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ARMY FIELD-ORIENTED S&T EXPERIMENTATION VENUES: A COMPARATIVE ANALYSIS

by
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September 2011

Final Report
March 2011 - September 2011

U.S. Army Natick Soldier Research, Development and Engineering Center
Natick, Massachusetts 01760-5056

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14. ABSTRACT

This report describes a survey that provided detailed information on experimental venues and sites that support US Army science and technology (S&T). In February 2010, the Office of the Deputy Assistant Secretary for Research and Technology (Army) (DAS(R&T)) directed the Natick Soldier Research Development and Engineering Center (NSRDEC) to conduct the survey to inform the S&T community of possible experimentation venues, capabilities, costs, and restrictions to help the S&T community understand where to go for experimental needs and to match the venue to the requirement. General direction on where to initiate the survey came from a collection of experimental venues and sites listed by the Research Development and Engineering Command (RDECOM) contacts within Army. The detailed information on experimental venues came from written questionnaires, phone interviews with Venue points of contact (POCs), and website reviews. The report results will provide Army S&T managers with a resource for field experiment planning.

15. SUBJECT TERMS

COSTS	CAPABILITIES	EXPERIMENTAL NEEDS	INFORMATION EXCHANGE
SHARING	ARMY RESEARCH	EXPERIMENTAL DESIGN	EMERGING TECHNOLOGIES
SURVEYS	QUESTIONNAIRES	TEST AND EVALUATION	TECHNOLOGY ASSESSMENT
WEBSITES	DATA COLLECTION	PROJECT MANAGEMENT	EXPERIMENTATION VENUES
PLANNING	DECISION MAKING	TECHNOLOGY TRANSFER	MODELING AND SIMULATION
INTERVIEWS	FIELD EXPERIMENT	S&T(SCIENCE AND TECHNOLOGY)	

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Preface

The Natick Soldier Research Development and Engineering Center (NSRDEC) conducted a survey of experimental venues, between March and July 2011, at the direction of the Deputy Assistant Secretary for Research and Technology (Army) (DAS**(**R&T)). The purpose was to inform science and technology (S&T) developers with the S&T community of possible experimentation venues and their capabilities, costs, and restrictions to help the S&T community understand where to go for experimental needs and to match the venue to the requirement. This report provides Army S&T managers with a comprehensive compilation of Army S&T venues for field experimental services and activities that can be aligned with S&T through all development phases.

While there are too many people to acknowledge individually, the author would like to thank Mr. Edan Lev-Ari, Research Analyst, NSRDEC Technology Systems and Program Integration Directorate (TSPID) for his support on the data collection presentation and the Research Development and Engineering Command (REDCOM), Training and Doctrine Command (TRADOC), Training Center and Test and Evaluation Leaders for their cooperation and invaluable assistance in answering survey questions and providing ample information regarding their agency's capabilities and command presentations.

ARMY FIELD-ORIENTED S&T EXPERIMENTATION VENUES: A COMPARATIVE ANALYSIS

1. Introduction

This report describes a survey of experimental venues and sites that support US Army science and technology (S&T) and a comparative analysis of the survey results conducted by the Natick Soldier Research Development and Engineering Center (NSRDEC). The survey was conducted between March and July 2011 at the direction of the Deputy Assistant Secretary of the Army for Research and Technology (DAS(R&T)). The comparative analysis was performed in August and September 2011. It provides a compilation of the major Army S&T venues for field experimental services and activities.

Army S&T investments are directed toward fostering innovation and accelerating technology to enable Future Force capabilities while exploiting opportunities to rapidly transition technology to the Current Force. The 2010 Army Modernization Strategy begins with a powerful reminder from LTG Robert P. Lennox:

> Every day our Soldiers put their lives on the line to serve their country, protect our Nation, and fight terrorism. These brave men and women deserve the best equipment available, as soon as possible. We always want them to be protected and able to defeat our enemies-today and tomorrow. But after eight years of combat, our Army is stretched-the supply of force exceeds the sustainable demand, putting the Army out of balance. The goal of Army Modernization is to develop and field a versatile and affordable mix of the best equipment available to allow Soldiers and units to succeed in both today's and tomorrow's full spectrum military operations. We must continue to transform into a force that is versatile, expeditionary, agile, lethal, sustainable, and interoperable to give our Soldiers a decisive advantage in any fight.

Dr. Marilyn M. Freeman, DASA(R&T), is working to reinvent Army S&T to develop and field a versatile and affordable mix of the best Soldier equipment available to allow Soldiers to succeed in both today's and tomorrow's full spectrum military operations and put the Army back in balance.

S&T investments in new scientific or technical ideas sometimes result in new Soldier capabilities. New capabilities must also be replicable at an economical cost and must satisfy a specific tactical need. Experimental investigations validate innovations and prove out new design innovations as workable and operationally relevant. From the concept phase through advanced development, S&T requires technical, tactical, and operational evaluation, assessment, and experimentation to substantiate operational value. Therefore, S&T should include Soldiers throughout the development phases. There are many locations across the United States that the Research Development and Engineering Command (RDECOM) can utilize to perform S&T experimentation with Soldiers in the development loop.

In February 2011, as part of Dr. Freeman's reinvention of Army S&T development and validation she requested that a study be initiated by NSRDEC to inform the S&T community of all possible field experimentation venues and their capabilities, costs, and restrictions. This will, in turn, help the S&T community understand where to go for experimental needs that would allow the venue to be matched to the requirement. Dr. Freeman mandated that experimentation plans and metrics of success accompany all requests for S&T program funding.

The study provided numerous experimentation options that satisfy S&T validation through all phases of technology development under Dr. Freeman's Army S&T reinvention. This report categorizes field experimentation venues and experimental services within the S&T community and identifies new opportunities for technology developers.

2. Approach

2.1 Data Collection Strategy

A tasker was submitted from NSRDEC to all RDECOM agencies that conduct experiments supporting S&T validation. The tasker requested a spreadsheet to include a point of contact (POC) knowledgeable about S&T experimentation venues and their operations. RDECs responded with several spreadsheets with the agencies, organizations, venue names, POCs and technology readiness levels (TRL) associated with each venue. Figure 1 is an example of a spreadsheet that was submitted.

RDECOM Technology Focus Team (TFT) leads within Army RDECs were contacted to assist in cataloging experimental venues with reference to metrics such as costs, resource requirements, lead times, unique facilities/environments, and types of data collection, data measurement, and constraints. The interviews with the TFT leads identified the significant agencies and venues used by that RDEC as part of normal mission or quick reaction activities (i.e., rapid fielding).

An interview guide was developed that addressed overall venue capabilities such as:

- Overall purpose (i.e., training, operational test, etc.)
- Typical experiments and activities
- Item types, experimentation types, and environments
- Unique facilities, environments, equipment, and operational and engineering human resource support (S&Ts, academics, and contractors from MITRE Corporation)
- Experimental planning and support (locally provided services, locations and facilities, lead time, safety document generation, and logistics)
- Experimental execution, data collection, and data analysis/reporting

Agency	Organization	Venue Name	Venue Location	Venue POC	POC 's email Address	POC's Phone#	S&T	TRL Values
US Army	AATD/AMRDEC	Brigade Combat Team Integration Exercise 12.1	WSMR, NM	Dale Johnson	dale.lee.johnson@us.army.mil	757-878-0123		
US Army	AATD/AMRDEC	Autonomous UAS Testing	Dugway Proving Ground, Utah	Keith Arthur	tracy.lunt@us.army.mil		Yes	
US Army	AATD/AMRDEC	Hampton Roads Unmanned System Experimentation Facility	Ft. Eustis, VA	Keith Arthur	keith.arthur@us.army.mil	757-878-2772	Yes	5-7
US Army	AATD/AMRDEC	Ballistc Test Range	Ft. Eustis, VA	Marc Portanova	marc.portanova@us.army.mil	757-878-4238	Yes	2-4
US Army	AATD/AMRDEC	Yuma Proving Ground	AZ	George Dimitrov	george.dimitrov@us.army.mil	757-878-6229	Yes	5-7
US Army	AATD/AMRDEC	Felker Airfield	Ft. Eustis, VA	LTC Wittges	charles.wittges@us.army.mil	757-878-2019	Yes	5-7
US Army	AATD/AMRDEC	Aberdeen Proving Ground	Md	George Dimitrov	george.dimitrov@us.army.mil	757-878-6229	Yes	5-7
US Army	Aeroflightdynamics Dir. (AMRDEC)	Moffett Field Federal Airfield	Moffett Field, CA	Mr. Arthur Ragosta	ragosta@MERLIN.ARC.NASA.GOV	(650) 604-5558	Yes	3 to 5
US Army	Aeroflightdynamics Dir. (AMRDEC)	NASA-Ames 7-by 10-Foot Wind Tunnel, Operated by US Army AFDD	Moffett Field, CA	Mr. Arthur Ragosta	ragosta@MERLIN.ARC.NASA.GOV	(650) 604-5558	Yes	3 to 5
US Army	Garrison Ft. Hunter Liggett	Fort Hunter Liggett	Jolon, CA	Mrs. Debbie King	debra.king2@us.army.mil	(831) 386-2510	Yes	3 to 5
	Fort Ord Resuse Authority	Fort Ord MOUT site	Marina, CA	Mr. Standen Cook	stan@fora.org	(831) 883-3672	Yes	3 to 5
NASA	Ames Research Ctr	NASA-Ames Vertical Motion Simulator	Moffett Field, CA	Mr. Bimal Aponso	bimal.l.aponso@nasa.gov	(650) 604-0471	Yes	3 to 5
USAF	Air Force Research Laboratory (AFRL)	Synthetic Immersive Research Environment (SIRE)	Wright-Patterson Air Force Base, Dayton, OH	Dr. R. Andy McKinley	richard.mckinley2@wpafb.af.mil	(937) 255-4575	Yes	3 to 5
USA	Yuma Proving Grnds	Yuma Test Center	Yuma, AZ	Mr. Michael Jonez	michael.d.jonez@us.army.mil	(928) 328-4033	Yes	3 to 6
USAF	46th Test Wing	Eglin AFB, remote test ranges	Ft Walton Beach, FL	Mr. David Conner	david.a.conner@us.army.mil	757-864-5276	Yes	3 to 9
USA	ARL/SLAD	White Sands Missile Range	Las Cruces, NM	Mr. David Conner	david.a.conner@us.army.mil	757-864-5276	Yes	3 to 9
USAF	AEDC	AEDC NFAC 40-by 80-Foot Wind Tunnel	Moffett Field, CA	Mr. Dave.Duesterhaus	Dave.Duesterhaus@arnold.af.mil	(650) 604-5191	Yes	3 to 5
USAF	AEDC	AEDC NFAC 80-by 120-Foot Wind Tunnel	Moffett Field, CA	Mr. Dave.Duesterhaus	Dave.Duesterhaus@arnold.af.mil	(650) 604-5191	Yes	3 to 5
Army	AMRDEC SSDD	Advanced Prototype and Experimentation Laboratory (APEX-2)	Redstone Arsenal, AL	Rob King	Rob.L.King@us.army.mil	256-842-5060	Yes	3 to 6
Army	AMRDEC SSDD	Airspace Integration Simulation Testbed	Redstone Arsenal, AL	Nancy Bucher	nancy.bucher@us.army.mil	256-842-9501	Yes	4-7
Army	AMRDEC SSDD	Small Unmanned Aeriel System Laboratory	Redstone Arsenal, AL	Lamar Auman	lamar.auman@us.army.mil	256-876-5201	Yes	5-7
Army	AMRDEC SSDD	Shadow Integration Laboratory	Redstone Arsenal, AL	Rob King	Rob.L.King@us.army.mil	256--842-5060	Yes	3 to 6
Army	AMRDEC SSDD	Army COE System Integration Laboratory	Redstone Arsenal, AL	Jeff Maddox	Jeffrey.a.maddox@us.army.mil	256-876-7716	No	
Army	AMRDEC SED	Aviation Systems Integration Facility	Redstone Arsenal, AL	Scott Dennis	scott.dennis@us.army.mil	256-876-1376	Yes	4-6

Figure 1. Example of RDECOM Venue Spreadsheet

2.2 Identifying the Key Players

Experimental venue environments (i.e., agencies, venues, and events), shown in Figure 2, were catalogued across the Army based on S&T applicability and cycle of development phase. The types of field experimentation venues were subcategorized as follows:

- Periodic Major Events (AEWE, C4ISR Network Modernization, and Brigade Modernization Command)
- Organizations conducting field-type S&T assessments on a relatively continuous basis (Training and Doctrine Command [TRADOC] Battle Labs)
- Organizations capable of facilitating or hosting experimentation (Army training centers, JRTC, NTC, and local Guard/Reserve facilities)

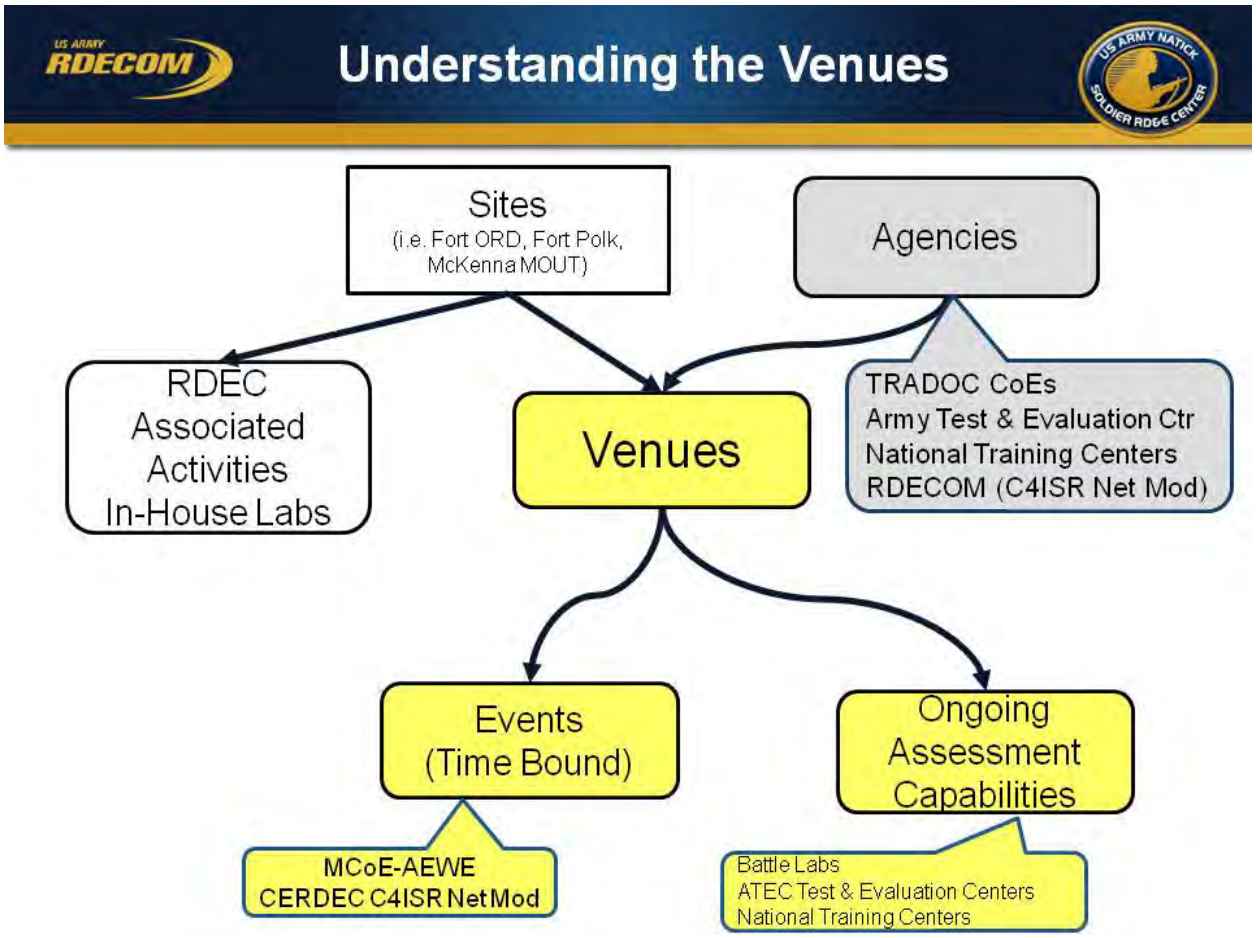

Figure 2. Types of Field Experimentation Venues

Interview guide questionnaires were developed to address agency specifics such as technology types, costs, entry criteria, evaluation environment, experiment services, analysis, data collection, reporting, etc. The interview questionnaire designed for venue POCs allowed all experimental venues to be organized, classified, and categorized to best match the needs of S&T programs and evolving experimental needs throughout S&T developmental iterations.

Letters paraphrasing the DASA(R&T) task objectives and interview guide questionnaires were sent to POCs at venue agencies along with requests to schedule interviews regarding their agencies' ability to support S&T experimentation. The interview process was highly beneficial. Respondents addressed "typical" experiments that might be suitable to their venues.

2.3 Interviews and Compilation

Numerous hours of interviews were conducted with Army Field-Oriented S&T Experiment Venue POCs (i.e., training leaders, battle lab directors, test center directors, experiment designers, lab equipment technicians, and scientists who use data to inform technology developers). The interviews addressed agency capabilities, technology types, costs, entry criteria, evaluation environments, and experiment services such as analysis and data collection. Information was compiled on experiment options, relative cost ranges, unique facilities, environments, availability and lead times, and data collection/measurement activities. Additional information was compiled from presentation material supplied by the agency leaders, as well as from agency-recommended internet sites.

3. Results

The interviews conducted with Army Field-Oriented S&T Experiment Venue POCs revealed there are significant variations in experiment venues that can allow technology developer opportunities that can be tailored to specific technologies. Some experiment venues (i.e., test centers) were found to be more suitable to S&T component and subsystem experimentation while other experiment venues (i.e., battle labs) were found to be more suitable for holistic experimentation, integrating several technologies simultaneously. Therefore, to exploit the experimentation venues to their fullest potential, S&T agencies should contact the experiment venue leaders for field experimental services based on their particular scientific mission requirements.

Furthermore, prior to conducting field experiments, laboratory assessments involving the user community should be considered early in S&T development phases. Early operational evaluation and assessment of technology concepts provides an understanding of tactical value, as well as ideas, development approaches, concepts, models, and human dimension analyses. These assessments can have a major impact on improving the development of a specific component or system. Early operational and tactical assessments can save time and funds and provide a technology developer with valuable insight. Concept exploration and realm of the possible might include table-top experiments to assess integration-driven, technology-enabled warfighting experiments; technology-concept demonstrations that could provide vignette-driven, alternative-technology warfighting concept experiments; and concept-development experiments that could integrate technology capabilities and provide a well-defined focus on specific warfighter needs. Technology assessments with the user community that begin with concepts through the development phases to field evaluations provide the technology developer with an understanding that they are on the right track for meeting operational requirement objectives; see Figure 3. Early capability assessments could qualify and quantify the operational benefit of specific S&T concepts and establish a return on investment and an early requirement validation that would lead to improved experimentation at the Army Field-Oriented S&T Experimentation Venues reported on in this section.

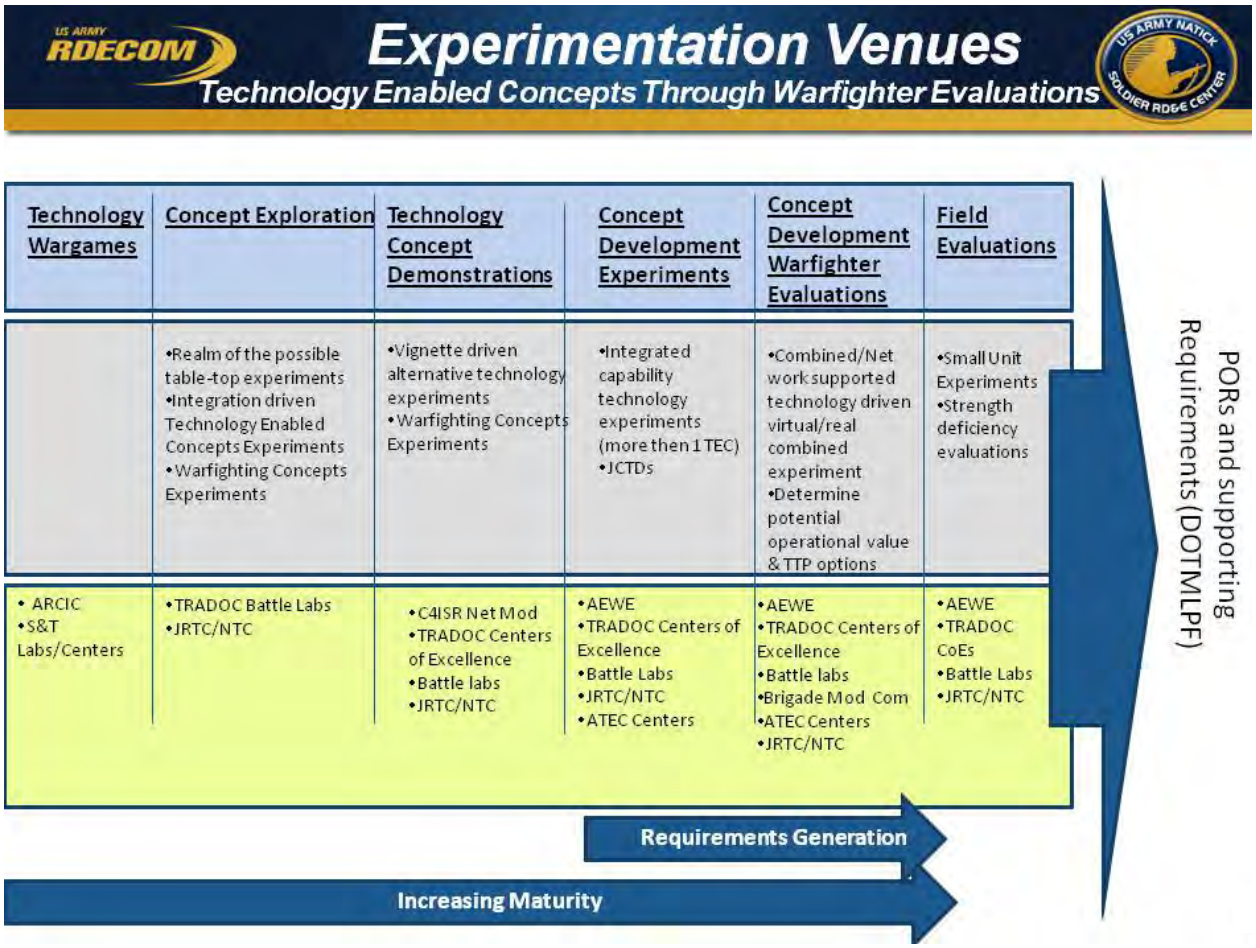

Figure 3. S&T Demonstrations & Experiments through Development Phases

The results of the comparative analysis compiled in this chapter are intended to provide the technology developer with information to optimize and match experiments to the venue. Information on each major Army field-oriented S&T experimentation venue is provided in the sections that follow. The results are summarized in Tables 1, 2, 3, and 4 for the major experiment venues and events, battle labs, training centers, and test agencies, respectively. The interview data were initially organized and arranged for a quick view in a PowerPoint presentation. It is presented here in six appendices according to venue type:

- Appendix A. TRADOC Experimentation Venue Objectives and Definition
- Appendix B. Major Experimentation Venues
- Appendix C. TRADOC Battle Labs
- Appendix D. Major Training Centers
- Appendix E. Additional Field Experiment Venues
- Appendix F. Study Strategy and Process

.

Table 1. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Major Experiment Venues and Events

Major Experiment Venues and Events	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on–Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
AEWE	Medium to Large Medium 30-100; Large 500+	6+	Experiment: Quantity of Technologies - Typical 60; up to 100 Government and contractor personnel Small experiments are feasible (squad level).	Soldiers are involved in all phases of AEWE.	Yes. EXFOR and OPFOR are included in an operational-like environment.	The Army Test and Evaluation Command (ATEC) conducts independent testing evaluations and experimentation and provides essential information to decision makers. Constraints: Several planning meetings, precise schedules, many documents required (i.e., vendor agreements, safety releases, security classification guides, test plans; training plans, Soldier training days).	Costs vary $50K - $100s K based on experiment complexity (i.e., Costs to the participating agency are transporting technology to the venues training Soldiers;TDY to planning meetings, venue closeout , and VIP demonstration.)	Scheduled every 12-18 months; candidate technologies are by a TRADOC-led Board of Directors. Benefits: Ability to quantify technology capability metrics with TRADOC Soldiers; provides a proof of concept; technology evaluated for form, fit, and functionality with appropriate MOS: high visibility correlation to TRADOC; and PM's AEWE not connected to acquisition
C4ISR Network Modernization	Small to Medium Small 15-30: Medium 30-100	3+	Experiment	New Jersey National Guard used for some experiments	No Force-on-Force; but National Guard assessment in technologically - relevant environment	Entry Criteria: Technology selection is during planning meetings and is early; Experimentation: fully instrumented ranges with distributed network connectivity. Collection and reduction of data services with costs negotiated dependant on experiment complexity. Constraints: Meeting the entry criteria in initial planning meeting.	Costs vary $20K - $100s K based on experiment complexity and the level of CERDEC support required.	Scheduled annually: S&T agencies control the technologies to integrate; restricted to emerging C4ISR capabilities. Venue Benefit: Ability to quantify technology capability and program metrics; high visibility correlation to TRADOC, PMs, and connection to acquisition; and follow-on assessment would be BMC-NIE.

Table 2. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Battle Labs

Battle Labs	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
MBL	Medium Medium 30-100	3-6+	Experiment	TRADOC EXFOR and MBL Soldiers are available for assessments, evaluation, and experimentation.	No Force-on-Force in typical technology component experiments, but technologies are often rolled up into larger experiments where Force-on-Force experimentation is possible.	Ongoing assessment capability: Small experiment, limited user assessment; limited operational assessment. MBL provides all services needed, i.e., design of experiment, data collection, analysis and reporting. Fully instrumented MOUT; TRADOC EXFOR Soldiers. Access to UGV, UAV, and sensor-compliant networked experimentation sites. Constraints: Scheduling is sometimes challenging based on Army priority experimentation; costs can prevent an agency from using MBL.	Costs: Expensive $10s k; negotiating lower rates is possible (i.e., by performing own data collection/ analysis)	Accessibility is satisfactory once schedules are coordinated. Venue benefit: unbiased and objective experimentation and evaluation of emerging technology with TRADOC Soldiers, ability to quantify technology capability and validate program metrics, high visibility correlation to TRADOC and PMs, and transition support through TRADOC capability manager.

Table 2. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Battle Labs (Continued)

Battle Labs	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
MCBL	Medium Medium 30-100	3-6+	Experiment	Soldiers are engaged in assessments, evaluation, and experimentation.	No Force-on-Force, but has Soldiers engaged in experimentation developing recommendations on C2 relationships and intelligence sharing, and shaping new warfighting concepts.	Ongoing assessment capability: Small experiment, limited user assessment, limited operational assessment. Experimentation is assessment of concepts and technologies related to human dimension of mission command functions. Data collection offers special experiment environments (i.e., tactical operations centers; DREN connectivity; live, virtual, constructive experiments) Constraints: None; MCBL appears quite accessible, flexible, and open to collaborative experimentation with other battle labs and joint experimentation.	Costs associated with MCBL experimentation are usually inexpensive (i.e., $5-10K)	Accessibility is good. Venue Benefits**:** MCBL has significant expertise to offer to RDECs engaged in Soldier and vehicle network interoperability, and opportunities exist for S&T experimentation in human dimension and situational awareness and understanding. MCBL is able to quantify technology capability and validate program metrics in experimentation related to SA, is tied closely to with TRADOC HQ and ARCIC, and develops capability based assessments. MCBL is also involved throughout acquisition cycle, notably in early phases of future technologies, and is able to influence technology transition.

Table 2. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Battle Labs (Continued)

Battle Labs	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
FBL	Medium Medium 30-100	3-6+	Experiment	Soldiers are involved in experimentation and technology concept evaluation.	No Force-on-Force, but has experiments with Soldier-in-the-loop, and these can be linked to joint experiments. FBL has created simulations with battles involving different types of brigades.	Ongoing assessment capability and is engaged in concepts/technologies related to field artillery, air defense artillery, and counter UAS mission. FBL types of technology are more conceptual vs. hardware oriented and a typical experiment is assessing effects of technology/intervention on effectiveness of artillery assets using in-house modeling and simulation expertise. Modeling and simulation as well as data collection and analysis are possible at FBL. Constraints: FBL Experiments are related to the fires mission; fires effects, networked fires tracing a round and following the trajectory of round.	Costs associated with FBL experimentation are usually inexpensive and in the $10-50K range, depending on experiment complexity.	Accessibility is good. Venue Benefits: Experiments are in an operationally relevant Soldier environment. This venue provides a proof of concept capability and fires technology assessment with appropriate Soldier MOS. High visibility correlation to TRADOC, PMs, and connection to acquisition and transition.

Table 3. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Training Centers

Training Centers	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
JRTC	Large Large 500+	7+ with lower TRLs possible between Training rotations	Experimentation possible	Soldiers are engaged in all experiments	Yes: Includes Force-on –Force in operationally relevant environment	Assessments and experimentation are in any type of capability, clothing, and individual equipment, including smart phone and radio network systems and testing new combat rations and combat feeding systems. Data collection by the S&T agency is possible. After action reviews that provide unbiased feedback can be conducted. Constraints: Access to Soldiers can vary because it is between training rotations. contact JRTC to schedule experiments.	Costs associated with JRTC experimentation are usually inexpensive ($10-20K or less) depending on S&T Agency TDY and equipment transport.	Accessibility for experimentation must be scheduled between training rotations. Venue Benefit: Ability to quantify technology capability and program metrics if data collection is executed; otherwise an after action review can provide an operationally relevant statistical assessment. There can be high visibility correlation to TRADOC, PMs and connection to acquisition and transition. Collaborative experimentation with PMs and TRADOC Center of Excellence representatives could support S&T transition. Meteorology: Heat and humidity are factors.

Table 3. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Training Centers (Continued)

Training Centers	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
NTC	Large	7+ 7+ with lower TRLs possible between training rotations	Experimentation possible	Soldiers are engaged in all experiments.	Yes: Includes Force-on –Force in operationally relevant environment	Assessments and experimentation are highly dependent on the specific training mission. TRL 3-5 S&T experimentation assessment is possible in experiments such as limited user evaluation and limited operational experiments between training rotations. Data collection by the S&T agency is possible. After action reviews that provide unbiased feedback can be conducted. Constraints: Access to Soldiers can vary because it is between training rotations. Contact NTC to schedule experiments.	Costs associated with NTC experimentation are usually inexpensive ($10-20K or less) depending on S&T agency TDY and equipment transport.	Accessibility for experimentation must be scheduled between training rotations. Venue Benefit: Ability to quantify technology capability and program metrics if data collection is executed; otherwise an after action review can provide an operationally relevant statistical assessment. High visibility correlation to TRADOC, PMs ,and connection to acquisition and transition. Meteorology: Extreme heat and dusty conditions are factors.

Table 4. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Test Agencies

Test Agencies	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
BMC	Large Large 500+	TRL 7+ Drives Milestone C Decisions	Test	Soldiers are engaged in all experiments	No Force on Force; however MRAP-equipped Infantry brigade combat teams replicate a counterinsurgency mission in Afghanistan	BMC conducts a semi-annual Network Integration Experiment which has a test and evaluation master plan against which systems are evaluated for success metrics. Constraints: Access to the BMC semi-annual Network Integration Experiment is through TRADOC Centers of Excellence and CERDEC C4IST Network Modernization leadership	Army Selected and Funded experimentation.	Scheduled twice per year; Access to BMC testing follows success at TRADOC Center of Excellence (CoE) experiments (i.e. AEWE; C4ISR Net-Mod) High visibility and correlation to TRADOC, PMs and connection to acquisition and transition
ATC	Small to Medium Small 15-30: Medium 30-100	6+	Test	Yes and No	Generally No Force on Force; however there can be technology assessments in the MOUT using Soldiers that use the experiment as a training venue.	ATC performs experimentation and assessment of Soldier technology items for later acquisition phases. ATC customers are PMs supporting war efforts therefore there is minimal down time for S&T evaluations Data collection and analysis is performed Constraints: S&T experimentation has schedule challenges; Lack of dedicated Soldiers	Costs associated with ATC experimentation are usually inexpensive and in the low thousands of dollars range (i.e. $10-20K) Soldier participation is up to the S&T agency to obtain.	There is High visibility and correlation to TRADOC, PMs and connection to acquisition and transition Scheduling is an issue therefore access is difficult

Table 4. Army Field-Oriented S&T Experiment Venues: A Comparative Analysis - Test Agencies (Continued)

Test Agencies	Typical Size[1]	Typical TRLs	Typical Type of Event : Test or Experiment	Typical Inclusion of Soldiers	Inclusion of Force-on –Force in an Operationally Relevant Environment	Types of Data Collection/Measurement Activities and Constraints	Costs and Required Resources	Accessibility and Venue Benefit
YTC	Small to Medium Small 15-30: Medium 30-100	6+	Test	Yes and No. Soldiers are engaged in test activities, but S&T experiments can be conducted without Soldier evaluation.	No Force-on-Force	There are 3 major instrumented firing ranges located at YTC with data collection and analysis capability. YTC environments are considered tactically relevant environments. YTC has a most realistic and harsh environment outside of theatre.	Experimentation costs are highly variable depending on experiment complexity, and length of time, platform. Contacting YTC on specific test and experiments is recommended.	Venue Benefit: Ability to quantify technology capability and program metrics if data collection is executed; otherwise an after action review can provide an operationally relevant statistical assessment. High visibility and correlation to TRADOC, PMs ,and connection to acquisition and transition. Meteorology: Extreme heat and dusty conditions are factors.
DPG	Very Small Very Small <15	N/A	Test	No	No Force on Force	DPG has modern facilities equipped to test chemical agents. DPG conducts reliability and survivability tests on all types of CB protective equipment in a chemical or biological environment. Constraints: None	Costs associated with DPG experimentation are usually inexpensive and in the low thousands of dollars range (i.e. 5-10K)	Venue Benefit: Ability to quantify CB protective capability of Soldier garments and vehicles. Tests on threat agents are reported for technology developers to better understand protection needs. Testing Access: Requests for test services at DPG are submitted directly to DPG, and information is on the web site.

3.1 Army Expeditionary Warfare Experiment

The AEWE is an event scheduled every 12-18 months and conducted at the Maneuver Center of Excellence (MCoE). The purpose of AEWE is to perform an integrated experiment looking at multiple concepts for operational value in a continuously operational force-on-force environment. AEWE incorporates all kinds of items in support of the mission (i.e., Microclimate Cooling Station (MCCS)). The Fort Benning AEWE provides the venue and the data collection and analysis. The costs to the S&T community depend on the complexity of technology integration, logistics, and support needed. The typical quantity of technologies at AEWE is 60 with approximately 60 to 100 government and contractor personnel participating in the experiments. The typical experiment based on Spiral G in 2011 has approximately 80 Experimental Force Soldiers (XFOR) and 30 Opposing Force (OPFOR) Soldiers. The 30 OPFOR Soldiers are 30 supplied from TRADOC Intelligence Support Activity (TRISA). AEWE experiments are feasible down to the Small Combat Unit (SCU) level. Typical TRLs for AEWE are 5-6 and suitable for tactical environments. However, AEWE is open to lower TRL items if there is appropriate technology developer support. AEWE is not a suitable venue for all research articles, as expectation is for technologies having higher TRLs. It should also be noted that AEWE is an experiment venue, not necessarily a stepping stone to acquisition.

Special Environments: McKenna Urban Training Site and surrounding training areas are the primary facilities used by AEWE. The McKenna Urban Training Site has an infantry company that conducts operations in a distributed battlespace using live, prototype, and force-on-force experimentation conducted in an operational environment (i.e., company, platoon, and squad) with data collection and analysis performed by an Army test center

AEWE experiment objectives are defined for a specific spiral, and the technology selection for the 2011 Spiral G is Soldier load, Soldier power, resupply, robotics, communications, and Nett Warrior technologies.

Technologies are selected by an AEWE Technology Selection Committee based on relevance to specific Spiral objectives. AEWE experiments consist of mostly industry (i.e., major/minor defense contractors), and very few RDECs participate. The costs associated with AEWE experimentation, directed by the MCoE Maneuver Battle Lab (MBL) are usually expensive and can easily be in the 10's of thousands of dollars range. (See MBL experimentation venue in Section 3.3.1). It is believed that high TRLs, costs, personnel, and logistics are the reason for low RDEC participation. Fort Benning is in the process of assessing how to evolve future AEWEs to better meet Army priority experimentation needs and conduct broader range of assessments.

3.2 C4ISR and Network Modernization

This event is scheduled annually and is a Research and Development (R&D) Program of Record (POR) chartered by the Director, Communication – Electronics Research Development and Engineering Command (CERDEC) and the Commanding General RDECOM. C4ISR & Network Modernization is a Research Development Engineering Command (RDECOM) -Wide System of Systems Evaluation managed by CERDEC at Fort Dix, NJ. The C4ISR & Network

Modernization Experimentation provides a military location and supports experiments looking at Soldier network concepts for technical relevance. Entry criteria for C4ISR & Network Modernization are participation in planning meetings that begin early each calendar year. At the planning meetings experiment objectives are presented along with range access and type of support required from CERDEC engineers and staff. Experiments are typically self-contained, meaning that systems and subsystems are stand-alone experiments. They usually consist of less than 20 S&T engineers and less than 10 support staff across a range of experiments and are usually supported by less than 25 National Guard Soldiers. The C4ISR & Network Modernization Experimentation TRLs are typically less than TRL 6. Costs for simple experiments, such as a component, network, or radio test, are inexpensive. If the S&T agency has data collection capability, costs are limited to travel and equipment transportation.

C4ISR & Network Modernization Experimentation consists of fully instrumented ranges with distributed network connectivity, commercially restricted airspace – unrestricted to military platforms to support unmanned aerial systems (UAS) and air operations up to 8000 ft. The Fort Dix environment has a wide variety of terrain (i.e., sand, forest, fields, etc.) and is designated as an Army experimental station with access to ground and an aerial fleet. Technology developers have optional data collection and reduction services with costs negotiated dependant on experiment complexity.

Special Environments: C4ISR & Network Modernization Experimentation **s**pecial environments provide component and subsystem interoperability assessments in a semi-operational setting where the venue provides frequency spectrum, limited live fire, Military Operations in Urban Terrain (MOUT), and logistics support. There are relatively few restrictions on conducting experimentation at C4ISR & Network Modernization compared to places such as battle labs and test centers. The informal organizational environment promotes flexibility of experiment scheduling, making C4ISR & Network Modernization Experimentation conducive to technology developers.

3.3 TRADOC Battle Labs

Maneuver Battle Lab (MBL), Mission Command Battle Lab (MCBL),and Fires Battle Lab (FBL) were evaluated in this report as having the greatest relevance to RDECOM S&T experimentation and assessment.

3.3.1 Maneuver Battle Lab**.** MBL, at TRADOC MCoE, Fort Benning, GA, has ongoing assessment capability (i.e., small iterative experiment, limited user assessment and limited operational assessment) and is the battle lab that manages the AEWE event. MBL provides all services needed to assess the effects of Soldier technology items and tactics on mission effectiveness for dismounted and mounted Soldiers. An example of a typical experiment is the Robotics Rodeo where MBL demonstrates new and innovative unmanned ground systems with the U.S. Army user and R&D communities. MBL presents a valuable opportunity to interact with experienced Soldiers and demonstrate potential benefits of innovative unmanned ground systems (UGS) on SCU effectiveness. MBL experiments help requirements writers better understand the value of emerging technologies while providing technology developers opportunities to get user feedback earlier in the RD&E process. Maneuver Battle Lab

experimentation typical experiment size is usually less than 30 Soldiers. MBL works with less mature technology; TRLs are usually in the in the TRL 3-6 range. MBL has extensive modeling and simulation and virtual environment capabilities. Types of experiments cross all development phases and include the following:

- Concept Experimentation Program (CEP)
- Limited Objective Experiment (LOE)
- Advanced Concept Technology Demonstration (ACTD)
- Advanced Warfighting Experiment (AWE)
- Technology Demonstration (TD), Advanced Technology Demonstration (ATD)

Special Environments: MBL environments include access to the fully instrumented McKenna MOUT site also used for AEWE. This environment provides extensive ability to conduct unbiased and objective experimentation and evaluation of emerging technology at the SCU (squad) level in a tactical environment. MBL has a fully instrumented professional EXFOR with access to UGV, UAV, and Sensor compliant training and experimentation areas including the Multiple Integrated Laser Engagement System (MILES), which supports tactical engagement training for small caliber gun crews without the need for dedicated ranges, targets, and live ammunition

MBL has an analysis branch that collects, synthesizes, and reports on all data collected in experiments, thus delivering to the technology developer a report that provides a comprehensive understanding of technology performance and operational value to Soldiers.

Based on the aforementioned capabilities, environment, modeling and analysis, and access to trained Soldiers, there are numerous advantages to working with MBL through all S&T development phases. Typical technology component experiments are often rolled up into larger experiments where force-on-force experimentation is possible using a singular technology. An important advantage is the proximity to have a conduit from the MBL to the TRADOC Capability Manager and the divisions that draft requirements for Soldier technology developments. The costs associated with MBL experimentation are usually expensive and can be in the tens of thousands of dollars, but negotiation with MBL leadership can reduce costs. For example, an S&T agency might conduct its own data collection and analysis, allowing savings of significant funds.

3.3.2 Mission Command Battle Lab. MCBL, at TRADOC Mission Command Center of Excellence, Fort Leavenworth, KS, has ongoing assessment capability (i.e., small iterative experiment, limited user assessment, and limited operational assessment). It is the US Army's Army Combined Arms Center; its product managers are associated with information technology (IT) and communications. Experimentation at MCBL is the assessment of concepts and technologies related to the human dimension of mission command functions. That is, the types of technology being associated with improved Mission Command Situational Awareness and Understanding (SA/SU) and cognitive performance. MCBL has a close association with the Army Research Labs Human Engineering Research Directorate. Typical experiments are associated with assessing effects of a technology (i.e., software and human interface) and the intervention on the commander's effectiveness and cognitive load. The typical size for formal experiments is 30 to100 participants with 30 to 50 be the most common size. MCBL is involved

throughout the acquisition cycle, and notably in early phases of future technologies TRL 1-3 are typical. MCBL mitigates risk to current and future Army forces by examining and evaluating emerging concepts and technologies through experimentation, studies, prototyping, and network integration, while simultaneously informing the combat development and acquisition processes. They work with other TRADOC centers of excellence and battle labs in support of experiments where their network and expertise in combined arms adds value.

Special Environments: MCBL special environments include tactical operations centers; Defense Research and Engineering Network (DREN) connectivity; and live, virtual and constructive experimentation used to develop, refine, test, and demonstrate concepts, architectures, and capabilities. The experiments are in an operationally relevant Soldier environment. Experiments can be conducted with various Soldier size groups (i.e. 10-30; 30-50; 100-150). Smaller groups are typically used in concept-brainstorming exercises. Data collection, analysis, and reporting can be executed by the TRADOC Analysis Center (TRAC).

MCBL works with DARPA and TRADOC from concepts to system development (i.e., hand-held applications/concepts), connecting Soldiers to digital applications (CSDA) and to human dimension of battle command and future battle command decision support systems. They have automated network management tools and information assurance tools to assess networks for operational security. MCBLs current S&T assessments efforts are CERDEC and ARL-HRED focused with TRADOC Headquarters and the Army Capabilities Integration Center (ARCIC). Together they develop capability-based assessments based on technology gaps. MCBL has significant expertise to offer RDECs engaged in Soldier and vehicle network interoperability, and opportunities exist for S&T experimentation in human dimension and situational awareness and understanding. However, according to MCBL leaders few RDECs take advantage of MCBL's capabilities.

MCBL supports limited operational experimentation and has the capability to assess several technologies simultaneously. It conducts inter-agency; multinational, and joint experiments. For example, in FY11 MCBL supported several joint experimentation events: "Joint Forcible Entry Warfighting Experiment 2011" and "Talon-Strike and Omni Fusion", which explored interoperability between US and UK Command and Control (C2) Systems. In these experiments MCBL assessed gaps, developed recommendations on C2 relationships and intelligence sharing, and shaped new warfighting concepts. Omni Fusion included ARL and ARI to develop trust building and social networking using MCBL venues.

MCBL has a budget of approximately $4M for experimentation. The costs associated with MCBL experimentation are usually inexpensive (i.e., $5-10K), resulting from TDY costs and experimentation provisions such as data collection and assessment of software and network compatibility. A large-scale limited operational experimentation could cost up to $100K. However, like many experiments, special needs for technology developers can be negotiated with MCBL leadership, who can make adjustments to costs. Access to experiments is ongoing, and the cooperative adaptability of the MCBL team indicated that it offers many beneficial experimentation opportunities.

3.3.3 Fires Battle Lab. FBL, at TRADOC Fires Center of Excellence, Fort Sill, OK, has ongoing assessment capability and is engaged in concepts and technologies related to field artillery, air defense artillery, and counter unmanned aerial systems (UAS mission). FBL types of technology are more conceptual than hardware oriented. A typical experiment is assessing effects of technology/intervention on the effectiveness of artillery assets using in-house modeling and simulation expertise. A typical size for a formal experiment is up to 100 participants on site, with an addition of up to ~300 participants offsite, as part of a federated experiment. Typical TRLs are in the TRL 3-6+.

Special Environments: FBL special environments are their tactical operations centers. Experiments are Soldier in the loop and can be linked to joint experiments such as Joint Forcible Entry Warfighting Experiment (JFEWE). In the Army Functional Concept Integrating Experiment 2010, FBL created simulations with battles involving different types of brigades, such as Fires, Stryker, heavy brigade combat teams, and aviation. Soldiers, civilians, and contractors performed simulations where they played critical roles, such as brigade commanders and operations officers.

Most experiments are related to the fires mission: fires effects, networked fires, tracing a round, and following the trajectory of a round. Additionally the FBL conducts experiments with robotics that pertain to ammunition handling. ARDEC is an agency that was described as one that would benefit from working closer with FBL. Ongoing FBL experiments could absorb S&T evaluations from ARDEC. The experiments are in an operationally relevant Soldier environment. Modeling and simulation, as well as data collection and analysis, are possible at FBL, but if an agency has the capability to conduct data analysis it could reduce experimentation costs at FBL. The interviews at FBL revealed there has been minimal experimentation affiliation with any RDECs since the Future Combat System development, where all RDEC and TRADOC focus was on the Future Combat System platform,. This was noted as an area that could use some remedial action from TRADOC and RDECOM. FBL perceives there to be many experimentation opportunities to support a broad range of lethality technologies.

3.4 Major Army Training

The Joint Readiness Training Center (JRTC) and the National Training Center (NTC) were evaluated in this report as having the greatest relevance to RDECOM S&T experimentation and assessment.

3.4.1 Joint Readiness Training Center. JRTC, at Fort Polk, LA, is a national ongoing assessment capability/training center that provides force-on-force joint combined arms training in a modern contemporary operational environment. Typical experiments are operations associated with contemporary operational environments and counterinsurgency environments. JRTC typical experiment sizes range from 20 to 2000 participants, and this is highly dependent on the specific training mission. JRTC has a constant turnover of experienced Army Forces Command (FORSCOM) Soldiers, providing a large population for a variety of experiments. Typical TRLs for experiments are at TRL 8-9. These are technology items with associated requirements, and they are relevant to current operations. However, TRL 3-5 S&T experimentation is possible in experiments such as limited user evaluation and limited operational experiments.

Soldiers training at JRTC are open to assessing any type of capability, clothing, and individual equipment including smart phone and radio network systems, and even testing new combat rations and combat feeding systems. Experimentation is possible during down time (i.e., between rotations described below) as long as the training operation is not disrupted. After action reviews provide unbiased feedback to trainers. Data collection by the S&T agency is possible as long as it is unobtrusive and after action reviews that provide unbiased feedback can be conducted. Experimentation at JRTC has a high degree of correlation to the TRADOC Centers of Excellence. User assessments conducted during training rotation can aide in transition. Benefits to conducting experiments at JRTC are similar to working with the MCoE MBL, where there is a connection to requirements generation. Collaborative experimentation with program managers and TRADOC Center of Excellence representatives could support S&T transition.

Special Environments: JRTC special environments are unique and all are considered tactically relevant environments. They have a most realistic and harsh environment outside of theatre. There are professional training mentors to assess performance of OPFOR and friendly Blue Force (BLUFOR) troops. A constant turnover of Soldiers due to training rotations provides a potentially "infinite" sample size over time. Role players are a key component of training rotations at JTRC. The role players bring authentic stress to urban battles. The role playing community includes cultural role players - natives of Iraq and Afghanistan - and American role players.

Typically JRTC conducts eight rotations and two mission readiness exercises per year. A single rotation consists of 16 days. This time is divided roughly as follows: Days 1-4 are spent in the intermediate staging base (ISB), and days 5-16 are spent performing the exercise itself. Based on this information, access to Soldiers can vary because it is between these training rotations, so it is best to call JRTC to obtain the latest schedule.

Experimentation at JRTC is very inexpensive (i.e., $10-20K) because Soldiers and their temporary duty assignments are pre-funded. Costs are associated with S&T agency TDY and equipment transportation costs. At JRTC there is a RDECOM relationship with a GS 14 representative assigned at JRTC/Fort Polk to link RDECOM with operationally relevant experimentation opportunities.

3.4.2 National Training Center. NTC, at Fort Irwin, CA, is a national ongoing assessment capability/training center that provides force-on-force joint combined arms training in modern contemporary operational environments. Typical experiments are focused on operations associated with contemporary operational environments and counterinsurgency environments. NTC typical experiment sizes range from 20 to 2000 participants. Similar to JRTC, NTC experiments are highly dependent on the specific training mission. These are technology items that have requirements associated with them that are relevant to current operations. However, TRL 3-5 S&T experimentation assessment is possible in experiments such as limited user evaluation and limited operational experiments. During this study, as a direct result of the interview with an NTC leader, a limited user assessment was conducted at NTC using the Human Universal Load Carrier (HULC) Soldier strength augmentation system with follow-on actions planned. FORCECOM Soldiers training at NTC are open to assessing any type of

equipment, especially during down time, as long as training operations are not disrupted. Benefits to conducting experiments at NTC, as at JRTC, are similar to working with the MCoE MBL, where there is a connection to requirements generation.

Special Environments: NTC special environments are unique, and all are considered tactically relevant environments. They have a most realistic and harsh environment outside of theatre. There are up to 300 role players including insurgents. NTC has a heavy combat vehicle OPFOR and BLUFOR for experimentation. Non-traditional user assessments by EXFOR trainers and role players are in an operationally relevant experimentation environment. S&T experiments and user assessments can be conducted during training rotations. The constant turnover of experienced FORSCOM Soldiers due to training rotations provides a potentially "infinite" sample size over time.

NTC handles 10 rotations, or about 50,000 warfighters, annually, and each rotation lasts about 30 days. Access to Soldiers can vary because it is only available between these 10 training rotations, so it is best to call NTC to obtain the latest schedule.

Experimentation at NTC is inexpensive (i.e., $10-20K) because Soldiers and their temporary duty assignments are pre-funded. Costs are associated with S&T agency TDY and equipment transportation costs. Based on observations, experimentation opportunities at NTC seem to be similar to those at JRTC, and the differences are due to the desert climate at NTC, as opposed to the frequent rainfall and high humidity at Fort Polk.

3.5 Army Test Centers

The Brigade Modernization Command (BMC), Aberdeen Test Center (ATC), Yuma Test Center (YTC), Tropic Regions Test Center, Cold Regions Test Center (CRTC), and Dugway Proving Ground (DPG) were evaluated in this study as having the greatest relevance to RDECOM S&T experimentation and assessment.

3.5.1 Brigade Modernization Command. BMC, at Fort Bliss, TX, is an integration operational test and evaluation agency that was stood up in February 2011. BMC is a part of the Army Capabilities Integration Center (ARCIC), TRADOC and hosts the 2nd Brigade, 1st Armored Division (2/1 AD). BMC's primary mission is to be the Army's centerpiece for integrated biannual network evaluations. BMC has a combat brigade tasked to evaluate mature network technologies and items ready to be fielded. BMC conducts physical integration and evaluations of the network, capability packages and other adaptive and core capabilities for Milestone B/C decisions. BMC's typical experiment size is at the brigade and below level.

Typical TRLs: 7+; supports Milestones B/C decisions that are beyond S&T TRLs of 2-6. According to interviews with BMC lead personnel, access to experimentation is through TRADOC Centers of Excellence, but according to PM C4ISR Network Modernization, mature technologies that have been evaluated and successfully demonstrated at that venue will be accepted for BMC evaluation.

Special Environments: BMC is a very large Army base that partners with White Sands Missile Range (WSMR) and is suitable for brigade and below size operational test and evaluations.

Experimentation at BMC is conducted at the TRADOC decision level, and S&T is not typically associated with this experiment venue based on the mission to evaluate mature network technologies and items ready to be fielded. However, through the US Army Signal Center of Excellence in conjunction with RDECOM, NSRDEC participated in the June 2011 Network Integration Evaluation (NIE) using Android smart phones as an evaluation of Joint Battle Command-Platform Hand-Held (JBCP-HH) integration into the network.

The NIE will be held every 6 months as a new agile acquisition process. These experiments support the Operational Needs Statement (ONS) and Joint Urgent Operational Needs Statement (JUONS) processes. At BMC, the Army has a single brigade dedicated to the effort of a holistically conducted network test and evaluation versus the evaluation of individual components and systems.

In the summer of 2011 BMC conducted the first integrated network baseline evaluation at Fort Bliss/WSMR. This first NIE evaluated network integration, including commercial off-the-shelf (COTS) technologies such as Android smart phones. Mine Resistant Ambush Protected (MRAP)-equipped infantry brigade combat teams replicate a counterinsurgency mission in Afghanistan where the primary mission is wide area security. Systems are evaluated for success against a test and evaluation master plan. Before the NIE takes place, industry ensures that Soldiers understand how to use the equipment.

The 2011 NIE demonstrated the Army's holistic focus to integrate network components simultaneously in one operational venue. The Army successfully brought the test, acquisition, and doctrine communities together to synchronize and streamline the evaluation and feedback approach, allowing for more usable test data and direct user feedback to the acquisition community. The Army combined and synchronized formal testing using one brigade combat team to perform operationally relevant test and evaluation as a whole, versus individual programs and systems. The Army evaluated the systems and figured out what to procure. These technologies will become part of a capability set for procurement.

NIE 12.1 is the second in a series of semi-annual field exercises designed to evaluate capabilities for rapid acquisition solutions, as well as integrate and mature the Army's tactical network. BMC, the Army Test and Evaluation Command (ATEC), and the Program Executive Office – Integration (PEO-I) will assess networked and non-networked capabilities. These include supporting interaction and gathering of information from the local populations; supporting expertise in and awareness of the capabilities of joint, interagency, intergovernmental, and multinational (JIIM) organizations; and determining the implications of these capabilities across Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF). The Army will measure success in terms of what is learned when it puts these networked capabilities in the hands of Soldiers in the field for evaluations.

NIE 12.1 will be conducted in October and November 2011 and will involve nearly 3,800 Soldiers and 1,000 vehicles of the 2/1 AD. The NIE's primary purpose is to continue required

evaluations in support of Program of Record milestones, to further advance the integration and understanding of the objective, and to bridge network architectures. It will also begin to establish the Objective Integrated Network baseline and common connectivity across the brigade combat team structure and will introduce industry participation into the NIE evaluation cycle. This second NIE will build off lessons learned from NIE 11.2 in order to support the Army's holistic focus to integrate network components simultaneously in one operational venue.

3.5.2 Aberdeen Test Center. ATC, at the Aberdeen Proving Ground, MD, is an ongoing assessment capability/test center and is an agency under ATEC. ATC performs experimentation and assessment of Soldier technology items for later acquisition phases. Typical experiments evaluate a Soldier technology item on effectiveness of Soldier SCUs (squads) in environments similar to those encountered in current conflicts. ATC typical experiment sizes can range from 20 to 100. ATC does not currently have Soldiers, but is currently exploring opportunities to have Soldiers available on site. Typical TRLs for test and evaluation are TRL 4-5.

ATC's budget for experimentation and experiment costs can range from $15K to $1M depending on experiment complexity and length of time for testing, but Soldiers TDY and lodging must be taken into consideration.

Special Environments: ATC has dedicated data collection ability and the ATC Soldier Systems Test Facility Environment's Tactical Maneuver Compound has a MOUT tactical maneuver village, which is an open air market environment. The MOUT village has an above ground tunnel, 1000 ft of narrow maze-like tunnel environment, small arms firing ranges, and tank armament systems with a direct fire test area for evaluation of mobile and stationary tank and target scenarios. Most customers for ATC test and evaluation are Army PMs, not RDECs. This is mostly due to the high work load and the pace of testing needed due to equipment needs in Iraq and Afghanistan. There is minimal down time for S&T evaluations, although there are exceptions. Contacting ATC would provide S&T technology developers with potential openings to conduct experiments.

Experimentation at ATC is inexpensive (i.e., $10-20K), but because Soldiers and their temporary duty assignments are not pre-funded paying for Soldier involvement is an added expense to S&T agency TDY and equipment transportation costs. Data collection and analysis costs can be saved if the S&T agency has the capability to conduct its own data collection and analysis.

3.5.3 Yuma Test Center. YTC, at the Yuma Proving Ground, Yuma AZ, is an ongoing assessment capability/test center and is an agency under the ATEC. YTC performs experimentation and assessment of Soldier technology such as tracked and wheeled military vehicles and artillery, test sensors used in Army air combat platforms, and test aerial delivery systems for later acquisition phases (Milestone B&C). The YTC mission is to plan, conduct, analyze, and report results of military materiel tests in development and production phases; review plans and monitor developmental testing conducted by developers, producers, and contractors; provide technical support, guidance, and services to Federal agencies and branches of the military; and conduct operational testing and troop training exercises.

Soldiers are involved in all test and experiment activities. Typical tests/experiments involve wheeled vehicles, new longer-range artillery, unmanned ground vehicle tests, integration of weapon platforms with fire control systems (i.e., unmanned combat aerial vehicles and cargo and personnel parachutes, including guided systems technologies). The Yuma Proving Ground conducts physical integration and evaluations of capability packages and core capabilities. Typical TRL's: 7+; supports Milestones B/C decisions that are beyond S&T TRLs of 2-6. The Yuma Proving Ground testing capabilities also support Rapid Fielding Initiative (RFI) and conduct low-rate initial production (LRIP) on sensors and other components for combat vehicles and rotorcraft. YTC's budget for experimentation and costs are highly variable depending on experiment complexity and length of time for testing and the test platform. Therefore, contacting YTC on specific tests and experiments is recommended.

YTC is one of a three multi-environment test facilities managed by the Yuma Proving Ground for the U.S. Army to test in three different environmental extremes; (1) desert (YTC), (2) tropical (the Tropic Regions Test Center, Panama Canal Zone), and (3) cold weather (CRTC, Bolio Lake Test Complex, AK.

Special Environments: YTC special environments are unique and all are considered tactically relevant environments. They have a most realistic and harsh environment outside of theatre. There are three major instrumented firing ranges located at YTC, and each range allows for a unique set of testing environments, data collection, and analysis, as well as hosting various weapon-specific testing areas for live fire. YTC has restricted air space/frequency and desert automotive test facilities that were developed in collaboration with General Motors. YTC has the desert environment test expertise and state-of-the-art facilities and ranges covering more than 1300 square miles of terrain and 2000 square miles of restricted airspace. All the center's test sites are connected by over 600 miles of fiber-optic cable. YTC is a multi-purpose test complex and operates with nearly every commodity in the ground combat arsenal. YTC's proving grounds have a wide variety of commodity areas: artillery, manned and unmanned aviation systems, armor, tactical vehicle, electronic countermeasure, and air delivery testing. YTC has combined arms synergy and highly efficient for military equipment developers.

3.5.4 Tropic Regions Test Center. This facility, located in the Panama Canal Zone and managed by the Yuma Proving Ground, has an overbearing environment that challenges military systems and equipment. The center features dense forests that block sunlight and retain moisture from frequent heavy rainfall and keep the temperature warm and the humidity at nearly 100 percent all year long. Several dozen contractors are based on a full-time basis in Panama to conduct tropic regions testing.

Access to the Tropic Regions Test Center is to work with test center managers who interface and coordinate with everyone necessary, the U.S. Army Southern Command, US embassy officials, or representatives of a foreign government. Tropic Regions Test Center customers receive turnkey service, everything needed to perform their mission. They are met at the airport by a test center employee and receive personal support each day. Computers and office space are offered at a modern office building in downtown Panama City whenever possible. Long before the test begins, U.S. embassy and foreign government officials are fully briefed, and any questions are answered. Test center employees make sure test equipment properly arrives at the test site.

3.5.5 Cold Regions Test Center**.** CRTC, located at the Bolio Lake Test Complex, AK, and managed by the Yuma Proving Ground, is the Army's cold, winter, mountain, and northern environmental test center. It is a large outdoor test area of over 670,000 acres with special use restricted airspace from the surface to unlimited altitude. CRTC accommodates a full range of cold weather or temperate climate tests, depending on the season. The Bolio Lake Test Complex provides automotive cold start capabilities and a base for Soldier equipment tests. Ranges are also available for testing mine and other explosives, small arms, direct fire, sensors, air defense, missiles, artillery, smoke and obscurants, and mobility testing. CRTC can accommodate indirect fire testing with the capability of observed fire to 30 km and unobserved fire to 50 km. Indirect fire, up to 100 km, can also be accomplished by utilizing ranges near Fort Wainwright, AK, with the impact on Fort Greely areas. Supporting infrastructure include a facility for surveillance testing, an ammunition storage area, administrative areas, communications circuits, meteorological sites, and an extensive network of roads and trails. Airfield-based and tactical air operations are supported, and airdrop zones/facilities are available. From November to February, temperatures below -50°F are possible.

Access recommendations to CRTC are for technology developers to contact CRTC at 1-888-822-1930 to arrange tests. Before arrival, visitors should coordinate their visit with CRTC to ensure their visit requests have been processed. No visitors will be allowed on CRTC premises without a visit request on file. A call to the toll free number will start the process. Personnel should consider taking the local shuttle between Delta Junction and Fairbanks or arranging a ride with CRTC personnel. Persons or groups should notify CRTC of their departure time from Fairbanks and should check in when they arrive at CRTC. The call will ensure safe arrival and will alert CRTC personnel of any visitors who have not arrived.

3.5.6 Dugway Proving Ground. DPG, in Utah, is part of the ATEC and performs ongoing test and evaluation of US Army chemical and biological protection technologies (i.e., CB protective suit system and swatch testing). The DPG mission is to test U.S. and Allied biological and chemical weapon defense systems in a secure and isolated environment. DoD has designated DPG as a major range and testing facility and the primary chemical and biological defense testing center under the Reliance Program. Testers at DPG determine the reliability and survivability of all types of military equipment in a chemical or biological environment. The costs associated with DPG experimentation are usually inexpensive and in the $5-10K cost range (i.e.,)

Special Environments: DPG has state-of-the-art facilities equipped to safely test and work with chemical and biological agents. These facilities include an ambient breeze tunnel to test aerosol clouds under a wide variety of conditions and a facility equipped to test military vehicles and equipment. TRLs for detection technology do not have to be mature, with TRLs ranging from 2-5, but the platforms on which they are tested are mature. An example provided was that new chemical detection sensor integration will be on mature weapon platforms with known performance and networked architectures. Data collection and analysis is possible, and DPG has qualified test experts to support all test and experiments from initial planning and test through test evaluation and reporting. Soldiers conduct all test and evaluation with support from civilian government employees.

Access: DPG covers 798,214 acres. It is located in the Great Salt Lake Desert, approximately 85 miles southwest of Salt Lake City, UT. Surrounded on three sides by mountain ranges, the Proving Ground's terrain varies from level salt flats to scattered sand dunes and rugged mountains. Requests for test services at DTC test ranges should be submitted to the DPG agency as early as possible to allow the test center to plan, coordinate, and schedule resources, and ensure that required safety, security, and environmental concerns are properly addressed prior to the test.

An additional DPG mission is that recently they have been conducting tests and experiments of air platforms such as UAS in restricted airspace. This testing is primarily for PM UAS and includes payload, sensor, UAS–based laser designation and Manned–Unmanned Teaming (MUM-T) with live video feeds from UAS.

3.6 Other Field Experiment Venues

These venues are listed in Appendix E because they offer a technology developer an opportunity to conduct field assessments in a less formal or simulated environment. They are predominantly military reservations and Guard/Reserve facilities, RDEC and ARL ad-hoc or local field experimentation sites with open space, and troop training facilities (e.g., obstacle courses, MOUT facilities). Some examples of the facilities listed in Appendix E are:

- Ft. Devens, MA
- Ft. Pickett, VA
- Ft. Hunter Liggett, CA
- Ft. Ord, CA
- Joint Base McGuire, NJ
- CERDEC's Flight Activity at Joint Base McGuire, NJ.

4. Discussion of Results

Prior to conducting field experiments, laboratory assessments involving the user community should be considered early in S&T development phases. Early operational evaluation and assessment of technology concepts provides an understanding of tactical value, as well as ideas, development approaches, concepts, models, and human dimension analyses. These assessments can have a major impact on improving the development of a specific component or system. Early operational and tactical assessments can save time and funds and provide a technology developer with valuable insight. Concept exploration and realm of the possible might include table-top experiments to assess integration-driven, technology-enabled warfighting experiments; technology-concept demonstrations that could provide vignette-driven, alternative-technology warfighting concept experiments; and concept-development experiments that could integrate technology capabilities and provide a well-defined focus on specific warfighter needs. Technology assessments with the user community that begin with concepts through the development phases to field evaluations provide the technology developer with an understanding that they are on the right track for meeting operational requirement objectives; see Figure 3. Early capability assessments could qualify and quantify the operational benefit of specific S&T concepts and establish a return on investment and an early requirement validation that would lead to improved experimentation at the Army Field-Oriented S&T Experimentation venues reported on in this section.

Some experimental venues are highly specialized to the needs of a particular scientific mission of an RDEC. As a result they are not of interest to technology developers working outside that mission. For example, the chemical/biological testing chambers at DPG are of interest to the Edgewood Chemical Biological Center **(**ECBC**),** but not to other RDECs.

Other factors considered by the technology developer agency are size and costs of experimentation activities, integrated vs. non-integrated experiments, evaluation environments, experimental support services provided, and the role of the venue agency in the acquisition process. For example, BMC conducts test and evaluation on pre-engineering manufacturing and development [Milestone C] technologies).

Some venues traditionally used by the RDECs support lower- to mid-level TRL research such as the MBL at Fort Benning and the annual C4ISR Network Modernization venue sponsored by CERDEC**.**

4.1 Traditional Venues

Traditional experimental venues are organizations conducting field-type S&T assessments on a relatively continuous basis (TRADOC Battle Labs, CERDEC C4ISR Network Modernization, and RDEC-owned experimentation sites). These venues typically provide assessment of technology between TRL 3 and 5 feasibility. They provide technology maturity evaluation and assessment services.

C4ISR Network Modernization conducts a series of component level and “system of systems” (SoS) level scripted evaluations. At C4ISR Network Modernization a technology assessment is

conducted in a technologically relevant environment. The mission is to provide a relevant environment/venue to assess emerging capabilities in a C4ISR SoS configuration. This assessment is intended to enable a network centric environment and, in turn, reduce and mitigate risk for Future Force Concepts and Capabilities, accelerate technology insertion into the Current Force, and support Army Brigade Combat Team Modernization and the Future Force.

The MBL conducts many types of informal and formal experiments to support S&T from both technical and operational, aspects. MBL experiments help requirements writers better understand the value of emerging technologies while providing technology developers with opportunities to get user feedback earlier in the research, development, and engineering (RD&E) process. The MBL is relatively straightforward, and the value of conducting experiments with MBL is uncomplicated. Experimentation opportunities are varied in complexity, and data collection is part of the process. Examples of MBL experimentation are concept evaluation, limited user evaluation, limited operational experimentation, and advanced warfighting experiments such as the AEWE. The AEWE is a comprehensive experiment with limited systems integration, capability assessments of some networked communications, and battle command systems and sensors. During AEWE, an infantry company (the infantry brigade combat team) conducts operations in a distributed battlespace using live force-on-force experiments, conducted in an operational environment using a Southwest Asia scenario hybrid threat and constructive simulation. Most integrated systems employed are at company level and below.

4.2 Other Types of Experimental Environments Identified

Venues such as JRTC and NTC train Soldiers using technologies that have tactical relevance to current operations. Technologies used in experiments at training centers are usually late in the acquisition process with high TRLs (8-9) and are evaluated based on operational value that can meet high priority requirements.

JRTC and NTC have FORSCOM units in training and a professional OPFOR to provide realistic, stressful, and challenging combat conditions for JRTC and NTC rotational units. The FORSCOM units in training and OPFORs can conduct S&T assessments in tactically realistic environments. There is also an economic benefit to conducting experiments with JRTC and NTC because there is no cost for access to Soldiers or facilities, but experimentation must not impact formal training. Other non-traditional field experimentation venues listed in the appendices are Army test centers such as the ATC, Aberdeen, MD; the YPG, Yuma, AZ; and DPG, Dugway, UT.

5. Concluding Remarks

The investigation found a significant variety of field experimentation venues available that are not highly visible to RDECs because agency charters depicted on web sites do not reveal that they would engage in S&T experimentation. Training and test centers are open to negotiation and have Soldiers who are very interested in conducting S&T assessments in tactically realistic environments. This is easily arranged through a dialog between the technology developer and the agency leadership. These agencies can add significant value in evaluating incremental technology maturity status in support of requirements generation. The results of this study provide Army S&T managers with a new resource to explore field experiment planning suitable to various S&T development phases.

TRADOC battle lab relations can be enhanced to better support Army S&T experimentation (i.e., Fires Battle Lab working with ARDEC and Mission Command Battle Lab working with all RDECs developing networked communications).

JRTC- and NTC-FORSCOM units in training and OPFORs can conduct S&T assessments in tactically realistic environments with no cost for access to Soldiers or facilities, and test agencies that support formal development and operational testing can be a resource for S&T evaluations (i.e., Army test centers such as ATC, YTC, and DPG).

Data collected from the experiments are another subdivision of experimentation that should be explored. There is the need for modeling and analysis, as well as systems engineering. Design of experiments should be rigorous and comprehensive, with a clear relationship of the proposed experimental plan to transition criteria and data analysis strategy to support a demonstration of actual progress against milestones and exit criteria metrics. Experiments should examine emerging warfighting concepts and evaluate operational capabilities. Inclusion of Soldiers in all experimentation venues would establish familiarity with the technology. Soldiers would provide concepts of operation and tactics, techniques, and procedures that would support a more structured, operationally relevant, and disciplined approach to experimentation design criteria and mission based experiments. This would directly correlate experimentation to requirements generation and lead to improved technology transition.

This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 11/018 in a series of reports approved for publication.

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Appendix A

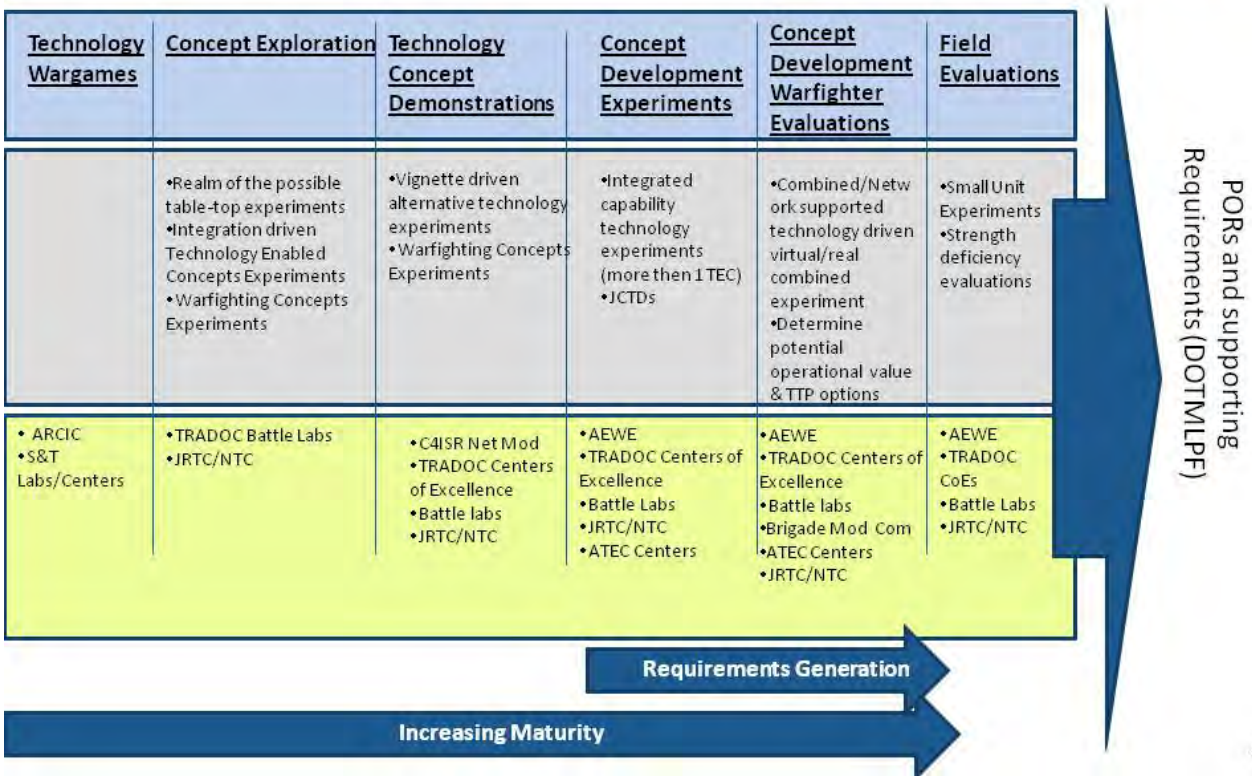
TRADOC Experimentation Venue Objectives and Definition

- Inform the S&T community of all possible field experimentation venues; their capabilities, costs, restrictions etc.
- Help our community better understand where to go for experimental needs and allow us to match the venue to the requirement.
- Dr. Freeman's Intent: Mandate that experimentation plans and metrics of success accompany requests for Science and Technology (S&T) program funding.

- Types of Field Experimentation Venues:
  - Periodic Major Events (AEWE, C4ISR Network Modernization, Brigade Modernization Command)
  - Organizations conducting field-type S&T assessments on relatively continuous basis (TRADOC Battle Labs)
  - Organizations capable of facilitating or hosting experimentation (ATEC Test Centers, JRTC/NTC, Local Guard/Reserve facilities)

Experimentation Venues

Technology Enabled Concepts Through Warfighter Evaluations



Field Experimentation Venue Summary

Major Events	Typical Size[1]	Typical TRLs	Typical Type of Event: Test or Experiment	Typically Includes Soldiers	Includes Force-on –Force in Operationally Relevant Environment
Army Expeditionary Warrior Experiment (AEWE)	Large	6+	Experiment	Yes	Can Be
C4ISR Network Modernization	Small	3+	Experiment	No	No
Ongoing Assessment Capabilities					
Mission Command Battle	Medium	3-6+	Experiment	Yes	No
Fires Battle Lab	Medium	3-6+	Experiment	Yes	No
Maneuver Battle Lab	Medium	3-6+	Experiment	Yes	No
Training Centers					
Joint Readiness Training Center	Very Large	7+	Experimentation Possible	Yes	Yes
National Training Center	Very Large	7+	Experiment ion Possible	Yes	Yes
Test Agencies					
Brigade Modernization Command	Very Large	Milestone C	Test	Yes	No
Yuma Proving Ground	Small to Medium	6+	Test	Yes and No	No
Dugway Proving Ground	Very Small	N/A	Test	No	No
Aberdeen Test Center	Small to Medium	6+	Test	Yes and No	Generally No
Military Reservations: Nat'l Guard-Reserve Facilities (See Separate Chart	Very Small	3+	Experiment	No	No

[1]Very Small = <15; Medium = 30-100; Large = 500+

Observations

- The characteristics of each major venue impact the applicability to a program/project/etc. (EG: Resource requirements and expected TRLs)

- Significant variety of venues available that are not all visible to all RDECs
  - Results will provide Army S&T managers with a resource for field experiment planning.
- JRTC and NTC: FORSCOM units in training can conduct S&T assessments in tactically relevant environments (i.e. use of OPFOR)
  - No cost for access to Soldiers or facilities, but must not impact training.
- Test agencies that support formal development and operational testing can also be a resource for S&T evaluations (i.e. ATEC Centers: Aberdeen, Yuma, Dugway)

Appendix B

Major Experimentation Venues

- Army Expeditionary Warfare Experiment
- C4ISR & Network Modernization

Army Expeditionary Warfare Experiment (AEWE)

- Type: Event (scheduled 12-18 months)
- Agency: Maneuver CoE
- Location: Fort Benning
- Purpose: Integrated experiment looking at multiple concepts for operational value. Continuously operational/force on force environment

AEWE S&T Inclusion

- AEWE incorporates all kinds of items in support of the mission (i.e. Microclimate Cooling Station (MCCS))
- AEWE provides the venue; costs to the S&T community depend on complexity of technology integration, logistics and support needed.
- Quantity of Technologies - Typical 60
- 60-100 government and contractor personnel

AEWE Experiment

- Typical Experiment Size:
  - XFOR = ~80; OPFOR =~30 supplied from TRADOC Intelligence Support Activity (TRISA).
  - Smaller experiments down to SCU level are feasible.
- Typical TRLs: 5-6, suitable for tactical environment.
  - AEWE is open to lower TRL items if there is appropriate Tech Developer support
- AEWE probably not a suitable venue for all research articles;
  - Expectation is for high Technology Readiness Levels
  - AEWE - an experiment venue; not a stepping stone to acquisition

AEWE Facilities

- McKenna Urban Training Site and surrounding training areas
  - Infantry Company (IBCT) Conducting Operations in a Distributed Battlespace -- Live, prototype, force on force experiment, conducted in an operational environment.
- Company, platoon, squad
- Analysis performed by ATEC, Army Evaluation Center

AEWE Experiment Objectives

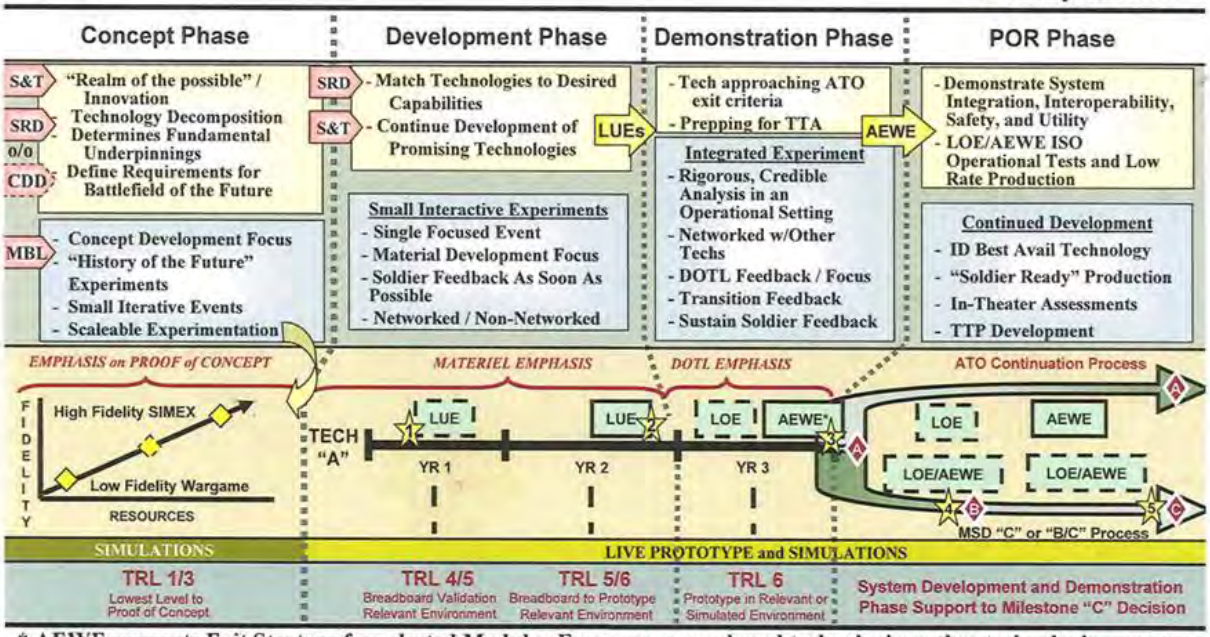
- Experiment Objectives are defined for a specific spiral (i.e. Spiral G is current)
- Wide-ranging technology selection
- AEWE Technology Selection Committee down selects technology relevant to the experiment objectives

AEWE

S&T and Experimentation Framework

- Focus: ATOs, JCTDs, & other S&T
- Initial purpose to develop technology against requirement
- May be Modular Force or FCS
- Concept ➡ Materiel ➡ DOTL ➡ Exit Demo

Ready for POR!



* AEWE supports Exit Strategy for selected Modular Force maneuver based technologies; other technologies may use a different venue.

AEWE example for 2011

AEWE Spiral G

Experiment Description

- **Limited systems integration. Capability assessments of some networked communications, battle command systems and sensors. 60 participating systems.**
  - -- Infantry Company (IBCT) Conducting Operations in a Distributed Battlespace
  - -- Live, prototype, force on force experiment , conducted in an operational environment.
    - o Southwest Asia Scenario.
    - o Hybrid Threat
  - -- Limited constructive simulation wrap-around.
  - -- Most Integrated Systems employed at Company level and below.
  - -- Network build focuses on cellular technologies and digital applications to provide mounted and dismounted battle command.

Experiment Focus

Communications
Capability assessment of select cellular technologies

Robotics
Capability assessment of select controllers, UAS, UGV and UGS alternatives

Power Solutions
Map power solutions (power generation, batteries, charging) to experimental systems

Soldier Load
Assess means of reducing or mitigating Soldier/small unit load (mule variants, exoskeletal systems, protective ensembles)

Resupply
Assess means of improving small unit resupply (autonomous ground and air solutions, precision aerial delivery systems, water generation)

AEWE Experimentation

- Recent Past: Mostly industry participates (i.e. major/minor defense contractors)
- Very few RDECs participate. Why? (i.e. high TRL, frequency, costs, logistics, personnel)

- MCoE in the process of assessing how to evolve future AEWEs to better meet Army priority experimentation needs and conduct broader range of assessments.

C4ISR & Network Modernization

- Type: Event (Scheduled Annually)
  - R&D Program of Record (POR) chartered by the Director, CERDEC and CG, RDECOM
  - RDECOM-Wide System of Systems Evaluations
- Agency: CERDEC
- Location: Fort Dix, NJ
- Purpose: Provides location, support experiment looking at multiple concepts for technical relevance.

C4ISR & Network Modernization Experimentation

- Typical Experiment Size:
  - Experiments are typically self contained
  - Usually less than 20 S&T engineers and less than 10 support Staff
  - Usually less than 25 Soldiers

- Typical TRL's: Less than TRL 6

SRW On-the-Move

C4ISR system-of-systems, integrated capabilities

C4ISR & Network Modernization Experimentation Environments

- Fully Instrumented ranges Experiment command and control
- Distributed Network Connectivity
- Commercially restricted airspace – unrestricted to support UAS and Air operations up 8000 ft
- Full spectrum of terrain (i.e. sand, forest, fields etc.)
- Designated Army experimental station
- Access to Ground & Aerial Fleet
- Optional: Collection and Reduction of Data

C4ISR & Network Modernization Experimentation Environments

- Special Environments:
- Technically/operationally relevant environment
  - Component and subsystem interoperability assessment
  - Venue provides frequency spectrum, limited live fire, MOUT, logistics support
  - Relatively few restrictions on conducting experimentation compared to places such as Battle Labs and Test Centers
  - Informal organizational environment promotes flexibility of experiment scheduling

C4ISR Facilities

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Appendix C

TRADOC Battle Labs

- Maneuver Battle Lab
- Mission Command Battle Lab
- Fires Battle Lab

Maneuver Battle Lab

- Type: Ongoing Assessment Capability (i.e. Small iterative experiment, Limited user assessment; Limited operational assessment)
- Agency: TRADOC Maneuver Center of Excellence.
- Site: Fort Benning
- Purpose: Provide all services needed to asses the effects of Soldier technology items on mission effectiveness for dismounted/mounted Soldiers.

Maneuver Battle Lab

- Typical Experiment: Asses the potential benefits of innovative unmanned ground systems (UGS) on Small Combat Unit effectiveness (i.e. Robotics Rodeo)
- MBL experiments help requirements writers better understand the value of emerging technologies while providing technology developers opportunities to get user feedback earlier in the RD&E process.

Maneuver Battle Lab Experimentation

- Typical Experiment Size: Usually less than 30 Soldiers.
- Typical TRL's
  - Works with less mature technology
  - Very flexible, usually TRL 3-6
  - Modeling and Simulation & Virtual Environment capabilities

Maneuver Battle Lab Environments

- Special Environments - McKenna MOUT site.
  - Fully Instrumented (including Multiple Integrated Laser Engagement System (MILES))
  - Professional Red Force
  - UGV, UAV, Sensor compliant

- Purpose: Instrumented training and experimentation with Soldiers using new equipment and tactics.
- Typical Experiment: Emerging technology assessments at the Small Combat Unit level in a tactical environment

Mission Command Battle Lab

- Type: Ongoing Assessment Capability
- Agency: Army Combined Arms Center
  - Customers PM's (IT/communications) and CoE's
- Site: Fort Leavenworth, KS
- Purpose: Asses concepts/technologies related to Human Dimension of Mission Command functions.
- Types of Technology: Improved Mission Command SA/SU and cognitive performance
- Typical Experiment: Asses effect of a technology/intervention on the commanders effectiveness

- Typical Experiment Size:
  - Formal experiment: 30-100 participants, 30-50 most common
  - Workshop: ~10 participants
- Typical TRLs:
  - MCBL is involved throughout ACQ cycle, and notably in early phases of future technologies TRL 1-3.
- Special Environments:
  - Tactical Operations Center(s)
  - Defense Research and Engineering Network (DREN) connectivity

Mission Command Battle Lab

- Live, virtual and constructive experimentation used to develop, refine, test, and demonstrate concepts, architectures and capabilities
- Works with DARPA and TRADOC from Concepts to system development (i.e. Hand Held Applications/Concepts)
  - Human Dimension of Battle Command
  - Future Battle Command Decision Support System

Mission Command

- MCBL - ARL HRED relationships are strong
  - Automated Network Management Tools
  - Information Assurance Tools
- Current S&T assessments efforts are CERDEC-ARL-HRED focused with TRADOC
- Opportunities exist for S&T experimentation
  - Human dimension
  - Situational awareness and understanding

Mission Command Battle Lab

- Support the Joint Forcible Entry Warfighting Experiment 2011
- Talon-Strike and Omni Fusion explore interoperability between US and UK Command and Control Systems
  - MCBL assessed gaps; developed recommendations on C2 relationships, intelligence sharing, and shaping new warfighting concepts
  - Omni Fusion included ARL & ARI to develop trust building, social networking using MCBL venues

Army Fighting Future Battles in Digital Laboratories

Fires Battle Lab

- Type: Ongoing Assessment Capability
- Agency: TRADOC Fires CoE
- Site: Fort Sill, KS
- Purpose: Assess concepts/technologies related to field artillery, air defense artillery, and counter UAS mission
- Types of Technology:
  - More conceptual vs. hardware oriented
- Typical Experiment: Assess effect of a technology/intervention on effectiveness of artillery assets using in-house M&S expertise.

Fires Battle Lab Experimentation and Environments

- Typical Experiment Size:
  - Formal experiment: up to 100 participants on site, additional up to ~300 offsite as part of a federated experiment.
- Typical TRLs:
  - TRL 3-6+
- Special Environments:
  - Tactical Operations Center(s)

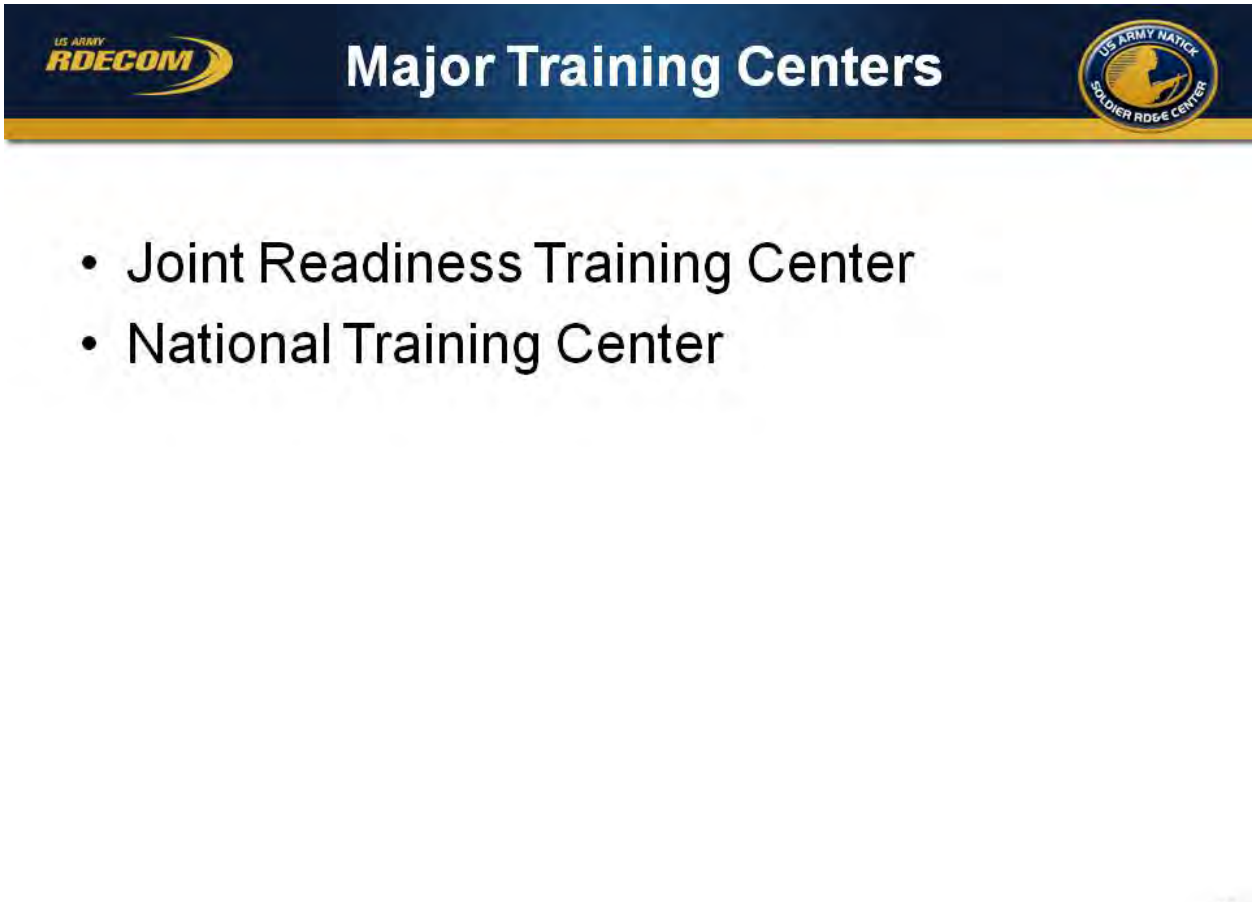
Reloading Apache helicopters with live rounds for the integrated live firing exercise AT Fort Sill

Air Defense Artillery Center is moving to Fort Sill, Okla., to be part of the Fires Center of Excellence.

Apache Longbow helicopter firing at an enemy target during live firing at Exercise

Appendix D

Major Training Centers



Joint Readiness Training Center

- Type: Ongoing Assessment Capability/Training Center
- Agency: (FORSCOM) Joint Readiness Training Center (JRTC)
- Site: Fort Polk, LA
- Purpose: JRTC is a National Training Center that provides force on force joint combined arms training in modern contemporary operational environment (CoE)
- Typical Experiment: Operations associated with contemporary operational environment and counterinsurgency environment

Joint Readiness Training Center Experimentation

- Typical Experiment Size: 20 to 2000+; very dependant on training mission.
  - Training Centers have constant turnover of experienced Soldiers
- Typical TRL's
  - TRL 8-9 items that are relevant to current operations and that have requirements
  - TRL 3-5 S&T assessment is possible
  - Soldiers on training are open to assessing any type of equipment, especially during down time as long as training operations are not disrupted

Rotational training exercise

Joint Readiness Training Center Environments

- Special Environments.
  - Unique Tactically Relevant Environment.
    - Most realistic and harsh environment outside of theatre
    - Low cost to participate because Soldiers/TDY is pre-funded
    - Potential for professional training mentors to assess performance OPFOR and BLUFOR
  - Constant turnover of Soldiers due to training rotations
    - Potentially "Infinite" sample size over time.

Joint Readiness Training Center Observations

- Command Relationship: GS 14 RDECOM representative assigned at JRTC/Fort Polk to link RDECOM with operationally relevant experimentation opportunities
- User Assessment conducted during training rotation
  - Can aide in transition

Soldiers in a training rotation

National Training Center

- Type: Ongoing Assessment Capability/Training Center
- Agency: (FORSCOM) National Training Center (NTC)
- Site: Fort Irwin, CA
- Purpose: NTC is a National Training Center that provides force on force joint combined arms training in modern contemporary operational environment (CoE)
- Typical Experiment: Operations associated with contemporary operational environment and counterinsurgency environment

National Training Center Experimentation

- Typical Experiment Size: 20 to 2000+; very dependant on training mission.
  - Training Centers have constant turnover of Soldiers
- Typical TRL's
  - TRL 8-9 items that are relevant to current operations and that have requirements
  - TRL 3-5 S&T assessment is possible
  - Soldiers on training are open to assessing any type of equipment, especially during down time as long as training operations are not disrupted

National Training Center Environments

- Special Environments
  - Unique Tactically Relevant Environment.
    - Most realistic and harsh hot desert environment outside of theatre.
    - Up to 300 Role Players including insurgents
    - Relatively low cost to participate because Soldiers/TDY is pre-funded.
    - Heavy Combat vehicle OPFOR and BLUFOR
  - Constant turnover of Soldiers due to training rotations.
    - Potentially "Infinite" sample size over time.

Soldiers examine evidence at an IED training site.

National Training Center Observations

- Similar to JRTC
- Non-traditional user assessment by red force trainers and role players in an operationally relevant experimentation
- Armored Cavalry Regiment stationed at the base to provide OPFOR
- User Assessment conducted during training rotation

Training at mock Iraqi villages at the National Training Center

Army Test Centers

- Brigade Modernization Command
- Aberdeen Test Center
- Yuma Test Center
- Dugway Proving Ground

Brigade Modernization Command

- Type: Integration Operational Test and Evaluation
- Agency: Brigade Modernization Command
  - BMC is a part of ARCIC, TRADOC
  - Hosts 2nd Brigade, 1st Armored Division
- Site: Fort Bliss, TX
- Purpose: Army's centerpiece for integrated network evaluations.
  - Combat Brigade tasked to evaluate mature network technologies and items ready to be fielded
  - System capability and manufacturing process demonstration for MS B/C decision
  - Integration and evaluation of network capability packages

- Typical Experiment Size: Brigade and Below
  - Integrated Network Baseline Evaluation in FY11 at Fort Bliss / WSMR
  - Semi annual event to evaluate network integration including COTS technologies (i.e. Android Smartphones)
- Typical TRL's: 7+; supports Milestones B/C decisions that are beyond S&T

Brigade Modernization Command Environments

- Special Environments:
  - Large Army base that partners with White Sands Missile Range
  - Suitable for Brigade and Below size operational test and evaluations

Secure WiFi for the battlefield

Network Integration Kits are an integrated suite of equipment

Aberdeen Test Center: Soldier Systems Test Facility

- Type: Ongoing Assessment Capability
- Agency: Army Test & Evaluation Command
- Site: Aberdeen Proving Ground
- Purpose: Asses Soldier technology items for later ACQ phases
- Typical Experiment: Asses effect of a Soldier technology item on effectiveness of Soldiers/SCUs in environments similar to those encountered in current conflicts






Aberdeen Test Center: Soldier Systems Test Facility Environment

- Special Environments:
  - Tactical Maneuver Compound
    - MOUT environment
  - Tactical Maneuver Village
    - Open Air market environment.
  - Above Ground Tunnel
    - 1000ft of Narrow maze-like tunnel environment
  - Small Arms firing ranges
  - Tank armament systems direct fire test area for evaluation of mobile and stationary tank and target scenarios

Yuma Test Center

- Type: Test Agency/Center
- Agency: ATEC
- Site: Yuma Proving Ground, Yuma AZ
- Purpose: Test Army tracked and wheeled military vehicles and artillery; test sensors used in Army Air Combat platforms; test aerial delivery systems
- Typical Test/Experiments:
  - Test Army wheeled vehicles
  - Testing of new, longer range artillery
  - Unmanned ground vehicle tests
  - Assess integration of weapon platforms with fire control systems (i.e. UCAVs)
  - Cargo and personnel parachutes, including guided systems technologies

YTC National Counter-Terrorism/Counter -Insurgency Integrated T&E Center

- Type: Test Agency/Center
- Agency: ATEC/YTC National Counter-Terrorism/Counter-Insurgency Integrated Test and Evaluation Center (NACCITEC)
- Site: Yuma Proving Ground, Yuma AZ
- Purpose: Test and evaluation site for improvised explosive devices in support of JIEDDO programs

- Typical Test/Experiments:
  - Tests counter-improvised-explosive- device and counter-terrorism technologies
  - Test pending and currently fielded counter-IED and counter-terrorism technologies.

YPG detonates a blast with the force equal to that of some of IEDs used against U.S. forces

Yuma Test Center Experimentation

- Typical Experiment Size: Dependant on the precise items being tested.

- Typical TRL's: 1-6, and possibly higher if doing experimentation for rapid fielding initiatives.

Yuma Test Center Environment

- Special Environments:
  - ATEC/YPG Facilities: e.g. Live fire, restricted air space/frequency; many instrumented ranges
  - Desert automotive test facility developed in collaboration with GM

Counter IED

Automotive Test Facility

Stryker on Tilt Table

Cargo parachute tests

Dugway Proving Ground

- Type: Test Agency/Center
- Agency: ATEC/Dugway PG
- Site: Dugway PG, Utah
- Purpose: Asses issues with Chem/Bio Mission (i.e. CB Protective suit system and swatch testing)
- More recently test Air Platforms
- Typical Test/Experiments :
  - Unmanned Aircraft Systems testing and integration in restricted airspace
  - Chemical Weapons assessment

Dugway Proving Ground Experimentation

- Typical Experiment Size: Dependant on the precise CB items being tested.
- Typical TRL's: Mature TRLs, Mostly DT-OT

Dugway Proving Ground Environments

- Special Environments:
  - Facility equipped to safely test chemical agents
  - Facility equipped to safely test and work with biological agents
  - Explosives Disposal Testing Facilities

Appendix E

Additional Field Experiment Venues

Ad Hoc/Local Experimentation Sites

Site Name	Location
Felker Airfield	Ft. Eustis, VA
Ft. Hunter Liggett	Ft. Hunter Liggett, CA
Fort Ord	Marina, CA
Davison Army Airfield	Ft. Belvoir, VA
Ft. Pickett	Ft. Pickett, VA
Ft. A. P Hill	Ft. A. P Hill, VA
Joint Base McGuire-Dix-Lakehurst	Ft. Dix, NJ
Ft. Devens, MA	Lancaster, MA
Ft. Drum, NY	Ft. Drum, NY
Camp Roberts	Camp Roberts, CA
Ft. Carson	Ft. Carson, CO
Ft. Huachuca	Ft. Huachuca, AZ
Ft. Story	Fort Story, VA

CERDEC Flight Activity

- Type: Ongoing Assessment Capability
- Agency: CERDEC/I2WD
- Site: Joint Base McGuire, NJ
- Purpose: Assess items/technologies related to C4ISR assets in the air.
- Typical Experiment: Examine new UAV with an externally mounted developmental sensor pod.

CERDEC Flight Activity Experimentation

- Typical Experiment Size:
  - Typically very small due to "one-off" nature of items. However much larger experiments are possible if desired
- Typical TRL's
  - Usually > TRL 3
  - Any item at any TRL, assuming it can be mounted on a mature airframe/platform can be evaluated

RDECOM Deputy CG visits CERDEC Flight Activity

CERDEC Flight Activity Environment

- Special Environments.
  - Large Restricted Air Space and secure environments
  - RF/EMI testing chambers
  - Limited FAA Airworthiness reliability allows CERDEC Flight Activity to self-approve new items being attached to existing air frames
  - Supports all current and future planned airborne C4ISR programs

Future "Field Experimentation"

- Virtual Field Experimentation
  - Example: HRED Cognitive Assessment, Simulation and Engineering Lab (CASEL)

Cognitive Assessment, Simulation and Engineering Lab (CASEL)

- Type: Ongoing Assessment Capability/ Virtual Field Environment Research Lab
- Agency: ARL-HRED
- Site: Aberdeen Proving Ground, Maryland
- Purpose: Asses the effects of Soldier technology items on Soldier mind and cognition.
- Typical Experiment: Asses effect of a technology item on effectiveness of Soldiers in a realistic virtual environment, that is heavily instrumented for unobtrusive measurement.

CASEL Experiments

- Typical Experiment Size:
  - Formal experiment: ~15 participants.
  - Some experimentation is done one person at a time, but the size of the experiment is larger
  - CASEL experimentation is done within a formal process which includes technical and IRB approval
- Typical TRLs:
  - TRL 2-5

IMMERSIVE COMBAT READINESS SIMULATOR

SIMULATED-TACTICAL OPERATIONS CENTER

CASEL Environments

- Special Environments:
  - Various simulation rooms can create immersive virtual environments
    - Indoor environments (i.e. a Tactical Operations Center) can be simulated
  - The entire CASEL facility is heavily instrumented with camera's/microphones/network traffic monitors
  - CASEL also has physiological monitoring equipment, including eye tracking devices

EXPERIMENTAL CHAMBERS

360 Avatars

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Appendix F

Study Strategy and Process

- Study Process
- Venue Summary Footnotes


Experiment Venues Supporting U.S. Army S&T
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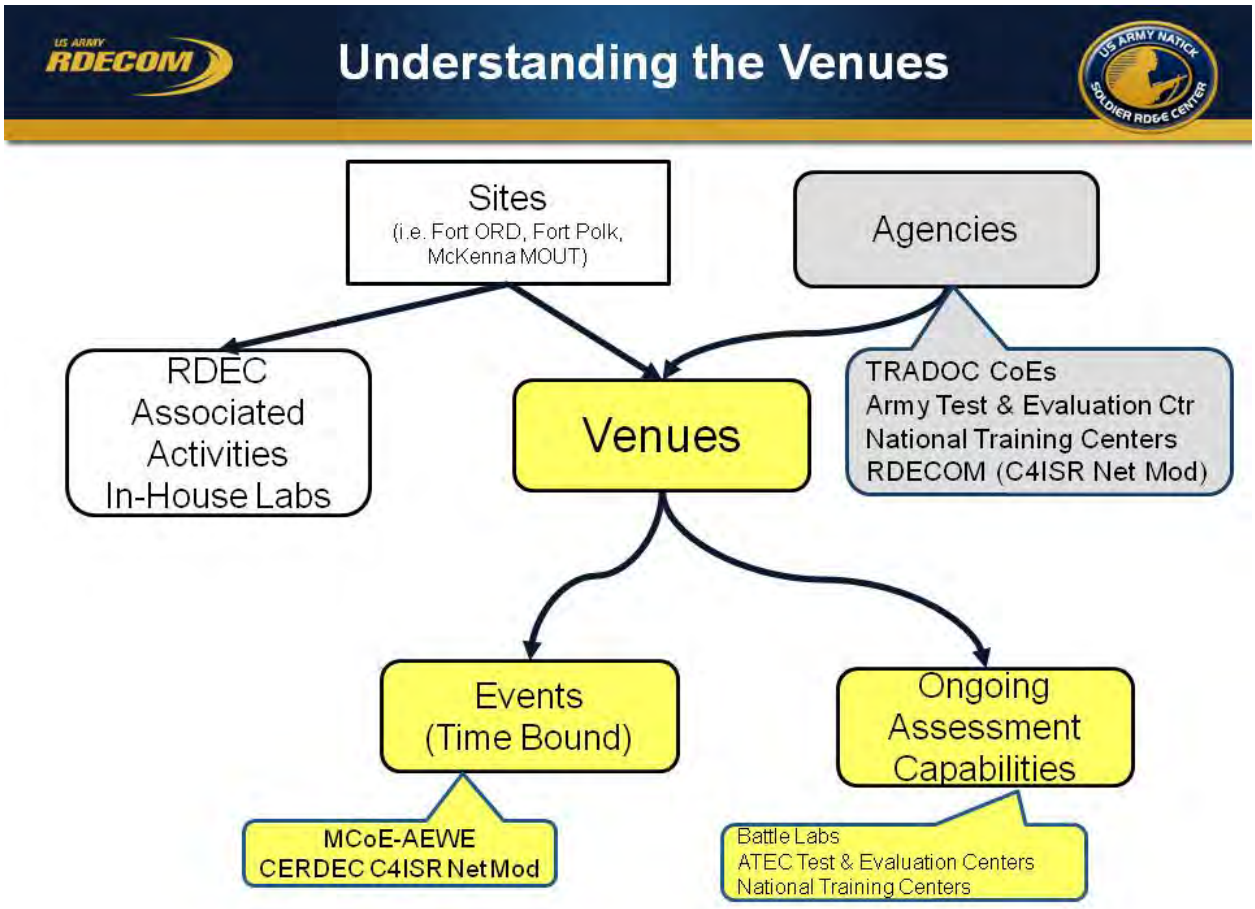
RDECOM
US ARMY NATICK
SOLDIER RD&E CENTER

Field Experimentation Venue Types

- Types of Field Experimentation Venues:
  - Periodic Major Events (AEWE, C4ISR Network Modernization, Brigade Modernization Command)
  - Organizations conducting field-type S&T assessments on relatively continuous basis (TRADOC Battle Labs)
  - Organizations capable of facilitating or hosting experimentation (ATEC Test Centers, JRTC/NTC, Local Guard/Reserve facilities)

Understanding Agencies, Venues and Sites

- Sites: Physical locations where experimental activities can take place.
  - Example: Ft Devens, Ft Benning, APG, Natick Soldier Center.
- Sites may host
  - Agencies: government organizations that provide venues (organized/structured activities where experiments can take place).
    - i.e. Maneuver Center of Excellence[*AGENCY*] (Maneuver Battle Lab) [*VENUE*] at Fort Benning, GA [*SITE*]


US ARMY RDECOM
Understanding the Venues
US ARMY NATICK SOLDIER RD&E CENTER
Sites
(i.e. Fort ORD, Fort Polk, McKenna MOUT)
Agencies
RDEC Associated Activities In-House Labs
Venues
TRADOC CoEs
Army Test & Evaluation Ctr
National Training Centers
RDECOM (C4ISR Net Mod)
Events (Time Bound)
Ongoing Assessment Capabilities
MCoE-AEWE
CERDEC C4ISR Net Mod
Battle Labs
ATEC Test & Evaluation Centers
National Training Centers

Strategy

- Collection of possible Venues thru TFT/SID Leads and contacts within Army/DoD
  - Excellent TFT responsiveness! – large number of proposed venues (some not field experimentation-oriented)
- Website reviews, written questionnaires and phone interviews with Venue POCs

- Metrics under consideration:
  - Costs and other resource requirements
  - Availability and lead times
  - Unique facilities/environments
  - Types of data collection/measurement activities and constraints
  - Technology Readiness Levels typically supported
  - Access to on-site RDECOM support or LNO

STRATEGY (Cont'd)

- Spoke with RDEC TFT leads to identify Agencies/Venues used by that RDEC as part of
  - Normal mission
  - Quick Reaction Activities
- Associate TRLs + S&T categories (i.e. 6.2. 6.3, 6.4) with each of the major Agency Venues.

Strategy (Cont'd)

- Identified agencies that might support S&T validation at the macro level such as Brigade Modernization Command; ATEC, TRADOC CoEs etc (includes Agency System Integration Labs; TARDEC, ARDEC NSRDEC, CERDEC.

- Organized, classified and categorized agency characteristics from their WEB site and phone interviews to best match the needs of each S&T program and their evolving experimental needs throughout S&T developmental iterations.

Strategy (Cont'd)

- Developed an interview guide that addressed overall capabilities:
  - Overall purpose
  - Typical Experiments and activities
  - Item Types; Experimentation types and environments
  - Unique facilities, environments, equipment, human resource support (Operational, Engineering, S&T, Academics, Contractors, MITRE)
  - Experimental Planning and support, Locally provided services; locations and facilities; lead time; safety document generation; Logistics
  - Experimental Execution; Data Collection; Data analysis/Reporting; Statistical consulting

Experimental Environments

- Each experimental venue offers different types of environments for conducting experiments
- Are some experimental environments better than others? It depends.
- Some factors to consider are:
  - Costs
  - What type of data is needed
  - Technically relevant versus operationally relevant venue
  - What are technology readiness levels
  - Is it a limited user assessment versus technology metric validation
  - Is the experiment/assessment requirements driven

Experimental Environments (Cont'd)

- Lab Environment
  - Usually indoors, highly controlled, possibly with specialized equipment
    - Experimentation with acoustic gunfire detector in an Anechoic (sound insulated) chamber.
- Technology Relevant Environment
  - May be outdoors, non-stressful conditions that allow assessment of technology in an environment similar to the technological environment in an operational area.
    - Experimentation with acoustic gunfire detector in an open field, using an Enhanced Position Location Reporting System (EPLRS) radio to send messages.

Experimental Environments (Cont'd)

- Operationally Relevant Environment
  - Evaluating performance of an item/technology in a physical environment similar to an operational environment. (i.e. C4ISR Network Modernization at Ft. Dix)
    - Evaluating an acoustic gunfire detector at a MOUT site, using an EPLRS radio to send messages
    - Compared to the technologically relevant environment, this environment includes effects of buildings (environmental factors) that could degrade performance (i.e. RF interference, echoes)

Experimental Environments (Cont'd)

- Soldier Relevant Environment:
  - Evaluation involving Soldiers using/interacting with the technology as if it were in an operational environment. (i.e. Army Expeditionary Warrior Experiment (AEWE))
    - Soldiers in an Small Combat Unit formation evaluating acoustic gunfire detector at an MOUT site, using an EPLRS radio to send messages.

Experimental Environments (Cont'd)

- Tactically Relevant Environment:
  - Harsh and realistic environment similar to contemporary operational environment.
  - Usually involving OPFOR/BLUFOR engagement, at a training facility. (i.e. Joint Readiness Training Center (JRTC))
    - Soldiers in an SCU formation using acoustic gunfire detector at an Joint Training Center, while doing a multi-day urban combat missions vs. OPFOR.
    - Training Centers usually have harsh climatic and physical conditions

Experiment Distinctions

- Minimum Size of typical experiments
  - All venues offer the ability to do conduct surveys (~1-10) most venues have a preferred minimum experiment size.
    - ACAC/Mission Command BL prefers ~30 people to simulate a command staff.
    - Brigade Modernization Command; "brigade sized" experiments requiring many test items.
- Types of measurement activities
  - Unobtrusive measurement vs. active measurement.
    - Unobtrusive measures (i.e. video capture) vs. interviews, surveys and questionnaires

Reporting

- Interview questionnaire structured for respondents to address "typical" experiments that might be suitable to their venue.
- Typical
  - Size
  - Costs/Resources/manpower
  - Data collection process and management
  - TRL levels
  - Environments

Venue Summary Footnotes

1. Typical Size for normal mission activities: S&T Support, Soldiers:
2. S&T activities are negotiable and usually require fewer people than normal mission activities
   - Very Small = less than 15
   - Small = less than 30
   - Medium = 30-100
   - Large = 100 - 500
   - Very Large = 500+
3. Normal mission activities TRL Levels
4. S&T activities can be less than TRL 6 and subject to negotiation.
5. Tactically Relevant Environment - Professional OPFOR ; austere environment like contemporary operational environment.
6. Test/Experiment- Test and Training Centers will perform experiments if there is no interference with their core mission