were unavailable, causing systems to “drift” and disrupting data transfer. Note: All digital operating systems run faster than real time due to ‘lost tick’ overcompensation. A SATCOM signal periodically synchronizes operating systems’ digital clock; this synchronization facilitates data transfer between digital systems.

(3) GPS-guided Unmanned Aircraft System (UAS), Tactical Unmanned Aircraft System (TUAS), and Tactical Unmanned Aerial Vehicles (TUAV) became ineffective or limited to line-of-sight, limiting units’ ability to perform reconnaissance, surveillance, and/or intelligence missions, and Battle Damage Assessment (BDA) tasks.

(4) GPS-guided precision munitions were unavailable causing an increase in required supply rate and an increase in civilian casualties and collateral damage.

c. Loss or degradation of Intelligence, Surveillance & Reconnaissance (ISR). The loss of ISR denied Joint Worldwide Intelligence Communications System (JWICS), DCGS / DCGS-A, and TIGR access to

information derived from all-source intelligence. Intelligence operations, from planning and direction, collection, processing and exploitation, analysis and production, dissemination and integration, evaluation and feedback were severely inhibited. Feeds from Dismounted Battle Command to Every Soldier as a Sensor (ES2) elements; Full Motion Video (FMV), incident reporting, biometrics, and CI/HUMINT enabling "the last tactical mile" were denied. The Army Airborne Intelligence Surveillance and Reconnaissance (A2ISR) layer consisting of Guardrail Common Sensor (GRCS), Enhanced Medium Altitude Reconnaissance and Surveillance System (EMARSS), GPS-guided UAS, TUAS, and TUAV became ineffective. Prophet, CI/HUMINT, Real-Time Regional Gateway (RT/RG) for targeting, tipping and cueing support, analyst tools and reporting to include the conduct of Battle Damage Assessment, were no longer available.

d. Loss or degradation of Environmental Monitoring (EM). The absence of EM denied critical meteorological data and weather forecasting needed for safety of flight aviation operations, field artillery operations, and other weather dependent activities.

e. Loss or degradation of Early Warning (EW). The absence of EW delayed critical information on ballistic missile attacks, reducing the commander’s SA and available reaction time.

Appendix D (Potential Mitigating Actions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

The purpose of this appendix is to provide a list of the potential mitigating actions the MC Working Group (MCWG) and MC ICDT identified and developed as actions to mitigate the degraded /denied Space Force Enhancement (SFE) conditions. The MCWG and ICDT identified potential alternative Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) actions to mitigate the operational issues identified during execution of the Corps and Division Scenario Integrated Security Construct-B (CDS ISC-B) by Army echelons. The operational issues are identified in Appendix C, Operational Issues Under Degraded/Denied SFE Conditions. The MCWG consolidated a proposed group of actions, staffed these consolidated actions with the MC ICDT, and then further refined the actions into 24 potential mitigating actions.

These alternative actions include actions which can be executed prior to or during an operation, as well as those which must be executed over time during the standard Joint Capabilities Integration and Development System (JCIDS) process. As with a CBA, materiel solutions will be proposed only if other non-materiel actions across the DOTMLPF-P domains will not mitigate the operational issue.

Those potential mitigating actions are documented below with their title, the operational issue(s) mitigated, the description, and the type and amount of impact the solution has on specific denied/ degraded SFE and their component parts.

1. **Increase Use of LOS Communications** **Issue(s) Mitigated:** SATCOM, PNT
Description: Units at all echelons will increase reliance on LOS Comms. LOS networks include capabilities such as HNR, JTRS, and SINCGARS
Impact: This solution somewhat mitigates SATCOM/LOS Voice by providing an alternate method with several systems of sending and receiving information with higher HQs, adjacent and supported units, and host nation officials when in a degraded/denied SATCOM environment; however, this solution mitigates very little SATCOM/BLOS, Voice and Data, and Situational Awareness/Friendly Data and Neutral Civ Info while providing a network on which the Friendly data and Civ Info may be sent.

2. **Increase Air Defense Posture** **Issue(s) Mitigated:** EW
Description: Increase in manning/operating timelines. Issues will be to identify scheduled maintenance impacts. TTP's developed in the event of space based denial. Due to the anticipated reduction in PK, additional ADA assets should be considered for force packages.
Impact: This solution somewhat mitigates Situational Awareness (SA)/Enemy, Point of Impact and Time-on-Target by providing more radar coverage time later in the missile flight with radars that might normally be down for maintenance; however, this solution mitigates very little SA/Enemy/Intel Data and Point-of-Origin by not having aerial layer ISR coverage available to detect a missile launch, and to establish a missile's flight track early in its flight.

3. **Operate Systems in a Disconnected Environment** **Issue(s) Mitigated:** PNT
Description: System operators must be capable of manually updating systems and operating those systems while disconnected from the network or a portion of the network. Systems must be capable of receiving manual updates.
Impact: This solution mitigates somewhat PNT/ Navig/Nav, and Timing/Data and Systems Ops; and, mitigates very little SATCOM/Comms/LOS & BLOS/Voice and Data, and Situational Awareness/ all

factors for Enemy, Friendly, and Neutral by populating manually the various digital systems, manually synchronizing the systems' timing, establishing voice and data links W/o PNT, using SSGF maps, and training without GPS and BFT.

4. **Navigate Using Map and Compass** **Issue(s) Mitigated:** PNT
Description: Soldiers navigate using map and compass.
Impact: This solution mitigates somewhat PNT/ Positioning/ PLI and Navigation/Nav by determining PLI through navigation with map and compass for units, and convoys, and Arty conducting mounted navigation using inertial guidance systems (and dead reckoning) to determine accurate firing unit locations, in conjunction with survey control points to assist delivery of precision fires, yet mitigating very little WRT PNT/ Precision Fires and Navigation/Nav.

5. **Prioritize Communications Traffic** **Issue(s) Mitigated:** SATCOM
Description: Commanders' limit data transmission to only that data deemed important to them. This may include the total shutdown of some systems to prevent them from calling for data from the network.
Impact: This action increases the likelihood that priority data and communications will make it to the intended recipient in a timely manner by reducing the amount of data competing for reduced bandwidth.

6. **Recognize Denied / Degraded SFE Conditions** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM
Description: Operators and/or systems must be capable of recognizing denied or degraded SFE conditions.
Impact: While not directly mitigating any of the operational issues identified in this study, it is critical that units recognize they are in a denied or degraded SFE environment so they can take appropriate steps to mitigate any reduction in capability.

7. **Repurpose Available Assets** **Issue(s) Mitigated:** SATCOM, ISR
Description: Repurpose assets under the commander's control to fill a more critical need no longer being provided by SFE. Examples include utilizing platforms (aerial and vehicle) as Retrans or tasking forces to perform reconnaissance missions.
Impact: This solution mitigates somewhat denial of SATCOM/Comms (all factors) and Situational Awareness/Enemy/Intel Data, Friendly Data/ Neutral /Terrain and Civilians by repurposing of available assets to provide an alternate means by which to fill a more critical need and accomplish tasks such as Retrans of LOS/BLOS Comms, and performing Recon to provide Friendly Data, Terrain and Civilian Info.

8. **Deploy Alternate Command Posts** **Issue(s) Mitigated:** SATCOM
Description: Equip commanders and principal battle staff officers with the means to rapidly form and displace mobile and survivable tactical command posts to facilitate mission command at forward locations.
Impact: This solution mitigates SATCOM/Comms/BLOS & LOS and Situational Awareness/Enemy/Intel Data, Friendly Data, Neutral/Terrain & Civ Info very little by maintaining a Cdrs' Mission Command with their forces while enroute to and operating at forward locations; however, a Cdr's operations from a

location which allows personal observations, provides a command presence, and maintains necessary MC functionality provides very little mitigation of degraded systems.

9. **Transfer Data & Information Manually or Verbally** **Issue(s) Mitigated:** SATCOM
Description: Data and information are passed via voice means or using storage media, written reports, etc. Increased reliance on spot reports, unit status reports, etc will be required.
Impact: This solution mitigates very little WRT SATCOM/Comms LOS/BLOS data transfer & Situational Awareness/ Enemy Intel data, Friendly data, and Neutral/Civ Info by manual sharing of data (BAT-A) thru transfer to computer discs and use of couriers; and, increase Tng to develop radio relay nets, use CAISI to train on Info/data transfer via voice means, storage media, written reports, status and spot reports.

10. **Reduce OPTEMPO of the Operation** **Issue(s) Mitigated:** SATCOM, ISR, PNT
Description: Loss of information and rapid dissemination provided by SFE will require operations to be conducted at a more deliberate pace.
Impact: The solution mitigates somewhat Situational Awareness (SA)/Friendly data by allowing commanders to gather friendly data that would have been provided by MC system thru SFE, and conduct operations at a reduced OPTEMPO, a more deliberate pace. The solution mitigates very little SA/Enemy Intel data and Neutral/Terrain Info due to the loss of capability to receive and rapidly disseminate Info and data.

11. **Reduce Distance Between Units** **Issue(s) Mitigated:** SATCOM
Description: Units reposition to be within LOS communications distances.
Impact: The solution mitigates somewhat SATCOM Comms/LOS and SA/Friendly Data and Civ Info by repositioning units to locate them within LOS Comms distances, thereby allowing synchronized operations. The solution mitigates very little WRT SATCOM/Comms/BLOS and SA/Enemy Intel Data due to the Recon/internal move of units to shorten distances between units in lieu of seeking contact with enemy forces.

12. **Increase Use of Graphic Control Measures** **Issue(s) Mitigated:** PNT
Description: Increase the number of graphic control measures (phase lines, coordination points, fire control measures, etc) used in operations to facilitate position reporting and situational awareness as well as maintaining control of the operation.
Impact: Increasing control measures mitigates the loss of PLI by giving units quick references to location and progress without having to develop exact grid coordinates for location.

13. **Incorporate Loss of SFE into Concepts** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM
Description: Expand Army and Joint Operating Concepts to include Degraded/Denied Space Annexes. Current and future Operating Concepts warn and advise the force to train and be prepared for "worst case" denied space scenarios, but these concepts lack the necessary specificity of how the force will operate under those conditions.
Impact: The solution mitigates all three operational issues and all associated factors within each of those issues very little by including Denied/Degraded Space annexes in Joint Operating Concepts to provide a unified vision that assists in driving the development of DOTMLPF-P mitigation solutions and actions.

Appendix D (Potential Mitigating Actions) to Annex I, Mission Command Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

14. **Maintain National Map Production Capabilities** **Issue(s) Mitigated:** PNT
Description: Maintain National Map Production Capabilities with Capability to Surge Production and Reproduction as Required. Soldiers are routinely trained in the use of paper maps for navigation and position location and reporting.
Impact: The solution mitigates very little Situational Awareness/Neutral/Terrain and PNT/PLI and Navigation/Nav by supplementing electronic systems with standardized hardcopy maps and charts to provide users an established means to determine and report their location.

15. **Review / Modify OPLANS** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM
Description: Review and, as needed, modify existing OPLANS and CONPLANS to account for actions which may be necessary to mitigate the loss or degradation of SFE. Many "immediate action" mitigation actions involve the repurposing of assets to mitigate the loss of SFE or the constriction of units to LOS distances. Planners can anticipate these requirements by reviewing OPLANS in an SFE degraded or denied environment and identify what additional assets or actions, such as fielding Geo-spatial Engineer Teams, deploying databases and analytic capability forward or adjusting task organization, would be required to accomplish the mission under those conditions.
Impact: The solution mitigates somewhat PNT/Positioning/PLI and Navigation/ Nav by supplementing existing Arty Survey teams and increasing the number of SCPs. However, the solution mitigates several other factors such as SATCOM/Comms/BLOS and SA/ Neutral/Weather and Terrain and PNT/ Positioning/Prec Fires by anticipating the loss of SFE, and providing additional assets to Cdrs to mitigate that loss, and creating centralized weather Spt cells while minimizing the loss of capability across the force. This solution allows planners to anticipate requirements and provide for Ops to maintain force ratios.

16. **Modify Training Policy** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM
Description: Modify Operating and Generating Force Training policy to require all formations participating in CTC or MCTP exercises conduct, as a minimum, one mission where the training audience must collectively plan, prepare, execute and assess an operation using manual Mission Command TTPs.
Impact: The CTC's, to include the MCTP, have historically served as "change agents" for the Army. Implementing this policy will result in units placing home-station training emphasis on non-digital mission command procedures in preparation for CTC participation. This solution mitigates somewhat SATCOM/Comms/LOS voice and data, and Situational Awareness (SA)/Enemy Intel Data, Friendly/Data, and Neutral/ Terrain and Civilian Info; PNT/ PLI and Navigation/Nav are somewhat mitigated. All other factors are mitigated very little by placing home-station training emphasis on non-digital MC procedures in preparation for CTC participation. That home-station emphasis mitigates risks associated with system vulnerabilities to environmental disruptions, threat interdiction, and equipment or power generation failure.

17. **Continue to Develop the JALN Concept** **Issue(s) Mitigated:** SATCOM
Description: Continue to develop the Joint Aerial Layered Network (JALN) concept to provide extended range voice and data communications. The JALN concept calls for bridging disparate radio systems to relay voice and data communications, create communication conference patches between radios and

common phone systems, provide Link 16 and SADL access, and integrate Naval Automatic Identification System (AIS) data.
Impact: This solution mitigates SATCOM/ Comms/LOS and BLOS partially and mitigates somewhat SA/Enemy/Intel Data, Friendly/Data and Neutral/Terrain by expanding the LOS voice and data Comms network beyond 2000KMs, bridging the disparate nature of radio systems, voice and data relay and Comms, and creating Comms patches between radios and common phone systems; and, mitigates the Neutral/ Civilian Info factor very little. The leadership/education aspect mitigates somewhat SATCOM/ Comms/LOS and SA/Intel Data, Friendly Data, and Neutral/Terrain and Civ Info with PNT/ Positioning/PLI and Navigation/Nav, while all other factors are mitigated very little by incorporating the teaching of non-digital MC procedures in leadership development and education.

18. **Modify MOA/Statement of Requirement with Air Force to Provide Weather Support** **Issue(s) Mitigated:** EM
Description: Modify agreement with Air Force to ensure weather personnel are adequately trained on "single station analysis" processes/techniques. The Army receives weather reports from the Air Force IAW an agreement which is updated every 2 years. This agreement must be updated to indicate the requirement to train on and utilize single station analysis processes and techniques.
Impacts: Provides weather forecasting capability without connectivity to weather satellites.

19. **Develop a Terrestrial Layer Network Capability** **Issue(s) Mitigated:** SATCOM
Description: Develop a High Bandwidth Networking Radio (HNR) - like capability and deploy at echelons down to company level. This terrestrial based, LOS system capable of handling the bandwidth requirements necessary for synchronized operations for units within LOS distances of other units.
Impact: This solution mitigates SATCOM/ Comms/LOS & BLOS (both voice and data) and Situational Awareness/ Enemy/Intel Data and Friendly/Data while Civ Info is mitigated very little. HNR mitigates by providing SIPRNET and NIPRNET voice and data services from DIV to CO level echelons; and, provides "drop-and-deploy" capabilities at static sites.

20. **Multi-Payload Capability for UASs** **Issue(s) Mitigated:** SATCOM, ISR, EW
Description: Ensure appropriate low-level, Army owned UASs are capable of carrying multiple payloads to include RETRANS, HNR (or similar capability) and other systems so they may be repurposed to mitigate loss or degradation of SFE.
Impact: This solution mitigates somewhat SATCOM/Comms/LOS and BLOS/ Voice, and SA/ Enemy/Intel Data and Friendly/Data by engineering the Shadow Unmanned Aircraft to become an aerial Comms node carrying single-channel radios designed to expand the LOS Comms network to 60 KMs. Comms/LOS and BLOS Data and SA/Neutral/Terrain and Civ Info are mitigated very little by the limited range and small data transfer rate/capacity of single-channel waveform radios that the aerial Comms node is carrying.

21. **Develop Aerostats** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM
Description: Develop and field aerostats capable of carrying systems which replicate SFE system capabilities.
Impact: This solution mitigates somewhat SATCOM/Comms/LOS and BLOS and Situational Awareness (SA)/Enemy/Intel Data, while SA/Neutral/ Civilians Info is mitigated very little by providing a

communication extension, expansion, and an ISR platform for direct support. This solution contains a doctrinal element that mitigates SA/Enemy/Intel Data and Neutral/ Civilian Info very little by developing the concepts, doctrine/TTP that serve to introduce and describe how to employ a Multi-Intel platform in the aerial layer.

22. **Develop a GPS Surrogate** **Issue(s) Mitigated:** PNT

Description: Develop a GPS surrogate compatible with current GPS receivers. A GPS surrogate can overpower the weaker signal from the constellation in space. Since it is closer to the earth and has a stronger emitting signal than a satellite in space, a surrogate will mitigate some of the effects of GPS jamming or spoofing.

Impact: This solution develops/employs a GPS-like surrogate system with two variants. A Pseudolite mitigates all PNT factors partially while somewhat mitigating SA/ Friendly Data. The GPS surrogate variant mitigates all PNT factors somewhat, and its employment with precision munitions mitigates very little of the Positioning factors and Navigation/Nav. This solution mitigates by positioning the system on terrestrial and/or aerial layer platforms where the systems' assured PNT capabilities (IAW the Tactical Assurance GPS Reference (TAGR) system) provide GPS capabilities; and, must be compatible with other RF-based systems such as JTRS, and with cell phones able to provide a timing signal.

23. **Develop Persistence Platforms** **Issue(s) Mitigated:** SATCOM, ISR, PNT, EW, EM

Description: Develop and field persistence platforms capable of carrying systems which replicate SFE system capabilities. There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms will be able to provide communication extension, expansion and Intelligence Collection for direct support.

Impact: This solution mitigates somewhat SATCOM/Comms/LOS and BLOS and Situational Awareness (SA)/Enemy/Intel Data, while SA/Neutral/ Civilians Info is mitigated very little by providing two types of persistence platforms, and both platforms act as a communication extension, expansion, and an ISR platform for direct support. This solution contains a doctrinal element that mitigates SA/Enemy/Intel Data and Neutral/ Civilian Info very little by developing the concepts, doctrine/TTP that serve to introduce and describe how to employ a Multi-Intel platform in the aerial layer.

24. **Update IPADS** **Issue(s) Mitigated:** PNT

Description: Update the Improved Position Azimuth Determining System (IPADS) to be more compact and maintain accuracy standards. Mount the IPADS on unit leader vehicles. This will allow Platoon Leaders and up to create their own Survey Control Points (SCPs). The SCPs can be shared with other units.

Impact: This solution mitigates PNT/ Positioning/PLI and Navigation/Nav somewhat by mounting the IPADS on unit leader vehicles to allow Platoon Leaders to create their own Survey Control Points (SCP) at firing unit and radar locations. Nonetheless, Positioning/Prec Fires is mitigated very little.

Annex II, Intelligence Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

1. Introduction.

a. BLUF. The operational aspect of degraded/denied space conditions is limited. In the prescribed conditions, likely information collection and intelligence development remains feasible, though the process cannot be conducted in the same manner or speed in a degraded/denied space environment as it is in a "normally enabled" space environment. Even though communication to/from regionally intelligence-processing nodes will significantly degrade (at best) or be completely lost (at worst) it is reasonable to expect analysts, devices, system, and tools to relocate from "rear-areas" to forward locations, communicating via line-of-sight communications if need be, in order to support war-fighting organizations with analytical support. This mitigating strategy is difficult to implement if space support is degraded or denied after a conflict has already started (and forces are already in theater). But it is reasonable to assume that U.S. agencies and forces will know enemy's efforts to deny or degraded space-based capabilities, and that within the scope of a pending conflict, strategies will evolve (like the above) in order to best support the warfighter in contact.

b. Facts. The ICoE's analysis took into account facts associated with current and projected fielding schedules, manning documents, etc. Facts of interest to the entire group were shared.

c. Assumptions.

(1) Intelligence systems available at the tactical level in 2030 are the same systems that are in the force today. While this situation is unlikely to actually occur, there are no new systems currently in development at this time which are scheduled for fielding at the tactical level (with the exception of updates to existing systems).

(2) Communications architectures that currently exist will not radically evolve/change by 2030. That is, communication via the tropospheric layer will remain limited, while most intelligence systems will continue to communicate via platforms that project to satellites and back to regional hubs. This largely assumes that WIN-T Increments 1 through 3 are fielded in their entirety across the force.

(3) Threat forces (see scenario) will have no more capability currently assessed to exist at this time (circa 2013).

2. Approach. The Intelligence Center of Excellence (ICoE) conducted significant analysis against the effects of the degraded/denied space environment, beginning in December 2012 (and continuing to the current date). Working groups, composed of subject-matter experts (SMEs) in areas of space, communications (both terrestrial and space-based), satellite intelligence, weather, and various intelligence systems associated with collection and analysis, and coordinated and directed by members of the ICoE ICDT. The ICDT defined the problems, identified intelligence shortcomings, and proposed solutions to the dilemmas posed by degraded/denied space conditions in 21st century conflict.

a. SMEs and ICDT personnel analyzed tactical intelligence systems projected to be employed by the force through 2030: the Prophet tactical signals intelligence (SIGINT) collection platform; the Trojan

Special Purpose Intelligence Remote Integrated Terminal (Trojan Spirit); the PSS-T aerial surveillance system; the Raven, Shadow, Grey Eagle, and Hunter tactical unmanned aerial systems (T-UAS) and associated One System Remote Video Terminal (OSRVT) viewing station; BAT-A human biometric analysis systems; the Guardrail, EMARRS, and ARL aerial reconnaissance and intelligence collection systems; and the Counterintelligence Human Intelligence Automated Reporting and Collection System (CHARCS) human intelligence processing platform and the ASAS-L and DCGS-A intelligence platforms. These systems were evaluated against the requirements outlined in the basic intelligence Uniform Task List (UTL) tasks. Initial analysis and product development took place within the ICDT; products were distributed for further analysis, revision, and feedback to the ICoE community. Strengths and weaknesses of these systems as well as potential mitigating strategies were identified during this process.

b. As the "Quick-Win" workshop approached, the ICDT refined the analysis already done to support the "by-phase" scenario expected for use during the actual workshop. During the workshop, the ICDT conducted and coordinated further analysis between the ICDT and the ICoE SMEs; the discussion generated from other CoEs during this workshop was invaluable in terms of generating understanding of likelihoods in degraded/denied space conditions. The scenario itself (classified SECRET at this time) was useful for challenging the tactical abilities of the units assigned to the scenario at the Division and lower levels. However, the scenario lacked a robust joint and strategic organization, which means that some analysis may have lacked the rigor that this process may deserve.

3. Results.

ISSUE TITLE: Reduced Range of Communications

SPACE CONDITION CAUSING ISSUE: Degraded/denied SATCOM, degraded/denied PNT

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: In a degraded or denied space environment where communications architecture is severely impacted, multiple platforms and organizations are limited to Line-of-Sight (LOS) distances. This constriction of the battlefield will likely result in more dangerous combat as U.S. systems (not just weapon systems but also intelligence and other systems) are reduced to relative equal status with enemy capabilities. Recommendation is to augment the TUAS platoon, at the BCT level, with 2 additional TUASs , additional support, and additional personnel (up to 13 personnel, roughly half the personnel in a current 27-man TUAS platoon).

ECHELON(S) ISSUE APPLIES TO: Corps, Div, BDE, but potentially all echelons
MITIGATING ACTION: Utilization of Intelligence Platforms as Re-Trans Platforms
DESCRIPTION: Utilization of Intelligence Platforms (Shadow TUASs) as Communications Re-Trans Platforms. Shadow TUASs currently have the ability to deploy with Re-trans capability and have been used in that capacity in Iraq and/or Afghanistan. Currently, there are 4 Shadow TUAVs in a BCT and a BCT is generally able (in terms of personnel and logistical support) to deploy 2 air frames simultaneously to support operations. Utilizing Shadows as Re-trans platforms rather than ISR platforms reduces the ability of the BCT to conduct effective reconnaissance--unless Shadow platoons are augmented with

personnel and additional air frames.

- **ISSUE MITIGATED:** Reduced Communications Range
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Adding additional personnel and TUAS systems to formations allows formations to continue to collect intelligence at current levels of capacity in addition to conducting communications Re-trans missions. This facilitates full-spectrum offensive and defensive operations.
- **LEVEL OF MITIGATION:** Mostly
- **TIME (QUICK-WIN)/SHORT/LONG:** SHORT-TERM. Shadow & PSS-T systems are already PoRs, as well as respective Re-trans comms packages. Funding & planning for 2 additional systems, additional logistical support (including contractor support), & up to 13 additional personnel, especially in low-spending environment, will likely take up to 4 POM cycles.
- **COST:** MEDIUM. Cost is lower for systems & support than it is for additional personnel. 2 systems, plus 13 enlisted personnel, plus support, times 32 BCTs; in excess of $10 million total.
- **TECHNICAL READINESS LEVEL:** 8-9
- **FEASIBILITY:** MEDIUM to LOW. Issues remain regarding increased manning & defense spending in current environment of austerity.

ISSUE TITLE: Access to CONUS Databases

SPACE CONDITION CAUSING ISSUE: Degraded/denied SATCOM

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Many intelligence systems function primarily through the process of collecting information in one location, then transmitting it via satellite to CONUS-based organizations, databases, and analysts for finishing into intelligence (the Prophet system). In a degraded/denied space environment, this capability will not exist. Since most SIGINT, IMINT, and other intelligence translation and analysis (including biometrically-enabled intelligence) takes place at agencies and by analysts in the U.S., forward elements will lack access to several types of finished intelligence. This therefore degrades the ability of forward intelligence elements to provide predictive intelligence to combat commanders.

ECHELON(S) ISSUE APPLIES TO: All
MITIGATING ACTION: Deployment of Databases & Analytic Capability Forward in Support of Operations
DESCRIPTION: A variety of agencies participate in the translation, development, and analytic process of turning raw data into intelligence. These agencies typically deploy personnel and equipment forward in support of the GWOT, even though, in some cases, a large part of the analytic and technical work is still done in CONUS. Recommendation moves a sufficient number of analysts forward, along with databasing capability, and physical equipment to support the intelligence requirements of forward-deployed U.S. forces. This requirement would change based not just on U.S. force deployment size and requirements, but also in terms of mission requirements by phase of operation (in terms of SIGINT, IMINT, and biometrically-enabled intelligence).

- **ISSUE MITIGATED:** Movement of intel assets into theater (DBs, analysis, etc)

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** If this capability is deployed forward, U.S. forces could "reach back" utilizing either LOS capability or re-transmitted communications. If this capability remains back in the U.S. while satellites are down, U.S. forces will lack access to large portions of several important forms of intelligence.
- **LEVEL OF MITIGATION:** Mostly
- **TIME (QUICK-WIN)/SHORT/LONG:** QUICK-WIN. In the past U.S. Intel architecture moved personnel and systems to support regional contingencies. This sets the precedent (assuming the personnel are available) that systems are transported and strategic assets relocated to provide a quick-turn "fix" for this shortfall.
- **COST:** HIGH (Assumption is that forward-deploying hundreds or thousands of analysts, building and/or increasing facilities, and properly equipping them with effective systems would cost in excess of $100 million).
- **TECHNICAL READINESS LEVEL:** 8-9. Likely would rely on existing LOS comms & database technology.
- **FEASIBILITY:** MEDIUM

ISSUE TITLE: Unpredictability of Weather Analysis Without Environmental Monitoring Satellite

SPACE CONDITION CAUSING ISSUE: Denied/Degraded Weather Satellite

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Denied weather satellite imagery cannot be replaced/augmented by any other means. Baseline weather satellite imagery provides comprehensive , near real-time SA over the AO. Fully utilized imagery and atmospheric sounding also assists in production of more accurate weather forecasters in support of all Army operations. Army aviation operations are especially vulnerable to weather conditions (winds, visibility, ceiling height, etc). Without reliable satellite imagery and data, forecasting these weather parameters becomes less reliable. Also, reliability of forecasting severe weather (thunderstorms, dust storms, tornadoes, etc) is noticeably degraded without weather satellite imagery.

Result:
-- Weather satellite "denied" -- Operational forecast accuracy decreased by 30%, weather support mission over watch capabilities decreased by 40% (Div and below operations)
-- Weather satellite "degraded" -- -- Operational forecast accuracy decreased by 15%, weather support mission over watch capabilities decreased by 20% (Div and below operations)

ECHELON(S) ISSUE APPLIES TO: ASCC, Corps, DIV, BDE
MITIGATING ACTION: Adequate training of AF weather support personnel on "single station analysis" processes/techniques will partly mitigate the shortfall created with the loss of weather satellite capabilities.

DESCRIPTION:
- **ISSUE MITIGATED:** Degraded/denied weather satellites
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Without replacement of imagery capabilities, environmental SA and SU will certainly suffer. Weather forecast accuracy will

decrease along with the ability to provide effective mission watch (difficult or impossible to monitor military operations environmental conditions during the course of mission execution). This training recommendation is only a partial fix (approximately 15% of lost satellite capabilities mitigated).

- **LEVEL OF MITIGATION:** Low
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick win to short term; create and implement training and training pipeline. Reflects time required to get sufficient numbers of trained forecasters out to Army operational units in sufficient quantity.
- **COST:** Low to Medium
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** Medium (but does not offer complete mitigation)

ISSUE TITLE: Degradation of Centralized Weather Support Without Environmental Monitoring Satellites.

SPACE CONDITION CAUSING ISSUE: Degraded/denied satellite communications

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Denied weather satellite communications leaves all in-theater weather support without CONUS (long haul comms) support capabilities. Without effective comms reach-back , weather observation and forecast support becomes critically limited to products that are generated "in-theater" (ie via LOS/relay communications). This in-theater capability assumes good line-of-sight communications are available to move weather information within and around the extensive AO. We realize this is a communications issue, and not exclusively a weather support limitation. The foundation of this mitigation recommendation is to ensure that centralized "in-theater" weather support is located within the LOS comms footprint. This recommendation assumes that somehow, any centralized weather support facility can import or generate weather support products required to support and disseminate to subordinate echelons/units.

ECHELON(S) ISSUE APPLIES TO: All, but most critically to weather support to DIV and below
MITIGATING ACTION: Provide **c**entralization of weather support within LOS footprint.
DESCRIPTION: Create augmented weather support cell(s) at Corps/Division/CAB level /Naval or theater-level that have line-of-sight communications with deployed operational, lower echelon units. These augmented weather cells will produce centralized weather products for all deployed units, and disseminate weather support products utilizing the LOS communications capability. This mitigation recommendation assumes that any newly formed, centralized weather support cell(s) can somehow receive updated weather data from within theater to process into weather support products that support all deployed operations (i.e., Naval Oceanographic Command [Naval] support to land based operations from afloat).

- **ISSUE MITIGATED:** Degraded/denied satellite comms to the DIV level and below
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Centralized weather support cells, especially in smaller or environmentally consistent regions, can distribute effective weather updates to lower levels via LOS communications.
- **LEVEL OF MITIGATION:** Mostly
- **TIME (QUICK-WIN)/SHORT/LONG:** "Quick-Win" to Short-Term

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- **COST:** Low to medium
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** High

ISSUE TITLE: Lack of Prophet Operator Training in Reference to Time Drift

SPACE CONDITION CAUSING ISSUE: Degraded/Denied PNT

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Degraded or denied Position Location, Navigation and Timing will have the following effects on the Prophet Spiral System:

- The Prophet Sensor and Prophet Control Data link (AN/VRC-99) and Voice comms (AN/VRC-89) will have to synch crypto manually vice using PLGR/DAGR to acquire GPS timing for crypto synch. During extended outages, time "drift" will occur.
- DF LOB can have greater error due to Prophet Sensor having to use inertial navigation system or compass vice DAGR GPS when determining direction to signal source.
- TS-Lite associated with Prophet Control will require longer time to acquire satellite link due to operators having to manually calculate azimuth and elevation to satellite based on current location. Additionally, operators will have to manually slew the antennae to acquire satellite signal lock.

ECHELON(S) ISSUE APPLIES TO: BDE, BfSB (i.e., organizations fielded the Prophet)
MITIGATING ACTION: Prophet Operator Training
DESCRIPTION: Operator training must stress "Operation under unusual conditions". Particularly, training the Prophet Sensor & Control operators to establish voice & data links without PNT.
The recommendation is to train Prophet Control operators to manually acquire satellite link. TTPs must be developed and rehearsed to ensure operators are proficient on tasks and steps to take if data/voice or satellite comms are disrupted. System set-up, employment and pre-mission checks will require more time to complete in a denied/degraded PNT environment due to more labor intensive steps being required.

- **ISSUE MITIGATED:** Lack of SIGINT collect due to system being "out of time".
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Doctrine exists to mitigate this issue, but it is not currently stressed at the "schoolhouse". Manual synch, especially with more emphasis on these procedures, will mitigate implications of time desynchronization issues.
- **LEVEL OF MITIGATION:** BDEs, BfSBs
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick-Win
- **COST**: Low
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** High

ISSUE TITLE: Inability of Prophet System to Network.

SPACE CONDITION CAUSING ISSUE: Degraded/denied communications satellites

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ISSUE DESCRIPTION AND OPERATIONAL IMPACT: All communications satellites are gone/denied will have the following effects on the Prophet System:
-Trojan SPIRIT – Lite terminal at the Prophet Control is denied access to the Trojan Data Networks (TDN-1, -2 & -3). The Control and Sensors cannot access their primary means of access NSANET, JWICS or SIPRNET.
- Reporting and data mining from the Prophet system (sensor & control) are severely hampered.
Inability of Prophet system to network to existing comms pathways will result in severely degraded or nonexistent Signals Intelligence to combat commanders.

ECHELON(S) ISSUE APPLIES TO: BCTs, BfSBs
MITIGATING ACTION: Alternate Communications Pathways
DESCRIPTION: Operation under unusual conditions will have to stress using alternate communications/networking routes to access TDNs 1-3. The Prophet Control has the capability to tie into alternate network access points via LAN cables. Signal Corps assets must provide some sort of terrestrial access to SIPRNET, JWICS, and NSANET. Once the Prophet Control is connected to the networks, the Control and Sensors can operate as normal.

- **ISSUE MITIGATED:** SIGINT collection to the warfighter
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Instead of being self-reliant for access to TDNs 1-3, the Prophet Control must rely on SignalCorps assets to establish communications paths. This will slow down SIGINT reporting and analysis until Signal can build a robust enough terrestrial network.
- **LEVEL OF MITIGATION:** BCT, BfSB
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick-Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** High

ISSUE TITLE: Inability of Trojan System to Acquire Communications Satellite if PNT is Degraded/Denied.

SPACE CONDITION CAUSING ISSUE: Degraded/Denied PNT

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Degraded or denied Position Location, Navigation and Timing will have the following effects on the Trojan SPIRIT-II System:

- The TS-II operators will have to manually acquire the satellite instead of allowing the antenna control computer to automatically slew to the correct position.

ECHELON(S) ISSUE APPLIES TO: Corps, DIV, BfSB, BCT
MITIGATING ACTION: TS-II operators using manual actions (“crew drills”) to operate the GPS & ACC (antenna control system).
DESCRIPTION: Operator training must stress “Operation under unusual conditions”. Particularly, training the TS-II operators to manually acquire satellite link. TTPs must be developed and rehearsed to ensure operators are proficient on tasks and steps to take if PNT is denied/degraded.

- **ISSUE MITIGATED:** Acquisition of comms satellites

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** This shouldn't add more than 10-15 minutes extra time to an initial set-up if the crew is proficient on their set-up drills. System set-up, employment and pre-mission checks will require more time to complete in a denied/degraded PNT environment due to more labor intensive steps required.
- **LEVEL OF MITIGATION:** Mostly
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** High

ISSUE TITLE: Alternate Communications Paths for the Trojan Spirit-II System.

SPACE CONDITION CAUSING ISSUE: Degraded/Denied Communications Satellites
ISSUE DESCRIPTION AND OPERATIONAL IMPACT: All communications satellites are gone/denied will have the following effects on the Trojan SPIRIT-II System:
-TS-II becomes useless except for the network router and generator. Prophet and other systems that rely on the Trojan IOT communicate with CONUS-based databases are unable to feed or extract intelligence IOT support combat commanders; enormous degradation in effective intelligences available to combat commanders.

ECHELON(S) ISSUE APPLIES TO: Corps and below
MITIGATING ACTION: Utilization of terrestrial SIGNAL assets
DESCRIPTION: TS-II operators will have to be trained in connecting the DIV/Corps/BfSB element they are supporting into terrestrial Signal Corps assets.

- **ISSUE MITIGATED:** TS-II-dominated communications pathways
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Instead of being self-reliant for access to SIPRNET, JWICS and NSANET access, the TS-II must rely on Signal Corps assets to establish communications paths. This will slow down all Intelligence reporting and analysis until Signal Corps can build a robust terrestrial network.
- **LEVEL OF MITIGATION:** Mostly
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** High

ISSUE TITLE: Loss of assured communications and syncing of radios due to reduced timing precision

SPACE CONDITION CAUSING ISSUE: Mobile and Handheld variants of the Biometrics Automated Toolset rely on assured space based communications to provide critical time and space data linkage to biometric records (degraded/denied communications satellites).

ISSUE DESCRIPTION AND OPERATIONAL IMPACT: Capability exists to enter both time and location into the collection systems manually, but so doing increases the time necessary to perform an identity check or identity enrollment, resulting in fewer ID checks or enrollments. Additionally, the lack of assured

communications directly impacts the ability to share data with the DoD authoritative biometric data repository. Lack of up to date biometric data could adversely impact the forward operations or could adversely impact homeland security (forward collected data is shared with the repository; the repository shares with USG databases). Lack of the ability to share with USG partners could put the US Homeland at risk of terrorist attacks.

ECHELON(S) ISSUE APPLIES TO: All Echelons
MITIGATING ACTION: Cross-leveled intelligence data (albeit at a much slower pace) through courier services and disk-to-disk data transfers (Small "m" domain). However, convoy operations in forward area will experience slowed or restricted support due to a change in the overall OPTEMPO.
DESCRIPTION: The BAT-A and handheld variants currently used in theater can write data to, and read data from, standard computer disks. These disks are then shared with other collection systems. One or more couriers are needed to conduct operations up and down the chains to the nearest theater repository or communications access to the national (DoD) data repository. This process is currently utilized in theater in areas that lack LOS communications and/or ready access to a SIPR connection.

- **ISSUE MITIGATED:** Location and time data of recorded encounters and biometric enrollments; sharing of biometric data vertically and laterally.
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Manual sharing of data
- **LEVEL OF MITIGATION:** Limited (25%)
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick-Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A
- **FEASIBILITY:** Medium

ISSUE TITLE: Reduced Operational Tempo Due to Lack of Precision Location, Intel, etc.

SPACE CONDITION CAUSING ISSUE: Degraded/denied ISR satellites

ISSUE DESCRIPTION AND OPERATIONAL IMPACT:
1. ART 5.6.1.2 Provide ISR support to the Soldier by coordinating and using DoD, national, and commercial space-based sensors and payloads and by coordinating with intelligence collection management personnel to enhance the G-2 collection capabilities.

a. Capability Gap Statement: The future Army force lacks the ability to provide persistent ISR coverage in denied areas of operation.

b. Why is there a gap: Future Army forces Corps and below lack a dedicated persistent ISR capability in areas denied to friendly forces because of geography, distance, or threat presence.

c. Impact: Decreased ability to perform IPB puts dispersed, small unit operations at increased risk and may cause the loss of opportunity to defeat the enemy. The lack of vital intelligence to support decision making will hamper the commanders' ability to integrate operations by providing relevant and timely information/data to his subordinate elements in sufficient time to plan and execute assigned

missions.

2. ART 2.3.4 surveillance is the systematic observation of aerospace, surface, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means (JP 3-0) Other means may include but are not limited to space-based systems, and special chemical, biological, radiological, and nuclear; artillery; engineer; special operations forces; and air defense equipment. Surveillance involves observing an area to collect information. (FM 2-0)

a. Capability Gap Statement: The future Army force BN and below lack the ability to disseminate ISR products in a timely manner to all users in a dispersed, mobile, and contested operational environment.

b. Why is there a gap: Future Army forces lack sufficient BLOS communications networks to transport information and intelligence. This results in insufficient and inefficient integration into joint/national intelligence communication architectures.

c. Impact: Decreased timeliness of ISR product transmission and increased latency of data and information dissemination results in commanders and units losing SA. This results in the units being unable to achieve desired effects during execution in a dynamic, fast-moving, operational environment. This could lead to a lack of unity of effort, failure to seize the initiative, failure to recognize and exploit favorable conditions, an inability to define and effectively understand complex and ill-structured problems. This can result in reduced initiative and a failure to achieve desired effects or even mission failure.

ECHELON(S) ISSUE APPLIES TO: Corps and below
MITIGATING ACTION: Multi-INT and persistent surveillance in aerial Intelligence Collection layer
DESCRIPTION: Develop concepts, doctrine, and TTP, that address the introduction of multi-INT and persistent surveillance capabilities of the Aerial Intelligence Collection layer. This includes manned and unmanned teaming focused on find, fix, finish, exploit, analyze, and disseminate (F3EAD).

- **ISSUE MITIGATED:** Reduced Tempo of Operations due to lack of precision location, Intel, etc
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Alleviates the over dependence on National level systems and establishes concepts, doctrine, and TTP that address the introduction of multi-INT and persistent surveillance capabilities of Aerial Intelligence Collection not currently optimized for CAM and WAS.
- **LEVEL OF MITIGATION:** Mostly – this mitigation action alone mitigates the issue to an acceptable level
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A (doctrine)
- **FEASIBILITY:** High

ISSUE TITLE: Reduced Tempo of Operations Due to Lack of Precision Location, Intel, etc

SPACE CONDITION CAUSING ISSUE: Denied/Degraded Satellite

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ISSUE DESCRIPTION AND OPERATIONAL IMPACT: ISR
1. ART 5.6.1.2 Provide ISR support to the Soldier by coordinating and using DoD, national, and commercial space-based sensors and payloads and by coordinating with intelligence collection management personnel to enhance the G-2 collection capabilities.

a. Capability Gap Statement: The future Army force lacks the ability to provide persistent ISR coverage in denied areas of operation.

b. Why is there a gap: Future Army forces Corps and below lack a dedicated persistent ISR capability in areas denied to friendly forces because of geography, distance, or threat presence.

c. Impact: Decreased ability to perform IPB puts dispersed, small unit operations at increased risk and may cause the loss of opportunity to defeat the enemy. The lack of vital intelligence to support decision making will hamper the commanders' ability to integrate operations by providing relevant and timely information/data to his subordinate elements in sufficient time to plan and execute assigned missions.

2. ART 2.3.4 surveillance is the systematic observation of aerospace, surface, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means (JP 3-0) Other means may include but are not limited to space-based systems, and special chemical, biological, radiological, and nuclear; artillery; engineer; special operations forces; and air defense equipment. Surveillance involves observing an area to collect information. (FM 2-0)

a. Capability Gap Statement: The future Army force BN and below lack the ability to disseminate ISR products in a timely manner to all users in a dispersed, mobile, and contested operational environment.

b. Why is there a gap: Future Army forces lack sufficient BLOS communications networks to transport information and intelligence. This results in insufficient and inefficient integration into joint/national intelligence communication architectures.

c. Impact: Decreased timeliness of ISR product transmission and increased latency of data and information dissemination results in commanders and units losing SA. This results in the units being unable to achieve desired effects during execution in a dynamic. Fast-moving, operational environment. This could lead to a lack of unity of effort, failure to seize the initiative, failure to recognize and exploit favorable conditions, an inability to define and effectively understand complex and ill-structured problems. This can result in reduced initiative and a failure to achieve desired effects or even mission failure.

ECHELON(S) ISSUE APPLIES TO: BCT & below
MITIGATING ACTION: Airborne Intelligence Collection support to BCT and below
DESCRIPTION: Revise affected ICoE and MCOE doctrine (FMs, TCs, TTPs) to reflect current and projected changes to the employment of Airborne Intelligence Collection assets (traditional and non-traditional) in direct support to Brigade Combat Teams and subordinate units. Common doctrinal inputs and language must evolve whenever possible in multiple documents. Additional inputs to augment base information

will be developed and included as needed. The focus of the new doctrine will be on implementation of the U.S. Army Aerial Layer Platform and Sensors (ALPS) Strategy and Joint Direct Airborne Intelligence, Surveillance and Reconnaissance (JDSAISR) Initial Capabilities Document (ICD) in support of overall Intelligence Collection operations.

- **ISSUE MITIGATED:** Reduced Tempo of Operations due to lack of precision location, Intel, etc
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Revise affected ICoE and MCOE doctrine (FMs, TCs, TTPs) to reflect current and projected changes to the employment of Airborne Intelligence Collection assets (traditional and non-traditional) in direct support to Brigade Combat Teams and subordinate units. This mitigation requires new common doctrinal inputs and language in multiple applicable documents. Additional inputs to augment base information must evolve as needed. The focus of the new doctrine is centered on implementation of the U.S. Army Aerial Layer Platform and Sensors (ALPS) Strategy and Joint Direct Airborne Intelligence, Surveillance and Reconnaissance (JDSAISR) Initial Capabilities Document (ICD) in support of overall Intelligence Collection operations.
- **LEVEL OF MITIGATION:** Mostly – this mitigation action alone mitigates the issue to an acceptable level,
- **TIME (QUICK-WIN)/SHORT/LONG:** Quick Win
- **COST:** Low
- **TECHNICAL READINESS LEVEL:** N/A (doctrine)
- **FEASIBILITY:** High

ISSUE TITLE: Reduced Tempo of Operations due to lack of precision location, Intel, etc

SPACE CONDITION CAUSING ISSUE: Degraded SATCOM, denied / degraded Satellite ISR, denied

ISSUE DESCRIPTION and OPERATIONAL IMPACT:
1. ART 5.6.1.2 Provide ISR support to the Soldier by coordinating and using DoD, national, and commercial space-based sensors and payloads and by coordinating with intelligence collection management personnel to enhance the G-2 collection capabilities.

a. Capability Gap Statement: The future Army force lacks the ability to provide persistent ISR coverage in denied areas of operation.

b. Why is there a gap: Future Army forces Corps and below lack a dedicated persistent ISR capability in areas denied to friendly forces because of geography, distance, or threat presence.

c. Impact: Decreased ability to perform IPB puts dispersed, small unit operations at increased risk and may cause the loss of opportunity to defeat the enemy. The lack of vital intelligence to support decision making will hamper the commanders' ability to integrate operations by providing relevant and timely information/data to his subordinate elements in sufficient time to plan and execute assigned missions.

Annex II, Intelligence Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

2. ART 2.3.4 surveillance is the systematic observation of aerospace, surface, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means (JP 3-0) Other means may include but are not limited to space-based systems, and special chemical, biological, radiological, and nuclear; artillery; engineer; special operations forces; and air defense equipment. Surveillance involves observing an area to collect information. (FM 2-0)

a. Capability Gap Statement: The future Army force BN and below lack the ability to disseminate ISR products in a timely manner to all users in a dispersed, mobile, and contested operational environment.

b. Why is there a gap: Future Army forces lack sufficient BLOS communications networks to transport information and intelligence. This results in insufficient and inefficient integration into joint/national intelligence communication architectures.

c. Impact: Decreased timeliness of ISR product transmission and increased latency of data and information dissemination results in commanders and units losing SA. This results in the units being unable to achieve desired effects during execution in a dynamic. Fast-moving, operational environment. This could lead to a lack of unity of effort, failure to seize the initiative, failure to recognize and exploit favorable conditions, an inability to define and effectively understand complex and ill-structured problems. This can result in reduced initiative and a failure to achieve desired effects or even mission failure.

ECHELON(S) ISSUE APPLIES TO: Corps & Below
MITIGATING ACTION: Persistence Platform
DESCRIPTION: There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms are able to provide communication extension, expansion and Intelligence Collection for direct support to the tactical user.

- **ISSUE MITIGATED:** Reduced Tempo of Operations due to lack of precision location, intelligence, etc
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** There are two basic types of persistence platforms, heavier than air (HTA) and lighter than air (LTA). Both types of platforms are able to provide communication extension, expansion and Intelligence Collection for direct support to the tactical user.
- **LEVEL OF MITIGATION:** Mostly – this mitigation action alone mitigates the issue to an acceptable level
- **TIME (QUICK-WIN/SHORT/LONG):** SHORT TERM = 5 – 8 Years (~2 – 4 POM Cycles
- **COST:** HIGH (>$100 Million) $522.0 Million Persistence Platform (Aerial Layer) capabilities development are already underway but unknown capabilities development POR at this time.
- **TECHNICAL READINESS LEVEL:** 5
- **FEASIBILITY:** MEDIUM – Reasonably easy, if no major issues occur

3. Summary of Conclusions – In conclusion, the operational aspects of degraded/denied space conditions on tactical operations remain limited. The greatest threat posed to U.S. forces in the course of the war-gamed scenario would be if enemy forces were able to deny or degrade space conditions in the midst of U.S. military operations (for argument's sake, say during Phase II operations). In the

prescribed conditions, likely information collection and intelligence development remains feasible, though the process cannot be conducted in the same manner or speed in a degraded/denied space environment as it is in a “normally enabled” space environment; it is also reasonable to expect mitigation to take place at the tactical level through the strategic level via proper planning, resourcing, and tactical and strategic modification to plans of execution.

Annex III, Signal Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

1. Introduction

a. BLUF. The requirement to support SATCOM network requirements with a mix of existing terrestrial and aerial layer networking capabilities will cause slower than expected delivery of critical Mission Command data. Although using a mix of terrestrial and aerial layer capabilities will allow SATCOM traffic to move, it will be limited to intra-theater communications without an access point to the space tier outside of the degraded space environment. Aerial tier capabilities that depend upon UAS will not be available to support the network in an area where GPS is not available.

b. Facts. UAS platforms require GPS access to be operational. SATCOM is the primary means of network connectivity for inter-theater traffic. Mission Command systems require network connectivity to provide commanders SA, COP, BFT, etc. In the cases where Mission Command updates are dependent on satellite connectivity, they will not provide the Commander with relevant information. To enable the science of Mission Command, alternate network paths must be identified. As traditional SATCOM data competes for space on the terrestrial and aerial tiers, those network paths will become congested. Commanders will have to prioritize the information being transported to ensure speed of service or accept risk in that area by flooding network paths with satellite traffic. Without ready access to SATCOM capabilities, the distance a unit can be separated will also be reduced to ensure network connectivity due to the range limitations of the alternate network paths.

c. Assumptions. The Signal CoE assumed that all space based capabilities were not available for this assessment.

2. Approach. First, the Signal CoE determined in the absence of SATCOM, what were the available capabilities that could be used to provide alternate network paths. Subject Matter Expert input was used to provide input to the solutions worksheet from TCM Network and Services, Tactical Radio, and UAS. TCM UAS was contacted to address whether or not the required CDL link would be impacted in a Degraded Space area. Also, TCM UAS was instrumental in determining the impact the loss of GPS had on platforms which aerial layer network extension capabilities depend on.

3. Results.

a. Operational Overview for your CoE. The network can survive in a Degraded Space environment, but to avoid latency issues, the traffic loaded on it will require the commander prioritize network dependent capabilities.

b. Operational Issues. Without access to SATCOM, the network will be slower and may not be adequate to support capabilities with zero tolerance for latency. Units will have to locate closer to each other to be within range of LOS systems or rely more heavily on aerial layer capabilities. Relying more on aerial layer capabilities will require multi-purpose platforms be taken away from other missions (such as reconnaissance and surveillance) to be dedicated in support of the network due to payload concerns and the different orbits required to support network extension. UAS will/ are not mission ready in areas where GPS is not available. Units within the degraded space footprint will require in-depth network

planning in order to allow them connectivity to inter-theater resources. In all cases, connectivity can be addressed, but capacity issues are exasperated.

c. Mitigating Actions. TTPs within the Signal units will mitigate connectivity issues. Directing traffic typically routed over SATCOM to the terrestrial LOS/aerial layer capabilities will provide connectivity. Commanders will have to prioritize traffic so that network planners can ensure that critical information is still delivered in a timely manner to address the capacity issue. The acquisition of Assured Positioning, Navigation and Timing (PNT) will mitigate any issues that arise due to the lack of GPS connectivity (i.e. preventing the use of UAS). Using aerial layer networking capabilities will allow for greater distances between units, and can provide the network infrastructure required to route information from a degraded space environment to points where SATCOM can be accessed. However, the Commander must remember that more UAS dedication to network support means fewer available to support the other missions.

4. Summary of Conclusions. Although network connectivity can be addressed, capacity will be a critical issue that will require the Commander's prioritization and careful network planning to resolve.

Annex IV, Maneuver Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Degraded Space Review - Maneuver Center of Excellence

1. Introduction.

a. BLUF. In a scenario where all space based capabilities are denied, BCT formations can function, albeit in a reduced capacity, while fighting in a degraded space environment. With all space based capabilities denied, Maneuver formations from Squad to Battalion can continue to operate without noticeable loss of capacity. Due to proximity of these formations, assigned tactical tasks can still be conducted in the denied environment. The links between Battalion HQ and BCT HQ would be hampered in a denied environment but these echelons could still function with reduced tempo provided they conduct operations within the FM communications bubble.

b. Assumptions. All Space capabilities would be denied. Maneuver formations would have to accomplish missions without any space capabilities. Formations would be without Positioning data, Navigation data, and Timing data, (PNT) Friendly Force Tracking data (FFT), Satellite Communication (SATCOM), Space Based Intelligence Surveillance and Reconnaissance (ISR), Missile Warning, and Environmental Monitoring. Missions, tasks, activities completed with no space capabilities available (Denied) could be completed to a more optimal degree in a degraded space environment where there was still some space capability available to the force. Digital CPs would have to operate in analog since there would be no SATCOM links to auto populate digital COPs. Navigation would be done by map and compass. Since COPs would not be self updating reporting would need to be done by FM radios. Additionally, BCT design will be projected 2020 formations; and, WIN-T increment III fielded.

2. Approach. The MCoE Degraded Space Study team consisted of TCM SME's (TRADOC Capability Manager Subject Matter Experts) from each formation and the on-site Space and Missile Defense Command LNO. SMEs from BCT Mission Command, Armor BCT, Infantry BCT, and Stryker BCT made up the team. We conducted a table top MapEx where we discussed how respective BCTs would maneuver within the Integrated Scenario Construct Bravo. The team analyzed BCT links to Space Force Enhancement areas in SATCOM, ISR, PNT, Missile Warning, and Environmental Monitoring. The team analyzed formation links to the space force enhancement areas against MCoE Required Capabilities (RC). The RC approach was based on guidance from the Degraded Space Review Study plan. From our MapEx we identified only one failed task. We articulated our MapEx findings during the SVTC with the Community of Practice(COP). During the dialogue with the COP additional datepoints were identified that were pertinent to MCoE. MC CoE compiled a list with these additional findings obtained in SVTC with the community of practice. MCoE team took the maneuver specific items from the compiled list and answered them within the specific format.

3. Results.

a. Operational Overview. MCoE team determined BCTs could still accomplish all our RCs minus conducting precision fires due to lack of PNT data. During the SVTC session with all the COEs we discussed our scheme of maneuver by phase with the community of practice. MCoE did not deviate from the missions assigned in the scenario. Phase II IBCT conducted an airborne assault. Phase III Turn 1 ABCT attacked on Axis Smash, SBCT Followed on and Support, BFSB screened Eastern flank, and IBCT

continued to secure lodgment. Phase III turn 2 an Inf Bn air assaulted to the East of the Axis Smash. It was during the discussion of the different phases with the wider audience additional data points were discovered. However, BCTs can still fight without space capabilities in echelons of BN and below. Due to the close proximity of units to mutually support each other, lower echelons remained within the Line of Site (LOS) communications bubble so they do not require a SATCOM link. Navigation at these echelons is still accomplished with map and compass. National ISR is helpful but was not a significant factor in our findings. Therefore, it was the conclusion of the MCoE team that these lower echelons could still fight with total loss of space capability.

The link between BN HQ and the BCT HQ would still remain intact provided these HQ did not use SATCOM to communicate. The conclusion of the MCoE team was BCTs could still fight with the loss of space based capability provided they remained within the FM communications bubble. However, because of the need to remain within LOS communications range, the amount of space a BCT could occupy on the ground would be limited by the terrain.

b. Operational Issues. Within the broad construct of the scenario, MCoE submitted additional findings as a result of the session with the community at large. All these activities combined would slow tempo until CPs learn from battlefield experience.

(1) Additional forces would be required due to reduced intelligence picture as a result of denied SATCOM, ISR, PNT, and Missile Warning (OPIR Data). With the loss of PNT, SATCOM, and space based ISR supporting the BCTs intelligence functions, BCTs will require additional troops devoted to reconnaissance. Without GPS, organic UAVs requiring GPS waypoints will not be as accurate traversing flight routes to NAIs and objectives. Lack of GPS will also affect the ability to loiter on an NAI, objective, or reacquire targets fleeing from an objective. Without GPS, accurate Meta data will not be displayed in video feed. The increase in time required for dead reckoning flying of UAV will require more flight time. 2nd order effects are more time spent flying UAVs and other NAIs not being serviced due to increased flight times on primary NAIs. 3rd order effects are maintenance issues due to increased flying. NMC UAV will mean other additional NAIs will not be serviced.

(2) The BCT organic Shadow UAV will have the same problem without GPS. Additionally, when the next variants of Ku-capable Shadows become fielded, they will not be able to operate using the SATCOM legs. Shadows will not be able to operate farther than the radio control link since SATCOM will be denied.

(3) An additional shortcoming due to Loss of SATCOM will be loss of feeds from national systems. This information will not be available to intelligence analysts or others who use this information. National feeds will not populate COPs or data bases. Loss of this information could result in PIR gaps.

(4) With NAIs not being serviced by UAVs due to loss of PNT or SATCOM maneuver forces would be needed to conduct reconnaissance. These maneuver forces will be required to perform in a reconnaissance role to obtain commanders' PIR. That BCT would need to be augmented with additional maneuver forces for combat operations. With the lack of intelligence assets and the reduced combat

power, a BCT's Area of Operations would be reduced to the older contiguous battle spaces. Or, more forces would be required to operate in an area that is currently assigned to a space-enabled BCT.

(5) Synchronization with adjacent units would be degraded by lack of SATCOM and PNT. Within the scenario there would be times when units from adjacent BCTs would operate on the flanks of each other. This increased potential for fratricide. In the ISC-B Phase III turn 2 had three BCT formations in relative close proximity to each other. These formation HQ's were probably outside the reach of line of sight communications. SATCOM would facilitate the communications link with the HQ from these adjacent units (ABCT, SBCT, and IN BN). Adjacent unit communication is important to prevent fratricide when friendly units are too close, facilitate link up at coordination points, prevent enemy exploiting seams between adjacent formations, and controlling tempo and synchronization between adjacent formations. With SATCOM denied, these HQ would need to stay within a LOS communications bubble or Retrans would be needed to facilitate the communications link.

(6) In a GPS denied environment, synchronization will be reduced due to errors in navigation and errors in reported unit location. With units moving there can also be a delay in.

(7) SATCOM links to BFT would also affect the population of COPs and displays. Without an auto populating COP a human in the loop will be needed to populate the COP. Errors in plotting, errors in reporting positions, and delays in the reports may erode the confidence of the man in the loop/COP, adding time to clearing fires, slowing tempo, and desynching operations.

(8) Since the skills of battle command on the move using analog methods may have atrophied with a reliance on auto populating and precision locations, there will be an initial learning curve until CPs are proficient in battle tracking.

(9) Reduced Tempo of Operations due to lack of precision location, Intel, BFT, SATCOM and PNT. With the loss of the aforementioned space force enhancement areas, tempo of operations will be reduced due to errors in navigation, errors in reported unit location, and lack of confidence in the COP. As units move at various speeds there will be latency in reporting and accuracy of information such as front line traces or actual location of troops in contact. CPs at all echelons would need to record unit positions on map boards with an increased potential for error due to human in the loop transcribing. Operations would be controlled from these mapboards as CPs did in OPERATION DESERT STORM. Precision fires would be nonexistent. Clearance of fires would be more time consuming since target location, observer position, and friendly positioning would not be precise.

(10) SATCOM links to BFT would also affect the population of COPs and displays. Without an auto populating COP, a human in the loop will be needed to populate the COP. Errors in plotting, errors in reporting positions, and delays in the reports may erode the confidence of in the man in the loop/COP adding time to clearing fires, slowing tempo, and desynching operations.

(11) The skills of battle command on the move using analog CPs may have atrophied with the reliance on auto populating and PNT. There will be an initial learning curve until CPs are proficient in battle tracking. For both, loss of PNT and BFT will result in movement and maneuver becoming slower

and more deliberate as information will not be in real time.

(12) Another SATCOM dependent activity would be the reach back to national data bases, analytical support, and intelligence feeds from CONUS. This reach back feeds the organic BCT intelligence apparatus. A good assumption is the lack of access to this information and services will preclude important niche information, analytical support, and access to NTM data from the fight. Additionally, it will add more work to organic formation Intel Soldiers and divert organic collection assets to try to obtain this PIR. Reduced Intelligence will contribute to a slower tempo.

c. Mitigating Actions. There are a few mitigating actions addressing the problem of reduced tempo.

(1) Leader training and awareness: Leaders need to understand the potential vulnerabilities to space systems our Army has grown accustomed to. They need to understand near-peer and regional hegemon adversaries have the capability to negate or deny space based capabilities we have relied on during previous conflicts.

(2) Training without GPS and BFT is a quick win. Commanders need to train their units in scenarios where GPS is not available. Units should train using map and compass in mounted and dismounted navigation. Land navigation is a perishable skill. The more training units receive, the more proficient they will become, and the less of a learning curve to overcome in the event the unit deploys to a contingency where GPS can be denied. There may be an aversion to this training. However, of all the space capabilities that can be denied, GPS signals can be jammed or spoofed locally by a savvy adversary using off the shelf technology.

(3) Another area for commanders to train concurrently with forces conducting map and compass land navigation would be for their CPs to battle track using paper maps. BFT feeds and auto populating COPs are dependant on GPS signals to populate location of icons on COPs. If COPs cannot auto populate, then a COP cannot be used to battle track.

(4) GPS surrogate. The Army needs to look at possibly having a GPS surrogate ready to deploy to an area where the potential of GPS denial can occur. The technology for a surrogate already exists. However, this would require an aerial platform or high altitude platform to mount these surrogates in and around the area of operation. Aerial platforms will be vulnerable to enemy air defenses. A high altitude platform would be safer since it can fly above the reach of enemy ADA assets.

(5) Use of maneuver forces for reconnaissance and an assumption more troops will be required for same area of operation. Because some PIRs could not collected due to national constellations not contributing to the intelligence picture and UAVs not conducting efficient reconnaissance due to lack of PNT, there is an assumption that maneuver forces would be needed to collect those PIRs. Maneuver units devoted to reconnaissance was an accepted TTP in the days before UAVs and other enablers. Since more maneuver forces would need to be devoted for the reconnaissance effort, these maneuver units will be taken away from the close fight. This is not an ideal solution. In the current environment of fiscal constraints, the notion of making BCTs larger is not an optimal idea. However with current BCT 2020 redesign, particularly the additions of a third CAB in ABCT and IBCT, this makes this option a possibility.

Not optimum or desired, but these new redesigned formations could be better suited to operate in a scenario where our ISR will be degraded and maneuver units will need to be devoted to collecting PIR. Higher echelon commanders (DIV and above) need to be aware of the additional limitations BCTs may face if reconnaissance assets contributing to collection effort are degraded or denied.

(6) Reduced synchronization among adjacent units. This was caused by the lack of SATCOM. A quick win solution would be to devote UAVs to the Retrans mission. However, that UAV will not be able to perform ISR if fitted with the communications relay package.

(7) A 'little m' solution would be to attach more UAVs to the deployed force to compensate for UAVs devoted to a Retrans mission. This is a Material/Organization solution, but may be necessary if we know a force can deploy to a contingency where the denial of SATCOM can occur. A contingent of additional UAVs could be part of a deployable contingency package.

4. Summary of Conclusions. Maneuver units could still fight. However, level of tempo, synchronization, and amount of area a BCT can currently occupy are issues because enabling space capabilities would be reduced to facilitate mission command of the formation. In a scenario where Space based ISR, SATCOM, PNT, Missile Warning, and Environmental Monitoring are denied, formations from Squad to Battalion can still operate with little adverse affect. Links between BN HQ and BCT HQ can be facilitated by LOS communications or Retrans. Synchronization of these formations will be degraded in a denied space environment due to lack of auto populating COPs. Awareness of the potential denial of space capabilities and training without them will mitigate some of the effects if these capabilities are denied during a contingency.

Annex V, Aviation Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Aviation Center of Excellence - Degraded Space Report Input (DRAFT)

1. Introduction.

a. Purpose. The purpose of this report is to identify Army Aviation failed tasks, assess capability gaps and potential solutions for mitigating gaps associated with 50 - 75% degradation and either a 100% degradation of space capability or a denied use of space-based capability. Emphasis for gap mitigation was given to 'Quick Win' strategies which are currently ready to implement or projected for initial operational capability (IOC) within 4 years.

b. Facts. Present and future Army Aviation systems will utilize spaced based systems for position updates, navigation, data transfer, voice communications, providing threat warnings and weather updates and forecasts.

c. Assumptions. Four (4) assumptions were used in identifying systems that would be impacted by degraded and/or denied space systems, analyzing those systems and determining mitigating solutions. These assumptions are listed below:

(1) Degraded space capability can include compromised, unreliable and/or intermittent reception of positioning, navigation and timing (PNT) signals which results in a low to no confidence level of PNT by the user. Denied space capabilities result in not being able to utilize PNT. In either case the user will not be able to receive consistent and reliable position update information or timing update information.

(2) Degraded space capability can cause unreliable and/or intermittent transmission and reception of satellite communication (SATCOM) signals which result in a low to no confidence level of voice or data communications by the user at non-line of sight distances (NLOS). Denied space capabilities result in not being able to utilize satellite communication. In either case the user will not be able to transmit or receive beyond line of sight (BLOS) voice or data communications consistently and reliably.

(3) Degraded space capability can cause an unreliable and/or intermittent satellite communications signal link which results in a low to no confidence level of unmanned aircraft systems (UAS) satellite communications link by the user. Denied space capabilities result in not being able to access any satellite communications. In either case the user will not be able to reliably and confidently maintain UAS NLOS control from the ground control station (GCS) necessary for executing successful missions.

These assumptions were applied to aviation systems such as radios for voice communications and data transfer (providing threat warnings, weather updates and forecasts), GPS receivers for receiving position updates and aiding in accurate navigation, and ground control stations for the operation of UAS.

Annex V, Aviation Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

2. Approach. A two-step approach/methodology was used to identify risks and mitigating strategies resulting from operating in a degraded and/or denied space environment. The first step involved identifying Army aviation aircraft onboard systems and any ground support systems required to support their operations that utilize spaced based systems. Army Aviation systems reliant on space based systems include Blue Force Tracker (BFT), Global Positioning System (GPS), radio communications and ground control stations for the operation of UAS. The second step involved assessing mission impacts when utilizing these systems in a degraded and/or denied space environment and determining potential mitigating solutions. The scenario was reviewed and analyzed for determining aviation support in the planning and execution phases of the mission and to assess impacts.

3. Results. Impacts of a degraded and/or denied space environment were found to be scenario independent. Degraded and/or denied space environment would result in the intermittent or total loss of PNT, SATCOM and SATCOM links for the operation of UAS in practically any scenario. These system specific impacts are further detailed/outlined below:

a. System Impact

(1) Blue Force Tracker (BFT) –BFT will not receive reliable and consistent position updates in a denied and/or degraded space environment. This will impact the currency of situational awareness provided to the crew.

(2) Global Positioning System (GPS) – Onboard, embedded GPS /Inertial (EGIs) receivers, in inertial navigation systems, will not receive reliable and consistent position updates in a denied and/or degraded space environment. The inertial navigation system (INS) accuracy, the EGI system, tends to drift over time.

(3) Onboard Aircraft Communication Systems - Onboard aircraft systems will not receive reliable and consistent timing update information in a denied and/or degraded space environment. This timing synchronization is required for use of jam resistant frequency-hopping communications. Radio satellite communications in a denied / degraded space environment will be unreliable, inconsistent, and at times inoperative.

(4) UAS Ground Control Stations - Satellite communications links in a denied / degraded space environment, will be unreliable, inconsistent, and at times inoperative. UAS will be unable to operate or transmit imagery beyond line of sight to the ground control station (GCS) unless a communication relay aircraft is utilized.

b. Operational Impact. Aviation mission tasks for the scenario examined would be to support joint forcible entry operations (JFEO) and ground maneuver as directed by the commander. This support would consist of providing close support to ground troops, providing air maneuver of troops throughout

the theater, performing reconnaissance and reporting actionable combat information. Successful execution of these missions is dependent on the use of space-based capabilities. Should denied and/or degraded space based capabilities be encountered, Army Aviation will be able to successfully conduct operations in a degraded or denied space-based environment, but will require more time in the planning and execution phases; and, Army Aviation may be limited in covering the required area of operation (AO) due to line of sight restrictions with UAS. Below is an outline of the operational issues and impacts.

(1) **NAVIGATION:** With denied and/or degraded PNT, onboard EGI receivers will not reliably and consistently receive position updates resulting in dependence on less accurate inertial navigation. Operational impact is considered Low.

(2) **TARGETING:** With denied and/or degraded PNT, onboard GPS receivers will not reliably and consistently receive position updates reducing the accuracy of target location. Inability to receive BFT updates will adversely impact crew SA and combat identification. Operational impact is considered Low to Medium.

(3) **JAM RESISTENT AND SECURE COMMUNICATIONS:** With denied and/or degraded PNT, onboard radios will not reliably and consistently receive timing updates, reducing synchronization with other radios. Operational impact is considered Low.

(4) **NLOS COMMUNICATIONS:** With denied and/or degraded SATCOM, onboard SATCOM radios will not provide consistent and reliable communications, and at times will be inoperative. UAS operating beyond line of sight (BLOS) will not be capable of transmitting imagery without dedicating resources to communications relay. Some degradation in mission command will result for executing mission changes, branches and sequels. Operational impact is considered Low to Medium .

(5) **UAS CONTROL:** With denied and/or degraded SATCOM, UAS SATCOM control links will not be consistent and reliable and, at times, they will be inoperative. BLOS controlled UAS flight will not be capable without dedicating resources to communications relay. Operational impact is considered Low to Medium.

c. Mitigating Actions. Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) mitigating actions for Army Aviation systems impacted by either degraded and/or denied space systems were considered minimal/low and consisted of training actions already being conducted. Outlined below are the issues/gaps, and mitigating actions.

(1) **NAVIGATION:** Lack of Aviation Navigation Precision/Aviation Navigation Accuracy

ISSUE DESCRIPTION: Fall back on onboard Inertial Navigation System (INS) and/or terrain flight navigation. DOTMLPF implications fall under training. Training for Inertial Navigation System and terrain flight navigation is conducted in flight school.

- **MITIGATING ACTION:** Alternative navigation solutions i.e. INS or terrain flight navigation.

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Alternative navigation solutions (i.e. INS) or terrain flight navigation. INS is an onboard navigation system which is integrated with GPS. Terrain flight navigation is a means of navigating based on landmarks, time, distance and heading and is used when all other navigation means are inoperative.

- **LEVEL OF MITIGATION:** This action mitigates the issue to an acceptable level

(2) **TARGETING:** Target engagement or hand-over of less accurate target data.

ISSUE DESCRIPTION: Fall back on onboard INS. DOTMLPF implications fall under training. Presently, training for INS is conducted in flight school.

- **MITIGATING ACTION:** Alternative position solutions (i.e. INS).

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Alternative position solutions (i.e. INS). INS is an onboard navigating system which is integrated currently with GPS.

- **LEVEL OF MITIGATION:** This action mitigates the issue to a low to moderate acceptable level

(3) **JAM RESISTENT AND SECURE COMMUNICATIONS:** Loss of timing information for secure communications.

ISSUE DESCRIPTION: Fall back on use of HAVEQUICK, SINCGARS, LINK-16, Soldier Radio Waveform (SRW), and Wideband Networking Waveform (WNW). DOTMLPF implications fall under training. Presently training for communications is part of flight school POI.

- **MITIGATING ACTION:** Fall back on use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization.

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization. Additional coordination is required to ensure synchronization with other elements.

- **LEVEL OF MITIGATION:** This action alone mitigates the issue to an acceptable level

(4) **NLOS COMMUNICATIONS:** No SATCOM.

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ISSUE DESCRIPTION: HAVEQUICK, SINCGARS, LINK-16, SRW and WNW. DOTMLPF implications fall under training. Communications training is part of flight school program of instruction (POI).

- **MITIGATING ACTION:** Use of HAVEQUICK, SINCGARS, LINK-16, SRW, WNW and/or dedicated communications relay.

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW.

- **LEVEL OF MITIGATION:** This action mitigates the issue to an acceptable level

(5) **UAS CONTROL:** Loss of control link to UAS.

ISSUE DESCRIPTION: Line of Sight (LOS) communication links to operate UAS. DOTMLPF implications fall under training. Using LOS communication links to operate UASs is part of training.

- **MITIGATING ACTION:** Use of dedicated LOS communication links to operate UAS.

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation is through the use of LOS links to operate UAS.

- **LEVEL OF MITIGATION:** This action mitigates the issue to an acceptable level

4. Summary of Conclusions

a. Aviation operations issues and impacts resulting from degraded and/or denied space capabilities will not prevent Army Aviation from deploying or conducting operations. However, onboard Army aircraft systems, i.e. BFT, EGI, radio communications would experience degradation in position updates, navigation and radio communications. Aviation assets will require more time in the planning and execution phases of the mission and operational reach may be affected should degraded or denied space-based capabilities be encountered.

b. Below is the list of operational impacts/issues outlining the space condition causing the issue, issue description and operational impact, mitigating action, and mitigation description. Note that the mitigation description is inclusive of the issue mitigated, how the mitigating action mitigates the issue, level of mitigation, time (quick-win/short/long), cost, technical readiness level (TRL), feasibility and support requirements.

AVIATION OPERATIONAL ISSUES AND IMPACTS SUMMARY

NAVIGATION: Lack of Aviation Navigation Accuracy

Annex V, Aviation Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

SPACE CONDITION CAUSING ISSUE: Denied PNT/degraded PNT which results in no position update information/to severely degraded position information.

ISSUE DESCRIPTION and OPERATIONAL IMPACT: With denied and/or degraded PNT, onboard EGI receivers will not receive position updates resulting in inertial-only navigation. Operational impact is considered Low.

MITIGATING ACTION: Alternative navigation solutions i.e. INS or terrain flight navigation

MITIGATION DESCRIPTION: Fall back on onboard INS and/or terrain flight navigation. DOTMLPF implications fall under training. Training for Inertial Navigation System and Terrain flight navigation is conducted in flight school.

- **ISSUE MITIGATED:** Lack of Aviation Navigation Precision
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Alternative navigation solutions i.e. inertial navigation system (INS) or terrain flight navigation. INS is an onboard navigating system which is integrated with GPS. Terrain flight navigation is a means of navigating based on landmarks, time, distance and heading and is used when all other navigating are inoperative.
- **LEVEL OF MITIGATION:** Mostly – this action mitigates the issue to an acceptable level.
- **TIME (QUICK-WIN/SHORT/LONG):** QUICK WIN = 1 – 4 Years (~ Current + 1 POM Cycle)
- **COST:** EXTREMELY LOW(<$1 Million)
- **TECHNICAL READINESS LEVEL:** TRL 9
- **FEASIBILITY:** HIGH – Easily implemented
- **SUPPORT REQUIREMENTS:** LOW – Very little additional support / cost (beyond IOC cost) to implement

TARGETING: Hand-over of less accurate target data

SPACE CONDITION CAUSING ISSUE: Denied PNT/degraded PNT which results in no position update information/to severely degraded position information.

ISSUE DESCRIPTION and OPERATIONAL IMPACT: With denied and/or degraded PNT, onboard GPS receivers will not receive position updates reducing the accuracy of target location. Operational impact is considered Low .

MITIGATING ACTION: Alternative position solutions i.e. INS

MITIGATION DESCRIPTION: Fall back on onboard INS. DOTMLPF implications fall under training. Presently training for INS is conducted in flight school.

- **ISSUE MITIGATED:** Hand-over of less accurate target data

- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Alternative position solutions i.e. INS. INS is an onboard navigation system which is integrated currently with GPS.
- **LEVEL OF MITIGATION:** Mostly – this action mitigates the issue to an acceptable level.
- **TIME (QUICK-WIN/SHORT/LONG):** QUICK WIN = 1 – 4 Years (~ Current + 1 POM Cycle)
- **COST:** EXTREMELY LOW(<$1 Million)
- **TECHNICAL READINESS LEVEL:** TRL 9
- **FEASIBILITY:** HIGH – Easily implemented
- **SUPPORT REQUIREMENTS:** LOW – Very little additional support / cost (beyond IOC cost) to implement

JAM RESISTENT AND SECURE COMMUNICATIONS: Loss of timing information for secure communications

SPACE CONDITION CAUSING ISSUE: Denied PNT/degraded PNT which results in no timing update information/to severely degraded timing information.

ISSUE DESCRIPTION and OPERATIONAL IMPACT: With denied and/or degraded PNT, onboard radios will not receive timing updates reducing synchronization with other radios. Operational impact is considered Low.

MITIGATING ACTION: Fall back on use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization.

MITIGATION DESCRIPTION: Fall back on use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW. DOTMLPF implications fall under training. Presently training for Communications is part of flight school POI.

- **ISSUE MITIGATED:** Loss of timing information for secure communications
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW which have autonomous clocks. Time is included in the signal for synchronization.
- **LEVEL OF MITIGATION:** Mostly – this action alone mitigates the issue to an acceptable level,
- **TIME (QUICK-WIN/SHORT/LONG):** QUICK WIN = 1 – 4 Years (~ Current + 1 POM Cycle)
- **COST:** EXTREMELY LOW(<$1 Million)
- **TECHNICAL READINESS LEVEL:** TRL 9
- **FEASIBILITY:** HIGH – Easily implemented
- **SUPPORT REQUIREMENTS:** LOW – Very little additional support / cost (beyond IOC cost) to implement

Annex V, Aviation Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

NLOS COMMUNICATIONS: No SATCOM **SPACE CONDITION CAUSING ISSUE:** denied / degraded SATCOM which results in no satellite communications.

ISSUE DESCRIPTION and OPERATIONAL IMPACT: With denied / degraded SATCOM, onboard SATCOM radios will be inoperative. Operational impact is considered, Low

MITIGATING ACTION: Use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW

MITIGATION DESCRIPTION: HAVEQUICK, SINCGARS, LINK-16, SRW and WNW. DOTMLPF implications fall under training. Communications training is part of flight school POI.

- **ISSUE MITIGATED:** Loss of timing information for secure communications
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation through the use of HAVEQUICK, SINCGARS, LINK-16, SRW and WNW
- **LEVEL OF MITIGATION:** Mostly – this action mitigates the issue to an acceptable level,
- **TIME (QUICK-WIN/SHORT/LONG):** QUICK WIN = 1 – 4 Years (~ Current + 1 POM Cycle)
- **COST:** EXTREMELY LOW(<$1 Million)
- **TECHNICAL READINESS LEVEL:** TRL 9
- **FEASIBILITY:** HIGH – Easily implemented
- **SUPPORT REQUIREMENTS:** LOW – Very little additional support / cost (beyond IOC cost) to implement
- **ECHELON:** Combat Aviation Brigade

UAS CONTROL: Loss of control link to UAS.

SPACE CONDITION CAUSING ISSUE: Denied / degraded SATCOM, SATCOM links will be inoperative. Operational impact is considered Low.

ISSUE DESCRIPTION and OPERATIONAL IMPACT: With denied / degraded SATCOM, UAS SATCOM links will be inoperative. Operational impact is considered Low.

MITIGATING ACTION: Use of LOS communication links to operate UAS.

MITIGATION DESCRIPTION: LOS communication links to operate UAS. DOTMLPF implications fall under training. Operating UAS with LOS communication links is part of training.

- **ISSUE MITIGATED:** Loss of control link to UAS.
- **HOW THE MITIGATING ACTION MITIGATES THE ISSUE:** Mitigation is through the use of LOS communication links to operate UAS.
- **LEVEL OF MITIGATION:** Mostly – this action mitigates the issue to an acceptable level,
- **TIME (QUICK-WIN/SHORT/LONG):** QUICK WIN = 1 – 4 Years (~ Current + 1 POM Cycle)

Annex V, Aviation Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

- **COST:** EXTREMELY LOW(<$1 Million)
- **TECHNICAL READINESS LEVEL:** TRL 9
- **FEASIBILITY:** HIGH – Easily implemented
- **SUPPORT REQUIREMENTS:** LOW – Very little additional support / cost (beyond IOC cost) to implement
- **ECHELON:** Combat Aviation Brigade

Annex VI, Fires Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Degraded Space Review - Fires Center of Excellence

1. Introduction.

a. BLUF – Fires (both ADA and FA) were considered in this assessment. In order to operate in a degraded / denied Space environment, Fires assets would require more centralized survey operations than currently used to maintain accuracy. Specific "smart munitions" that use GPS guidance could not be employed, resulting in less accurate Fires and more munitions required to accomplish most Fires missions.

b. Facts – The current FY13 Fires Required Capabilities (RC) were used as a basis for task requirements. Current TO&Es were used as a basis for the Fires organizations.

c. Assumptions – If Fires units are currently dependent on other organizations to provide information and services based on current TO&Es and doctrine, we maintain these dependencies. We did not ask for new organizations or new major end items. Two examples are: 1) Fires depend on other assets for deep targeting intelligence, as Fires units do not own/manage/operate intelligence/recon assets. 2) Fires personnel use the Signal backbone of networks to pass information once beyond tactical radio communications. In this Degraded Space Review, Fires did not request new signal communications for long-haul communications assuming the Signal Branch would adjust their requirements to take care of their customers' requirements in any environment.

2. Approach – Fires CoE operated from a 100% denied space (DS) environment for the analysis, while using the Fires Required Capabilities (RC) and SME contribution as our primary means of input. DS mitigations were discussed with TRADOC Capability Managers (TCM) and other SMEs by coordinating a survey IOT provide specific tasks and mission areas that would fail and their reasons why. As a finding result, not all of our RCs were affected by the DS environment.

3. Results

a. Operational Overview for your CoE. We identified four areas that we provided results for:

(1) Long-range (beyond line of sight) Battle Damage Assessment (BDA). Currently Fires does not have assets to put "eyes on" targets that have been engaged for BDA.

(2) Reduced Precision Fires.

(3) Lack of Early Warning.

(4) Lack of Weather (MET) Support via WTEM (weather, terrain, and environmental monitoring) satellites.

b. Operational Issues . The primary operational issues from the above conditions were:

(1) Reduced precision fires capability. The lack of GPS would affect observer location, shooter location, and use of precision guided munitions (PGM). Lack of WTEM satellites would also reduce the accuracy of

conventional munitions by not factoring the effects weather would have on munitions while in flight. Secondary and tertiary affects could be more rounds and more time required to achieve the same results of GPS guided munitions; potentially increased risks of collateral damage due to less accuracy (precision, near precision, and area fires); and increase in the logistics of providing the additional munitions requirements, impacting logisticians and number of personnel required to accomplish the mission.

(2) Lack of Early Warning would cause ADA units to potentially identify targets later in the kill chain than with early warning; result in a potentially lower probability of kill (PK).

(3) The lack of long-range BDA might result in targeting cells not confirming results in a timely manner to meet commander's requirements.

c. Mitigating Actions. Primary mitigating actions for reduced precision fires primarily caused by lack of Space PNT:

(1) Fires Battalion and Fires Brigade level survey teams still exist. The survey teams provide common survey reports to supported units using Improved Position Azimuth Determination System (Improved PADS). The IPADS primarily support the Fire units, and organic Firefinder radars, with Survey Control Points (SCP). The Fire units then bring the survey forward to desired locations using aiming circles, which lose accuracy with increased distance and turns from the SCP. This technique is still trained in Fires School and some units. Additional training efforts are required to ensure the force is proficient.

(2) Most firing platforms have inertial guidance systems that can update the platform with current location/direction from an SCP. The accuracy degrades over time and distance. Most crews have become dependent on GPS and would require further training to ensure accurate updates.

(3) If the PNT denial was localized and areas known, there are four potential mitigators:

(a) Currently in-use: Use Laser Guided munitions.

(b) Currently in-use: Use GPS lock-acquired PLGR signal outside the denied area/location to share with other GPS equipment.

(c) Currently in-use: Use existing terrestrially based UHF EPLRS to augment the GPS signal (for FFT).

(d) Future system: Provide a guided munition the ability to be fired by acquiring a GPS signal from another location. As the munition traveled, it would go outside the denied area and pick up a GPS signal, then be guided to its destination. This is a long-term option/solution.

4. Summary of Conclusions. In order to operate in a degraded / denied Space environment, Fires assets would require more centralized survey operations than currently used to maintain accuracy. Specific "smart munitions" that use GPS guidance could not be employed, resulting in less accurate Fires and more munitions required to accomplish most Fires missions. Additionally, lack of Early Warning would cause ADA units to potentially identify targets later in the kill chain than with early warning.

Annex VI, Fires Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Appendicies (as required)


DS Mitigation v2 5.xlsx


tcs matrix.xlsx

Annex VII, Maneuver Support Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Degraded Space Review – Maneuver Support Center of Excellence

1. Introduction.

a. BLUF – The Maneuver Support Center of Excellence (MSCoE) relies on space capabilities to enhance performance of the Maneuver Support and Protection (MSP) Warfighting Function (WfF). We have identified multiple shortfalls of MSP Required Capabilities (RC) during a degraded space environment and have identified a short term mitigation strategy that limits the impact of degraded space.

b. Facts

(1) In future operational environments, the Army will experience some degree of degraded effects to the Space capability.

(2) MSP WfF organizations will rely on the Space capabilities to enhance mission performance.

(3) Users are becoming ever increasingly dependent on GPS Positioning, Navigation, and Timing services, which are a satellite based capability that are easily jammed and/or degraded.

(4) Common Operating Environment Computing Environments are becoming increasingly dependent on data transfer and cloud network capabilities.

(5) Sustainment of a Common Operating Picture is dependent on satellite based transmissions.

(6) Terrain updates are primarily conducted using satellite imagery.

c. Assumptions .

(1) The Army force structure is likely to decrease due to budget constraints, but this will not result in any significant changes to Army required capabilities.

(2) The operational environment defined by *TRADOC G2 Operational Environment 2009-2025* represents that of the 2018-2030 timeframe of the MC CBA.

(3) Positioning, Navigation, and Timing (PNT) will be the most critical Space capability for the MSP WfF.

2. Approach. The Maneuver Support CoE conducted this assessment in the following three phased approach. First, we reviewed the results of the FY2010 Protection Capabilities-Based Assessment (CBA), Required Capabilities (RC), Task-Condition-Standards (TCS) and capability gaps that had any degraded/denied space implications. Secondly, we then reviewed and analyzed the 23 Maneuver Support and Protection (MSP) RC that were recently approved by TRADOC, and are being used to support the CNA 16-20 analysis. We considered each critical task associated with each RC to determine if they relied on space capabilities to perform it, and what impact there would be if degraded/denied

space occurred. Our initial list of shortfalls was based on a 100 percent denied space environment, and was adjusted by the ICDT lead as the study matured. The final step of our analysis included refining the capability gaps based on applicability of the scenario used for this assessment, and to ensure that the same criterion and formatting was consistent across all WfFs, and that mitigating strategies were developed for each gap.

3. Results.

a. Operational Overview. As we reviewed all missions, and TCS associated with each MSP RCs, we were able to identify key space capability areas that would have a major impact on MSP missions if those space capabilities are denied or degraded. The key space capability areas that enhance the MSP WfF are Satellite Communications (SATCOM), Positioning, Navigation and Timing (PNT), and Intelligence, Surveillance, and Reconnaissance (ISR). The following describes each space area's operational support for the MSP WfF:

(1) SATCOM - A number of MSP missions will require reachback and Beyond Line Of Sight (BLOS) communications with varying organizations. Military Police will have to interact with host nation agencies and could be BLOS from these agencies in contingency operations. Military Police, Engineers, and Chemical, Biological, Radiological, and Nuclear (CBRN) units will be required to reachback communicate with technical organizations from theater back to Continental United States (CONUS). Each of the MSP organizations will also be required to provide critical updates to the Common Operating Picture (COP), update positions, and send status reports through Blue Force Tracker (BFT) to higher headquarters and other units.

(2) PNT - MSP organizations will require quick and accurate positioning data to identify location and navigation data to support movement from point to point along routes and from base to base in an operational environment. OPTEMPO will be greatly affected if accurate positioning, navigation, and timing data are not available for units conducting MSP missions. Geospatial engineering makes extensive use of PNT services, primarily GPS for surveying and terrain change locations. Essentially all missions conducted by MSP units will require PNT.

(3) ISR – MSP organizations will consume multiple forms of ISR products, and during degraded space operations, they will coordinate with Intelligence organizations to receive these products via alternate means. Geospatial elements provide GEOINT support for operational terrain situational awareness using a standard and sharable geospatial foundation (SSGF) data concept. ISR services are critical to data production, acquisition, updates, and maintenance of terrain situational awareness. The SSGF is a Mission Command Essential Capability, and therefore essential to collaborative operational planning, execution, and shared situational awareness

b. Operational Issues - Below describes operational impacts that degraded/denied space conditions caused on the MSP WfF across applicable space capability area:

(1) SATCOM

- Loss of SATCOM reduces MSP units' ability to directly reachback to technical expertise and government agencies for technical assistance needed to accomplish their mission. Overall, degraded mission performance can be expected if SATCOM is degraded or denied.

- Chemical, Biological, Radiological, and Nuclear (CBRN) units and Corps and Division staffs are unable to send/receive critical CBRN warnings and reporting details of a CBRN hazard to the lowest tactical unit in a timely manner. By not being able to send warning to all tactical elements in a timely manner, those affected by a potential hazard may not be alerted, resulting in injury or death.

- Loss of SATCOM limits the ability of MSP organizations to post updates to the COP, and communicate with higher and adjacent units, host nation authorities when beyond LOS, on the move, and beyond range of organic systems. During degraded/denied space environment, units cannot easily communicate BLOS; this will limit the range of operations and OPTEMPO for MSP units.

- Although each unit deploys with a Standard and Sharable Geospatial Foundation (SSGF) data "basic load" of their area of operations, loss of satellite communications will impact the timeliness of geospatial data updates and the efficiency of Cloud computing environments to support Mission Command with updates and tools. Current concept requires units to continue deployment preparation in CONUS, during transport to the Area of Operation, and while in theater.

(2) PNT

- Denied/degraded PNT will limit accurate use of robotic platforms conducting route clearance operations. With denied/degraded PNT, use of robotic platforms to conduct route clearance will have a negative impact on assured mobility of all movement.

- Denied/degraded PNT would seriously impact MSP units conducting support operations. Loss of automated navigational aids would slow down the pace of operations placing Soldiers in critical danger.

- Loss of PNT will seriously degrade, or deny all activities that use continuous space- based PNT services. The accuracy and precision of stored or replicated data will not be lost, but software that requires constant position updates, such as GPS surveying, operational position reporting, and GPS-based navigation will be negatively impacted. Although map backgrounds will display accurate position information based on stored geospatial position data, asset tracking will rely on pre-GPS reporting techniques without timely updates.

(3) ISR

- Denied/degraded ISR (satellite imagery) will limit Geospatial Engineers with the ability to acquire and provide updated standard and shareable geospatial foundation data, or detect

changes in terrain, which will degrade accurate situation awareness and place Soldiers in critical danger.

- Loss of space-based ISR will degrade activities which use these capabilities to monitor potential incoming missile attacks. The Joint Tactical Air Ground Stations (JTAGS) provide the early warning of in-bound missile threats, which is essential to provide improved protection and survivability of Soldiers and equipment.

- Denial of satellite imagery adversely affects new SSGF data acquisition, updates, and detection of changes in terrain. Failure to detect key terrain changes can adversely affect operational planning and execution while degrading collaborative terrain situational awareness.

- Although each unit deploys with an SSGF data "basic load" of their area of operations, loss of satellite communication will impact the timeliness of geospatial data update reporting. The efficiency of cloud computing environments to support Mission Command with terrain data updates and tools is also negatively impacted.

c. Mitigating Actions – The following actions and recommended solutions will mitigate impacts from a denied/degraded space environment on the MSP WfF:

(1) SATCOM

- **Alternative Communications Package** - MSP units will have to access alternative communications packages, such as WIN-T (Inc 2) for voice and data connectivity for reachback to technical centers of expertise from theater to CONUS during denied/degraded SATCOM conditions. It should be noted that although WIN-T (Inc 2) systems will be more jam resistant than current systems, they still will not be entirely jam-proof. This will delay operations (slow OPTEMPO) as they will have to leave their location, travel to an access point either at the MEB, BCT, other functional Bde, ESB, or DIV/Corps TOC, conduct their collaboration with the technical agency, and continue with their mission. This action will provide an alternate means of communications with technical agencies using existing/programmed solutions

- **Manual population of the COP (Command Post of the Future-CPOF)** - MSP units will be required to send critical populace control information to higher headquarters by voice communications over shorter range systems for updates to the COP during denied/ degraded SATCOM conditions. This will delay timely flow of information between units, and limit the timeliness of situation awareness updates for units that may be impacted by the presence of civilian population in and along the areas of maneuver. Doctrinal manuals will have to be updated to describe the manual process of updating the COP and for units sending information to their higher headquarters during denied/degraded SATCOM. Units will be required to provide an alternate method of sending updates to the COP when in a denied/degraded SATCOM environment.

- **Tactics, Techniques, and Procedures (TTPs) for increased use of LOS communications** - MSP units will send and receive critical populace control information with higher headquarters, adjacent and supported units, and host nation agencies over organic assigned communications equipment during denied/degraded SATCOM environment. This mitigation will enable communication between units, but will reduce the range and OPTEMPO of operations. Doctrinal manuals will have to be updated to describe TTPs for operating within limitations of using LOS communications during denied/degraded SATCOM conditions; and, provide an alternate method of sending and receiving information with higherheadquarters, adjacent and supported units, and host nation officials when in a denied/degraded SATCOM environment.

- **Transmit over theater communication assets** - Transmit all SSGF updates and production using theater communication assets. The operational impact of using terrestrial communication assets to transmit data is considered to be low. Terrain updates are typically small and are not anticipated to introduce a significant additional load demand on terrestrial signal operations.

(2) PNT

- **Terrain navigation with map and compass w/training at BCT and below** - MSP units conducting clearance operations will have to conduct manual navigation during a denied/ degraded PNT environment. Doctrine will need to be updated describing the requirement to conduct manual navigation, institutional training will need to place emphasis on training Soldiers and leaders to use map and compass to identify location and navigate point-to-point, and units will need to train during exercises in anticipation that automated navigational aids would not be available or degraded in future operations. This action will provide an alternate method to identify location, and navigate from point-to-point along routes while conducting clearance to support mobility of friendly forces. Manual navigation will slow the OPTEMPO of operations.

- **Navigation training** - Add navigation training/emphasis to existing training during Initial Military Training and Leader Development courses, and incorporate at the unit level through individual and unit training, and training exercises. New training and emphasis on training will focus on identifying current location, location of enemy/points of interest, maintaining map boards, and navigating from point-to-point. Action will increase proficiency of Soldiers and leaders in positioning and navigation in order to conduct operations, navigate in a timely and safe manner, to track locations of units and personnel, and identify enemy locations and activities, in order to increase tempo of operations in a safe and confident manner when digital capabilities are not available or are degraded.

- **Maintain national map production** – To provide hardcopy maps for this capability requires that the National Geospatial-Intelligence Agency (NGA) maintain its hardcopy map production capability. Planned reduction of hardcopy map production by NGA must be maintained with the capability to surge production and reproduction, as required. Hardcopy maps are slower to use, and lack the accuracy of GPS systems, but all Soldiers are

routinely trained in their use for navigation and position location and reporting. Supplementing electronic systems with standardized hardcopy maps and charts provides users an established means to determine and report their location.

- **Use stored and replicated map data** – Use stored and replicated map data and implement other position determination techniques. Using non-GPS surveying techniques, and using stored and replicated data will provide Standard and Shareable Geospatial Foundation (SSGF) capable location information. Survey processes provide highly accurate location data for targeted locations, and dead-reckoning navigation processes provide an alternative to GPS navigation and location services. This will create a surge requirement of hardcopy maps that may exceed current production capabilities and logistical planning factors. NGA has announced its intent to reduce/eliminate reproduction of hardcopy maps. This mitigation requires capability to produce and/or reproduce maps in bulk quantities. Tactical Geospatial Engineers do not have this capability.

(3) ISR

- **Use manned and unmanned aerial vehicles (UAV) to augment satellite terrain imagery production.** The use of manned and unmanned aerial platforms to perform aerial mapping operations provides ideal platforms for all requirements to include standard, multi-spectral, Light Detection and Ranging (LIDAR), and nonstandard products (Buckeye). Both helicopters and fixed wing aircraft can be used for aerial mapping, but the higher altitude and speed capabilities of UAVs or fixed wing aircraft make them a more desirable platform. Currently, aviation assets are used for high resolution imagery and special missions. Greater terrain coverage by aerial assets will be required which will indirectly limit those assets for use in other mission sets.

4. Summary of Conclusions. Space capabilities enhance the MSP WfF through SATCOM, PNT, and ISR. During a denied/degraded space environment, MSP missions will be adversely impacted due to degradations in SATCOM, PNT, and ISR space capabilities. We have developed mitigation strategies to address shortfalls in order to minimize the impact on operations in the event of a degraded space environment. Some mitigation techniques require long term national planning and maintenance of capability to satisfy operational use in a timely fashion.

Annex VIII, Sustainment Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Degraded Space Review - Sustainment Center of Excellence

1. Introduction.

a. BLUF. The loss of space-based communications by U.S. Army forces conducting operations remains a major concern for those organizations responsible for sustaining the deployed forces. Whether the interruption of the communications is caused by enemy action against satellites or through the use of intermittent jamming or spoofing, the resulting "black-out" will require Army forces to adapt and adjust until the capability is restored.

Short term losses of SATCOM may be mitigated through alternative communications methods and courier networks. Compensating for long-term losses will require Army sustainment forces to train for operations without SATCOM support and may dictate a different approach to sustainment support, particularly in the use of automated information systems. For the purpose of this document, the term "sustainment" will encompass Quartermaster, Transportation, Ordnance, Adjutant General, Judge Advocate General, Medical Logistics, Human Resources, Finance, and Chaplain functions.

b. Facts. All military and commercial satellite communications systems are susceptible to uplink and downlink jamming or spoofing. The increasing dispersion of satellite communications terminals has increased the enemy's capability to target space communications systems by locking onto the satellites' transmit and receive signals. Some of the more sophisticated anti communications weapons, such as high-powered lasers and direct-ascent hit-to-kill vehicles, require more precise tracking information. Many countries have the capability to precisely track and identify space objects using advanced optical, radar, passive radio frequency (RF), and SIGINT tracking systems. The proliferation of this capability will only increase, and soon even the most rudimentary group or organization will be able to deploy anti-communication weapons.

Primary threats to our sustainment capabilities would be attacks designed to deny our Positioning, Navigation, and Timing (PNT) capabilities. Army sustainment forces have become so dependent upon the Global Positioning System (GPS), which provides PNT, that this space-based capability is often taken for granted. PNT capabilities provide position-location information and when combined with geospatial products, form the basis for military situational awareness and the common operational picture (COP).

The second threat would be focused on denying our ability to transport our critical sustainment data using satellite communications. This would most adversely affect the Army's ability to pass materiel requisition information, equipment status, and even coordinating instructions between commands. Even a relatively minor disruption could have catastrophic results depending on the time and duration of the interruption. The Army's increasing movement towards OSDdirected, web-based enterprise automated sustainment systems is a prime example of an area where a disruption of communications between deployed units and the national provider could lead to significant difficulties, and reinforces the need for strong Mission Command responsibilities.

c. Assumptions . The U.S. is more dependent on space than any other nation, yet the threat to the U.S. and its allies in and from space does not seem to get the attention it deserves from the

departments and agencies of the government charged with national security responsibilities. Recently, however, this has appeared to change and a greater effort has been expended to study the problem.

All military and commercial satellite communications systems are susceptible to uplink and downlink jamming or spoofing. Countries and organizations unfriendly toward the U.S. and its Allies will seek to level the playing field by disrupting our PNT and communications capabilities as these SATCOM links are easily detected and can be disrupted by either simple process or sophisticated technology. There is little doubt that these threats will continue.

2. Approach.

Much of the driving requirement for SATCOM in the Sustainment WfF is the need to enable streamlined logistics and distribution processes in an efficient sustainment operation; in effect, the use of an effective "Logistics Pull" system requires uninterrupted communications to ensure effectiveness. Should a communication-degrading incident occur, one of the key mitigations for the Sustainment community would be to adopt a "Logistics Push" paradigm which will not be as efficient or materially economical but will provide supplies and stock based on staff planning data from operational histories, estimates and SOPs. There will be a lack of In Transit-Visibility (ITV) and an unavoidable element of waste but the combat forces will be sustained at least as far as consumables which can be forecasted are concerned. Other commodities such as repair parts will require a different method of ordering, and that too will be inefficient. Therefore, while there is certainly increased reliance on SATCOM for log communication, monitoring, and delivery systems, essential planning and distribution functions should not be critically affected if alternative terrestrial communications and courier networks, as suggested above, are implemented.

The Sustainment COE as well as some of the other COEs (Intel, Maneuver, etc.) have agreed that another D/S/DS mitigating factor would be the movement of some functional groups forward in order to place them in direct contact with the combat elements they are supporting. For the Sustainment WfF, this includes such things as medical specialty teams, movement control teams etc. While these teams will help to mitigate the loss of long distance comms, they present another problem to the Sustainment WfF; each of these teams that move forward will require more food, ammunition, repair parts, etc. in order to provide their critical services. This places an additional burden on the distribution pipeline. Recognizing this dichotomy, sustainers must be ready to support a greater-sized force than had been initially planned.

3. Results.

a. Operational Overview for Sustainment CoE.

Operational Condition 1: GPS degraded/denied for Sustainment operations.
Sustainment operations are supported by GPS-based tracking and location systems such as the Movement Tracking System, SeaTel 410, etc. These are provided inside the cab of sustainment vehicles or on watercraft bridges in order to provide SA for operators/drivers and also allow commanders to have visual record of where their unit assets are on the battlefield. The GPS signal is the key that these systems use to provide exact, real-time location of the vehicle/platform. When the GPS signal is

degraded, the systems cannot determine or report their “on the ground” location during the intermittent period of degradation. Distribution platforms will continue to operate and perform missions, but will not be visible at times on SA screens in TOCs or command posts.

When signal is completely denied, the systems cannot establish or report their location. This will impact decision making at the command level as assets will not be visible. Loss of these location feeds will also impact the Sustainment Mission Command System, as it is a receiver of location data. The loss of GPS will also impact usage of the Joint Precision Aerial Delivery System (JPADS) which uses the GPS signal to guide the aerial delivery platform to the desired destination. If GPS signal is lost prior to deployment from aircraft, the JPADS will not be dropped. If GPS signal is lost after deployment, the system will attempt to land based on last received GPS signal.

Operational Condition 2: SATCOM degraded/denied for Sustainment movement tracking systems operations.

MTS uses L-band satellites and is being merged with the other vehicle tracking systems such as Blue Force Tracker. These systems are capable of using Low–Earth Orbit (LEO), Mid-Earth Orbit (MEO), and Geosynchronous Earth Orbit (GEO) satellite connectivity. This allows them to switch to other commercial L-Band providers with very little interruption, re-directing through other vendor systems. Currently, they communicate through the LEO system that has 66 "birds" launched with 12 spares in the "barn.” Satellite providers will be able to replace damaged or destroyed satellite assets in a relatively short time period. In the interim, units may rely on HF radio networks for use at the tactical level.

Operational Condition 3: SATCOM degraded or denied for automated Sustainment business systems operations.

Army sustainment automated business systems require dedicated communications to operate and will require SATCOM when deployed to theater in order to quickly pass/receive transaction information and status of materials in the distribution pipeline. Performing these functions also acts as feeder data for ITV of deploying units and equipment. This operational condition includes the current and emerging systems used for:

1. Ordnance/Maintenance (includes ammunition)
2. Transportation (includes unit deployment and materiel distribution)
3. Supply (includes Supply Support Activities and Unit Supply processes)
4. Medical and Medical Logistics (includes medical surveillance, data repositories, patient movement and log functions). Medical logistics are particularly vulnerable because supplies are almost entirely supplied via just in time direct vendor delivery.
5. Finance (includes tracking of multi-service costs, operational budgets)
6. Human Resources (includes personnel, PKI, and casualty reporting)

This operational condition is not vignette specific for sustainment systems, but applies to all operations across the military spectrum. Regardless of operations size, duration or intensity, the basic sustainment functions of fix, fuel, feed, move, finance, evacuate, report, etc. will remain the same. What will be scenario driven will be the amounts and types of supply classes required. Obviously, for nation-

building/humanitarian missions, there will less requirement for Class V and increased requirement for Class I and II.

In all cases, the turnaround time for supply/repair parts requests will be slowed. Units will have to rely on SOPs for manual operation of supply sites, and be prepared to use alternate means of transacting business requests to higher level sources of supply.

Operational Condition 4: SATCOM degraded/denied for Sustainment Mission Command System (Battle Command Sustainment Support System: BCS3)

Battle Command Sustainment Support System (BCS3) is the sustainment component of Mission Command (MC). It provides logistics information critical to operations and enhances the ability to manage sustainment operations through end-to-end visibility. BCS3 provides sustainment information from numerous sources into one user-defined, mission-focused, map-centric visual display by providing graphics that are scalable to the display requirements of tactical, operational and strategic users' needs. BCS3 provides ITV data to show critical supply and transportation asset information by displaying asset visibility throughout the supply chain from the point of shipment to final destination. It also tracks resources and establishes automated alerts when critical resources require tracking or are below required levels.

b. Operational Issues . There is the potential for hostile interference actions against the Brigade's network infrastructure to include the Tactical Sustainment Network. Combat forces need to be immediately aware when there is a problem with SATCOM and PNT. The SoldierSoldiers in these units need to be flexible and trained to continue their operations during SATCOM outages. Soldiers must be adaptable enough to go from extensive reliance on space capabilities to an environment where they continue to operate when space enabled capabilities are severely degraded or nonexistent.
Units must be prepared to train as they fight. This means training in a degraded, denied, or disrupted space operational environment. Soldiers and forces should be practicing operations without SATCOM and PNT signals. They need to learn how to rapidly recognize degraded capabilities and take action to mitigate their loss. During the Cold War, units trained to continue operations while undergoing intense radio-jamming or interference. This same approach must be taken with current units.

Sustainment system managers and operators will determine for each system what are the primary, alternate, contingency redundancies and pathways for data capture and transmission.

c. Mitigating Actions .

(1) **General Mitigating Actions:**

(a)"Push versus Pull" philosophy set in place. Much of the driving requirement for SATCOM in the sustainment WfF is the need to enable streamlined logistics and distribution processes in an efficient sustainment operation; in effect, the use of an effective "Logistics Pull" system requires uninterrupted communications to ensure effectiveness. Should a communication-degrading incident occur, the key mitigation for the Sustainment community would be to adopt a "Logistics Push" paradigm which will not be as efficient or materially economical; but, will provide supplies and stock based on staff planning data from operational histories, estimates and SOPs at least as far as consumables which can be forecasted

are concerned. Other commodities such as repair parts will require a different method of ordering, and that too will be inefficient.

(b)The Brigade Sustainment Automation Support Management Officer (SASMO) needs to plan for hostile interference toward the Tactical Sustainment Network. This plan should include

- Reviewing and implementing applicable preventive measures
- Providing, immediate counter actions and troubleshooting upon discovering hostile actions
- Reporting hostile actions to the network manager and chain of command
- Providing procedures for transitioning automated sustainment operations into WIN-T as a redundant network

(c)The Brigade SASMO should include Tactical Sustainment Network force protection measures, responses to hostile interference, and response procedures in his theater support plan.

(2) Specific Mitigating actions based on Operational conditions:

Operational Condition 1: GPS degraded/denied for Sustainment operations.
Soldiers will require increased training in land navigation tasks and map reading. Watercraft operators will need to maintain skills in celestial navigation, radio positioning, dead reckoning, etc. Convoy SOPs will require manual navigation info. Watercraft will switch to manual navigation methods. There must be coordination with other Army assets (such as MP) in order to support operations and highway regulation. Soldiers will require increased training in land navigation tasks and map reading. Leaders must plan, prepare, and execute individual and collective “day without space” training.

Future potential mitigating factors: DARPA researchers at the University of Michigan have made significant progress with a timing & inertial measurement unit (TIMU) that contains everything needed to aid navigation when GPS is temporarily unavailable. The single chip TIMU prototype contains a six axis IMU (three gyroscopes and three accelerometers) and integrates a highly-accurate master clock into a single miniature system, smaller than the size of a penny. This chip integrates breakthrough devices (clocks, gyroscopes and accelerometers), materials and designs from DARPA’s Micro-Technology for Positioning, Navigation and Timing (Micro-PNT) program.

There are a number of other technical mitigation strategies under development/investigation:

(a)Pseudolites—GPS like systems on terrestrial or aerial platforms

(b)RF-Based systems—using GPS in conjunction with JTRS, and cell phones to provide timing, GPS, and ranging data

(c)Multi-Sensor devices–dead reckoning devices, atomic clocks, etc. that can be used to provide GPS-like information

Operational Condition 2: SATCOM degraded/denied for sustainment movement tracking systems operations.

Annex VIII, Sustainment Center of Excellence Degraded Space Assessment, of the Degraded Space Mitigation Strategy

Unit level training may be required to ensure operators are aware of the implications and functionality of tracking system operations during degraded periods. Increased training in HF radio (such as SINCGARS) in order to communicate with organic HQs and coordinate with convoy/SSA/harbor control activities and with supported units.

Operational Condition 3: SATCOM degraded or denied for automated sustainment business systems operations.
Soldiers will require increased training in radio relay procedures, preparation of paper versions of documents for couriers, increased reliance on localized reference databases, or SOPs for such disparate functions as medical diagnosis or vehicle cannibalization procedures.

Leaders must consider both the individual and collective training requirements in planning, preparing and executing unit training plans.

Operational Condition 4: SATCOM degraded/denied for Sustainment Mission Command System (Battle Command Sustainment Support System BCS3).
Use manual procedures and hard copy documents. Soldiers will require increased training in radio relay procedures, preparation of paper versions of documents for courier, increased reliance on localized references, databases or SOPs. Leaders must consider both the individual and collective training requirements in planning, preparing and executing unit training plans.

4. Summary of Conclusions.

During periods of long-term degraded or denied space capabilities there will be a lack of ITV and an unavoidable element of waste but the combat forces will be sustained. Therefore, while there is certainly increased reliance on SATCOM for log communication, monitoring and delivery systems, essential planning and distribution functions should not be critically affected if alternative terrestrial communications and courier networks, as suggested above, are implemented.

Historically, Army leaders have been reluctant to train in a degraded space environment. Usually the loss of SATCOM or PNT is simulated, accompanied by the rationale that training time is too valuable to waste, and that we cannot afford to deny or degrade space-based capabilities as it would detract from the main training objective. Consequently, leaders and Soldiers are not trained to operate in a degraded space environment. This will have to change as the increased threat to space-based capabilities becomes more of a reality.