# Improved Process for Bridging the Technology Transition Valley of Death

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## ABSTRACT

One of the biggest obstacles facing research organizations is how to effectively develop innovative technologies that transition into Programs of Records (PoRs). On the other hand, Project Managers (PMs) are interested in technology developments efforts that mitigate the technology risks of their PoRs with minimal risks to their existing Engineering, Manufacturing, & Development or Production acquisition phases. Solving this technology transition "valley of death" has long been elusive as technologies have been developed that are not transitioned, and PoRs continue to have their technology gaps that are not addressed. To attempt to solve the quagmire created by this mismatch, the Army Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (ARL HRED STTC) partnered with the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) Project Manager for Constructive Simulation (PM ConSim) to develop a new process to bridge the technology transition chasm. The effort created a program called the Risk Reduction Test Bed (RRTB) with a defined process for risk mitigation and streamlined the technology insertion from Research and Development (R&D) programs. This program has quickly become a model for technology maturation and transition between these two organizations. The initial phase of the process requires a capability and technology gap analysis that extends into the project's users and long-term life cycle. A concurrent activity within this phase includes building representative test beds to develop and test the technologies. The process involves a gap analysis that determines which are feasible and provides the greatest return on investment to the PoRs. The process then develops projects that look at possible solutions. This paper details examples of how this process moves from gaps to solutions to transition to the PoRs providing a model example for any organization seeking to improve their processes in this area.

## ABOUT THE AUTHORS

**Henry Marshall** is a Science and Technology Manager at the Army Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (ARL HRED STTC). His assignment experience spans across several agencies including Army, Department of Homeland Security (DHS), and Navy. His 30+ years with the Government have been spent assigned to leading edge simulation technology efforts in Modeling and Simulation (M&S) Architecture, law enforcement training, embedded training technology, Semi-Automated Forces (SAF), and simulation software development and acquisition. He received a Bachelor of Science in Engineering degree in Electrical Engineering and a Master of Science degree in Systems Simulation from the University of Central Florida.

**Paul Dumanoir** is the Chief Engineer for the United States (U.S.) Army Product Manager for Warrior Training Integration (PdM WTI) under the Project Manager for Integrated Training Environment (PM ITE) at PEO STRI. He is currently the PM ITE Risk Reduction Test Bed project manager and has 26+ years of experience working in Army and Department of Defense simulation and training programs as Product Manager, Project Director, and Systems / Software Engineer. His current interests include component-based product-line engineering, enterprise architectures, and system of system integration and interoperability. He earned his Bachelor of Science in Electrical Engineering from the University of South Alabama in 1987 and his Master of Science in Computer Systems from the University of Central Florida in 1991.

**Robert A. Wells** is a Project Engineer at Dynamic Animation Systems, Inc. He has led the development of the Risk Reduction Test Bed (RRTB) as part of the Advanced Simulation Systems Integration Modeling Interoperability Laboratory and Test Environment (ASSIMILATE) research effort. Mr. Wells has over 17 years of experience in the Modeling & Simulation (M&S) community and has managed a wide range of training systems within the industry. He has integrated Live, Virtual, and Constructive (LVC) components from the LVC Integrating Architecture (LVC-IA) program as well as core-system components from the LVC domains to include Homestation Instrumentation System (HITS), Aviation Combined Arms Tactical Trainer (AVCATT) & Close-Combat Tactical Trainer (CCTT) Semi-Automated Forces (SAF), and Joint Land Component Constructive Training Capability (JLCCTC) within the RRTB. He earned his Bachelor of Science degree in Computer Science from the UCF and his Master in Business Administration from the Crummer Graduate School of Business at Rollins College.

**Bob Burch** is the Chief Technology Officer at Dignitas Technologies, LLC. Mr. Burch has over 30 years of development experience in the modeling and simulation industry working in both the Virtual and Constructive domains. Mr. Burch has a wide range of simulation experience, ranging from simple maintenance trainers, to aircraft cockpit simulators, to large complex Constructive systems. His Virtual simulation experience focused on Virtual system architectures, executive scheduling systems, concurrent systems, simulation time management, hard real-time performance and monitoring, computational resource utilization, modeling frameworks, and Input/Output (I/O) systems. His Constructive experience has been technology leadership positions of the Army's two largest Computer Generated Forces systems: Close Combat Tactical Trainer (CCTT) Semi-Automated Forces (SAF) and OneSAF. Mr. Burch was the Chief Scientist for the CCTT SAF. He was the Software Architect for OneSAF as well as Architecture Modeler and eventually System Architect. He has practical experience with Product Line Architecture development for OneSAF, Synthetic Environment (SE) Core, and the United Kingdom's Combined Arms Tactical Trainer (UK CATT) programs. Mr. Burch is currently supporting the analysis and development efforts for the Simulation and Training Technology Center Risk Reduction Test Bed (RRTB).

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## INTRODUCTION

The purpose of this paper is to share a new technology development process that was developed by an engineering team that has extensive development experiences in both the Science and Technology (S&T) processes and major simulation Programs of Record (PoRs) development processes. The team is made up of members from the Army Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (ARL HRED STTC) and the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) Project Manager for Constructive Simulation (PM ConSim). This paper may be useful for any organization looking to improve their technology development and transition processes as well as providing insight into technology development efforts that have been through this process. To jump ahead to the conclusion, this new process has been viewed as positive improvement by the S&T and Project Manager (PM) communities and is being used as a common framework for the rest of the PEO STRI PMs and supporting engineering organizations. The team believed that too many research projects managed under the S&T organizations lacked a transition strategy and consequently never transitioned to a PoR. The PM desperately needed technology risk mitigation for programs that were becoming more and more aggressive in pushing the requirements and technology readiness envelope. This predicament follows the classic “Valley of Death” (DAU, 2006) between the S&T and PM communities that are shown in Figure 1. The goal of this team was to develop a program and accompanied processes to integrate the S&T of the two organizations into a seamless development path that maximized technology transition and assured that the S&T needs of the program’s entire life cycle was addressed seamlessly.

As part of their product line, PEO STRI is undertaking a coordinated product catalog of training capabilities for an Integrated Training Environment (ITE) for the Soldier. These ITE capabilities included interoperation between Live, Virtual, Constructive, and Game simulations that presented a high number of technology challenges that lacked clear solutions. As an initial focus for this new process, a Risk Reduction Test Bed (RRTB) program was developed for the Live, Virtual, and Constructive (LVC) Integrating Architecture (LVC-IA) program to create a relevant hardware and software environment that is discussed in more detail later. The LVC-IA program was a perfect candidate since it cuts across all of the LVC domains of the PEO STRI organization (Dumanoir, 2012). The numbers of technology gaps with high return potential quickly surfaced making this a fertile area to refine the new RRTB process.

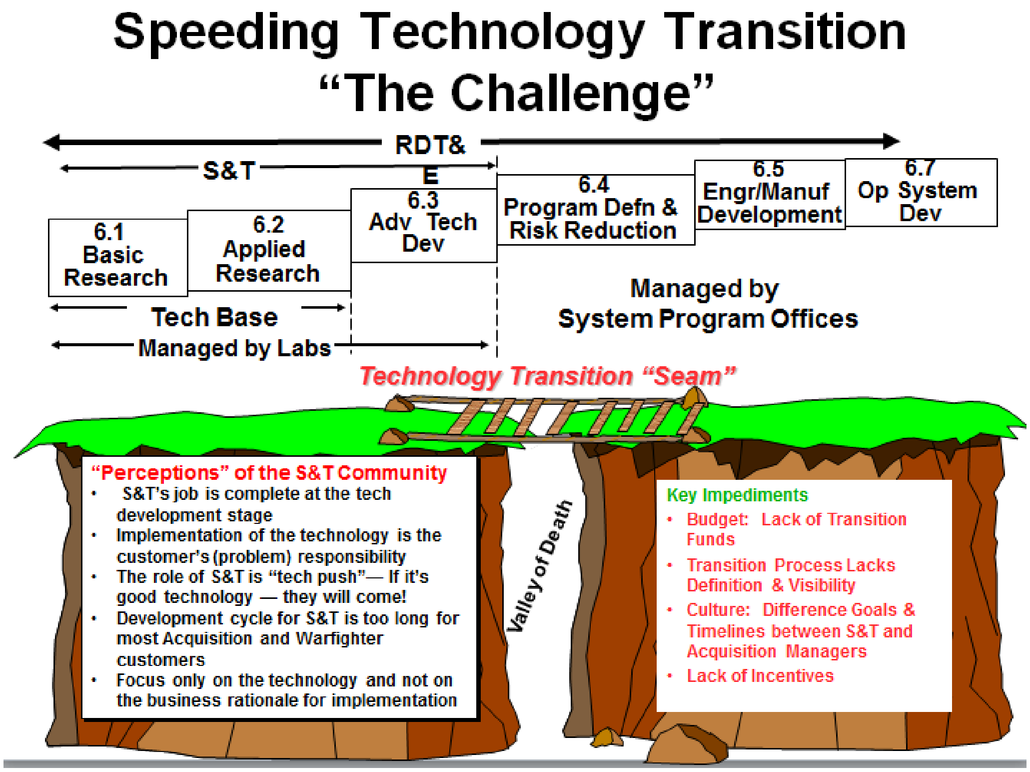


**Figure 1 - Valley of Death between S&T and PoRs**

## BASIC RRTB PROCESS CONCEPT OF OPERATIONS

### Overview of the Process

The following section provides an overview of the RRTB process based on the Work Breakdown Structure (WBS) and tasks executed by the partnering organizations. A lead Government engineer was identified from the Research and PM organization to oversee the RRTB contractor team.

- **Task 1 – Strategic Objectives Analysis.** This determines the program goals and governances. The output of this task includes a Concept of Operation (CONOPS) for the test bed, a strategic map with specific goals and objectives, and a set of metrics to measure how well those goals and objectives are being executed.
- **Task 2 – Capability and Technology Gap Analysis.** This determines capability and technology shortfalls in the PoRs, and assess the impact technologies might have on programs. It also looks at research costs and Return on Investment (ROI) estimates. One of the goals is to identify gaps that potentially will be addressed by the progression of industry (e.g. computer graphics, computing, etc.) and not focus on these gaps until results can be achieved with reasonable risks and costs. The gap process is described in detail later in this paper.
- **Task 3 – Hardware & Software (HW & SW) Procurement.** Buys hardware and software to start the RRTB.
- **Task 4 – Test Bed Configuration**. Determines the optimum configuration for the lab to be a test bed for the technology gaps and the PoRs which the RRTB focuses on. A critical part of this design is to maximize the effectiveness of the test bed in gap development while minimizing the footprint and overhead associated with fielding large simulation systems, the methods we took to achieve this is discussed in detail later in this paper.

- **Task 5 – Test Bed Maintenance.** Keeps the systems up to date and operational. Also ensure Information Assurance (IA) compliance.
- **Task 6 – Engineering Services.** Conduct research topics. Once a gap has been defined as an S&T project it requires a white paper to initially define its development scope and suggested technology solutions/ approaches to mitigate the gap it will attempt to address. The white paper also proposes a technology development approach and schedule to mature the technology. Estimated costs to conduct the research are also provided. After a topic is approved by the RRTB Government managers and funding is identified, it becomes a research project. The RRTB projects require regular progress reviews and testing to verify its progress. Key process elements include: System Engineering; HW/SW Development and Integration; Demonstration and Experimentation; Reviews with stakeholders; Transition Planning; and Findings Report.
- **Task 7 – Program Management.** Provides program oversight in cost, schedule, and performance management.
- **Task 8 – Conferences and Reviews.** Supports conferences and regular progress reviews to share its discoveries.

In the initial RRTB start up development, tasks 1, 2, 3, and 4 happened concurrently. The goal was to have a fully operational test bed and the gaps it would address available at the same time and allow management to see quick results from the RRTB program.

The rest of the paper describes Task 2 (Capability and Technology Gap Analysis), Task 4 (Test Bed Configuration), and Task 6 (Engineering Services) in greater details since these tasks comprise the majority of the effort for our innovative approach.

## TASK 2: CAPABILITY AND TECHNOLOGY GAP ANALYSIS

It was identified that one of the issues that limits successful transition is having a firm understanding of PoR S&T needs. Under this effort, we obtained input on capability gaps from each of the original four PM ConSim stakeholders. From this list of gaps we mapped against current capability and technology challenges to define a common list of capability gaps. This list was reviewed by stakeholders and served as the basis for research planning and communication of gaps. The idea is to conduct this gap analysis on a recurring basis to update previous data as necessary and adjust focus to address the latest organizational needs. Below we discuss the individual aspects of the process we used.

### Focus and Stakeholders

At the onset, our preliminary set of stakeholders was from four of the major ITE programs from the same PM office. The initial list of gaps identified was focused mainly on these four sources targeting the specific training needs of each program. As we revisited the gaps after the first year, the stakeholder focus evolved from single program need to the ITE enterprise needs. Subsequent efforts included input from other user communities for their program vision and future ITE concept to understand the Army's vision for the future. As the effort moved forward, in-process reviews were expanded to include other organizations that are part of the ITE as well as other research and analysis efforts targeting future architectures and systems in order to expand an enterprise view of the need. Regular reviews are held with stakeholders who provide feedback on the prioritized gaps and buy-in on the path forward.

### Gap Analysis Process

**Error! Reference source not found.** below details each step in the technology identification process. The first part of the research effort was the collection of gaps from each of the original four PM ConSim stakeholders. The main goal of Steps 1 and 2 is to elicit and analyze the capability gaps from various sources to correlate and derive the top ITE enterprise-level gaps. The gaps are further decomposed and grouped into functional "bins." The gaps are traced back to their primary sources and are provided with an identification number (ID) that encodes the source. A count of the number of sources is maintained to show how *popular* a particular gap is between the stakeholders.

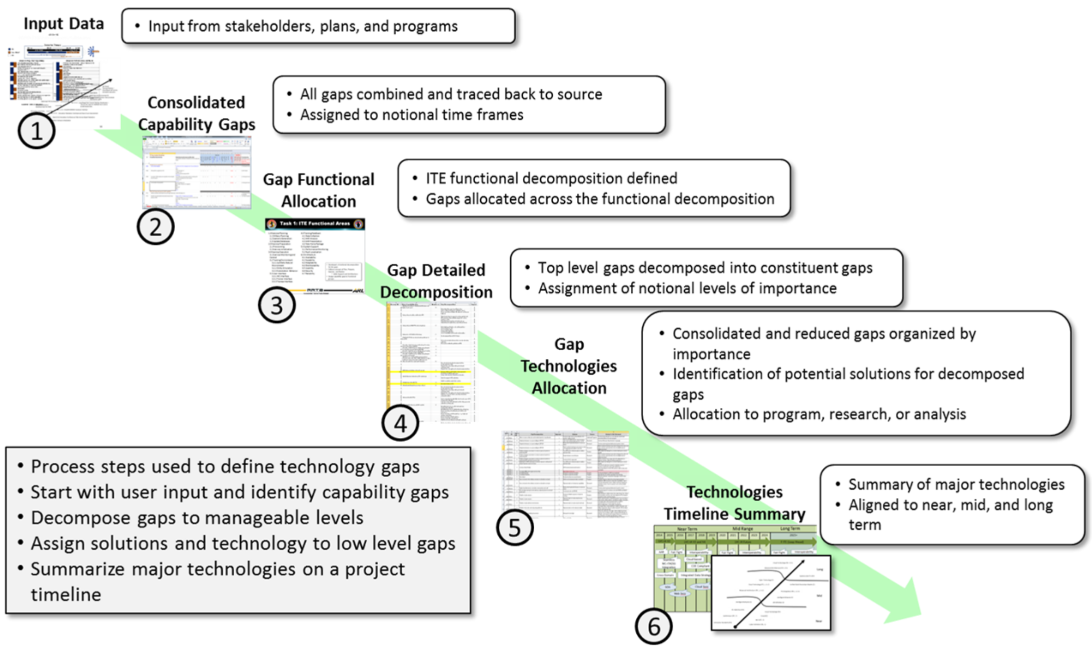


**Figure 2 – Technology Identification Process**

In Step 3 we performed a functional allocation of the capability gaps. The functional partitioning is based on activities in exercise lifecycle phases. The exercise phases include Planning, Preparation, Execution, and Training Feedback. Added to the functional activity from the phases are activities related to system support and architectural characteristics of the ITE enterprise. Each gap is assigned to one of the functional areas. The functional allocation provides clues with regard to the types of technologies and solutions would apply to the gap. Figure 3 provides an example of identified gaps, source ID, allocation to timeline, and functional decomposition.

| ID | ITE Capability/Characteristic/Gap | Near-term | Mid-term | Long-term | ITE Functional Area |
|---|---|---|---|---|---|
| FUA 25 | Re-constitution of friendly forces in the virtual environment | y | | | 3,1 Exercise Monitoring and Control |
| FUA 13 | Too many system "ExCons" | y | | | 3.1 Exercise Monitoring and Control |
| FUA 30 | Managing the exercise (i.e. OC's, fire markers, and injects) requires a significant external support element | y | | | 3.1 Exercise Monitoring and Control |
| FITE 11 | Integration of USAF FW virtual systems. | y | | | 3.2 Training Environment |
| FITE 13 | UTM Integrated (Operations Process) | y | y | y | 3.2 Training Environment |
| FITE 14 | Multi-Echelon Collective (JTF and below) | y | y | y | 3.2 Training Environment |
| FITE 15 | Fully Integrated with TII | | | y | 3.2 Training Environment |
| FITE 17 | Integrated with CTCs | y | y | | 3.2 Training Environment |
| FITE 18 | Joint, Multinational, and SOF enabled | y | y | | 3.2 Training Environment |
| FITE 20 | L, V, C, G and Augmented Reality Enabled | | | y | 3.2 Training Environment |
| FITE 23 | Integrates system, non-system TADSS and Digital Ranges | y | y | y | 3.2 Training Environment |
| FITE 34 | Minimize new requirements -- product improve current capabilities to the extent possible. | y | y | | 3.2 Training Environment |
| FITE 42 | Replicates operational complexity and uncertainty | y | y | y | 3.2 Training Environment |
| FITE 43 | Good-enough fidelity | y | y | | 3.2 Training Environment |
| FITE 7 | Inclusion of JIIM capabilities. | y | | | 3.2 Training Environment |
| FITE 8 | Ability to conduct Mission Rehearsal activities using LVC-IA and all core systems. | y | | | 3.2 Training Environment |
| FUA 2 | Limited Live capability (IDF from Virtual & Constructive) | | y | | 3.2 Training Environment |
| FUA 31 | Lack of AVCATT direct communications with CCTT | y | | | 3.2 Training Environment |

**Figure 3 - Example Allocated Gaps**

In Step 4 we performed a functional decomposition of the capability gaps into the functional capabilities needed to realize the gap. This step was necessary because the source gaps provided were at a high level, making it difficult to assign technologies and solutions to them. Across the full functional decomposition, there are common decomposed functional capabilities, for example, common data models and correlated terrain to support interoperability across the ITE enterprise. Once the functional decomposition was complete, it became possible to allocate technologies and solutions to the individual capability gaps.

In Step 5 we performed an allocation of technologies and solutions across the decomposed capability gaps. The ID of the capability gap is preserved to allow a technology need to be traced back to its source. The decomposed capabilities were then ranked in importance. The importance was based on the context of the decomposed capability in the high-level capability gap. Finally solutions are mapped to each decomposed capability along with an indication of source and associated activity.

In step 6, the major technologies were summarized and then allocated to near-, mid-, and long-term time frames. The technologies were then annotated to show their domain of application as ITE, L, V, and C. All of the technologies involve a level of research and then application to their programs signified by the domains. Technologies marked with all four indicate standards defined by the ITE and implemented in the domain programs.

## TASK 4: TEST BED CONFIGURATION

One of the key aspects of test bed configuration task is the development of a lab design to build a relevant test bed environment suitable for technology research and evaluation. Some of the key requirements and capabilities taken into consideration when standing up the test bed include: network infrastructure; IT and network support; physical security; change management; subject matter expertise; and program reach-back. These are covered in the following subsections.

### Required Functional Capabilities

The LVC-IA system of systems was identified as the primary focus for our test bed. The LVC-IA system was selected because it reaches across each of the Live, Virtual, Constructive, and Gaming domains as well as interfaces with Mission Command systems (PEO STRI, 2012). This provides the breadth within the lab to conduct research projects across a wide range of simulation systems. The Live simulation systems primarily consist of the Home Station Instrumentation Training System (HITS) which was implemented in our test bed environment through the use of SAF to surrogate the movement of Live entities using the correct Live protocol. The Virtual core simulation systems include SAF representations of the Aviation Combined Arms Tactical Trainer (AVCATT) as well as the Close Combat Tactical Training (CCTT) systems using the correct Virtual protocol. Within the Constructive domain, the test bed hosts simulation assets from the Joint Land Component Constructive Training Capability (JLCCTC) to include the Joint Conflict and Tactical Simulation (JCATS) from the Entity Resolution Federation (ERF), One Semi-Automated Force (OneSAF), and Warfighter’s Simulation (WARSIM) from the Multi-Resolution Federation - WARSIM (MRF-W). In addition, selected components from the Games for Training (GFT) program was also incorporated into the test bed. The test bed also includes Mission Command systems (MCS) such as Force XXI Battle Command Brigade and Below (FBCB2), Advanced Field Artillery Tactical Data System (AFATDS), Command Post of the Future (CPOF), and Data Dissemination Service (DDS). These systems provide a comprehensive LVC&G and Command and Control (C2) capability within the test bed in order to conduct a wide-range of research topics for analysis, experimentation and prototype development.

### Physical Facility Requirements

The physical layout of the test bed is also an important part of the design process. The Exercise Control (EXCON) and After Action Review (AAR) workstations from the LVC-IA system stretch across the main wall providing quick access from the rows of Live, Virtual, and Constructive components. Consequently this also provides a front-end viewing capability that lends itself well for in-lab demonstrations. Overall system hardware footprint was minimized through the use of virtualization and SAFs. The SAF test harnesses used to simulate the Live and Virtual training systems mimic the same data transmissions as they would if the data was coming from a Manned Module (manned simulator) in the case of the Virtual system, or a player unit in the case of the Live systems, providing the overall same interface data as they would when running with real player units and Manned Modules. This provides the maximum throughput with the minimal amount of overhead enabling us to test and evaluate large scale LVC systems within the confines of a small lab footprint. Figure 4 provides a view of the current RRTB lab layout.

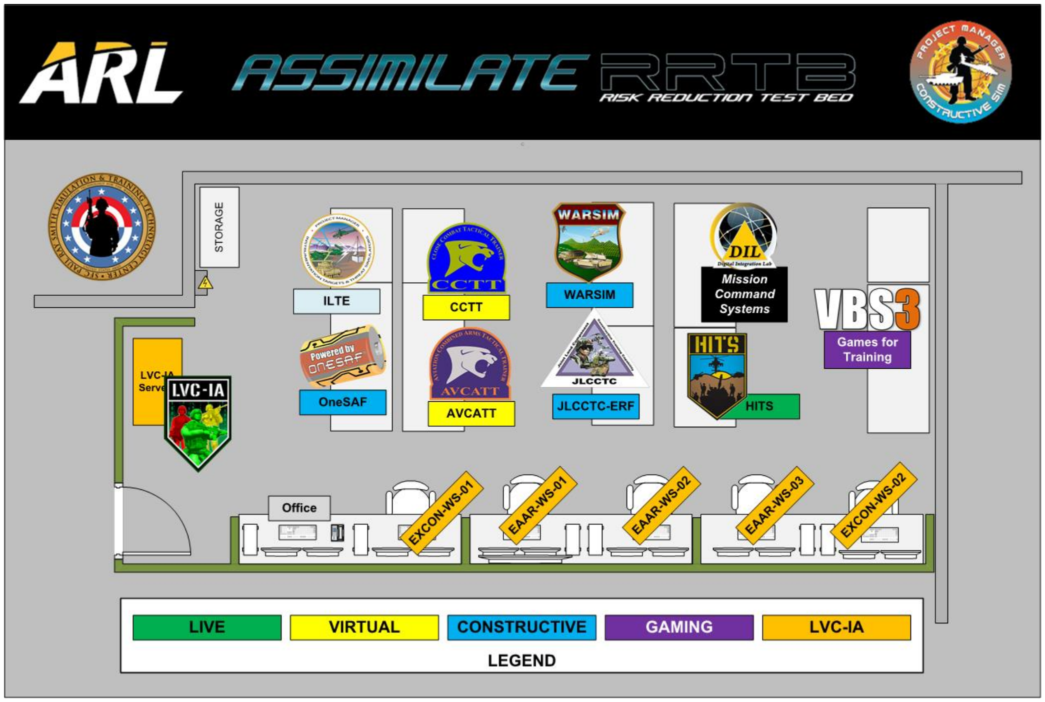


**Figure 4 - Current RRTB Lab Layout**

### Change Management Process

While there exists a wide range of capability within the test bed, this comes with a cost to maintain and operate each of these systems. Each of the core programs have their own Post Production Product support (PDSS) lifecycle and provide software updates, enhancements, and patches at various intervals. Although it is important for the test bed to be kept up to date with the latest updates, the impacts to the other system must also be considered prior to accepting new software updates.

### Required Information Technology (IT) Support

A significant level of IT support is required to maintain the integrity of the network and operation systems within the test bed as well as support for password maintenance and sometimes data recovery. A Configuration Control Board (CCB) is established to manage changes to test bed when required. Additionally, a ticket system should be considered and used as part of the change control process in order to document and provide traceability when adding or upgrading new systems.

### Required Skills, SME, and Program Reach-back

A wide range of Subject Matter Experts (SMEs) with in-depth knowledge of tactical operations, system architectures, and information technology, is required in order to operate, maintain, and sustain a test environment such as the RRTB test bed. An engineering team with a diverse range of skills and experience is crucial to effectively manage the test environment. Some systems require specific skills in military operations in order to operate mission command lab assets such as an AFATDS device. It is important to know and understand the order of operations when using mission command devices for research purposes and sometimes external support may be required. Therefore, it is important to have government reach back into the core programs for support when necessary to gain additional support. The challenge to overcome is being able to balance how much operational knowledge of each of these systems is maintained within the research team in order to be self-sufficient to and when to rely or call upon external support and SMEs to efficiently execute the research projects.

## TASK 6: ENGINEERING SERVICES

The output of RRTB Process Task 2 (Capability and Technology Gap Analysis) described above produces a list of prioritized gaps and COAs. Each approved gap/COA eventually results in a research topic to be performed as part of the Task 6 Engineering Services.

### RRTB Systems Engineering Process

To ensure that research that we perform has a high potential for transition, we follow a deliberate process for the selection and execution of research candidates. Figure 5 depicts the steps in the RRTB Systems Engineering Process.

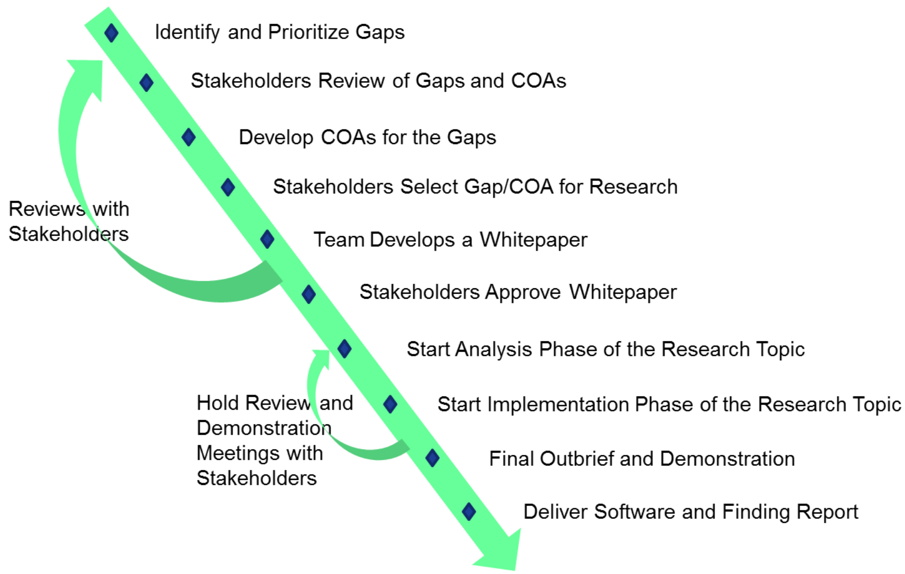


**Figure 5 - RRTB Systems Engineering Process**

Once the list of technology gaps is identified and assigned levels of importance in Step 5 as outlined in the Task 2 Capability and Technology Gap Analysis process, candidate courses of action (COAs) are developed. These COAs are then provided to stakeholders for their review. From this review, stakeholders identify which potential research candidates provide them with the best return on research investment. They consider their program goals, schedules, and potential gap risk when providing feedback. Once a research topic is selected, the team develops a short white paper that captures the main concepts including the problem to address, the approach being proposed to address the problem, benefits expected, tasks, deliverables, schedule, and cost. This then undergoes a series of stakeholder reviews to ensure that the final effort is in-line with their needs. The whitepaper may also include a desired Technical Readiness Level (TRL) of the product if one is produced per project scope. Once the whitepaper is approved and funding is in place, research project can begin.

Each typical project consists of two main phases: Analysis phase and Implementation phase. During the Analysis phase, a domain/gap analysis is performed to assess the requirements and the initial Technology Readiness Level (TRL) of the technology. Based on requirement decomposition, a high-level architecture is composed to drive the design of the prototype product to be developed. The Implementation phase consists of Design, Development, and Integration & Test tasks. Design includes a trade study that considers existing technologies for possible re-use or development from scratch. During and at the completion of Implementation phase, demonstrations may be given as requested to our sponsors and other stakeholders to solicit feedbacks in the form of In Process Reviews (IPRs). These IPRs are held to support decision points in the effort allowing stakeholders to understand the progress being made and provide a timely opportunity for additional guidance and course correction as needed. This process of selection, planning, and execution oversight improves the transition potential of our research. Finally, a Finding Report, along with all software produced, is delivered to the sponsors as the conclusion of each research topic.

**Research Topics**

The gap analyses conducted to date in close collaboration with the PoR stakeholders identified the following research topics. Some of these research topics have been concluded and transitioned to the PoRs while others are either in-progress or planned.

- Constructive Simulation Aggregate to Entity Level Data Translation
- Scenario Development Improvements
- Service-Oriented Architecture (SOA) based MC Systems Interface
- Common Enterprise AAR capability
- Simulation Plug & Play
- Cloud and SOA Architectures
- Augmented Reality
- Cyber Warfare
- Enterprise Architecture Standards
- Intelligent Adversaries
- Intelligent Tutoring Systems
- Multi-Level Security
- Natural Interaction Modalities
- Population/Cultural Models

## LESSONS LEARNED

By following the process developed and using the RRTB facility, we have successfully conducted several research efforts as outline above. The software prototype products from some of the completed researches have been transitioned to the PoRs following this process. The research topics conducted by the RRTB team mitigate some risks for the PoRs and allowed them to execute their programs with minimal interruptions. These benefits present a strong argument that the RRTB provides good Return on Investment (ROI) for the sponsoring agencies. However, despite the initial success, there are still rooms for improvement. Through these research efforts conducted some valuable lessons were learned as summarized below.

- Need to allocate necessary Level of Effort (LOE) to addressing Information Assurance (IA) regulations for the system and network components required for the research topics. For example, in order to conduct our cloud computing for LVC training research topic, we had to upgrade systems to the versions that were accredited in order to apply for an Interim Authority to Test (IATT). This process has proven to be time consuming and resource intensive. Without adequate LOE allocation for the IA tasks, the project completion time may be greatly extended and project may run the risk of running out of funding.

- Need to establish formal S&T Program Objective Memorandum (POM) line items in PEO STRI PoR life cycle cost and in ARL HRED STTC funding lines that support this process and technology acceptance. Need to plan program life cycles closer to this process, to assure funding, schedules, and transition all merge to fill in the technology transition "Valley of Death."

- Make the process part of the acquisition program so contractors that manage a major PoR must plan and accept technology from the S&T developers. A typical PoR plan usually does not include provision to evaluate and insert technologies from S&T developers. Upper PM offices need to encourage and allow for S&T technology insertion in the PoR project plans so that the overall Army M&S capability can benefit.

- Need for greater access to industry and academia ideas to address the tech gaps via Broad Agency Announcement (BAA) and/or other contract vehicles or ARL's Open Campus Concept that encourages teaming and Cooperative Research and Development Agreements (CRADAs) with industry partners. The goal is to leverage and incorporate, as much as possible, the latest technologies and creative ideas from the industry and academia into our S&T research efforts and PoRs.

- Establish more rigorous TRL exit criteria to help define final TRL of product being produced by the research topic. The technology's initial TRL should be assessed during initial capability and gap analysis. An objective TRL for the prototype to be produced should be stated as part of the research effort's exit criteria.
- Enhance the lab design such that maintenance and reconfiguration tasks can be accomplished more easily and quickly. Lab systems may need to be re-configured to accommodate different research topics. Some of the research topics being conducted may be overlapped in schedule. The ability for the lab systems and network configuration to be updated quickly is crucial to the timely and successful project execution.
- Project funding and timeline need to be adequate in order to yield prototype at a TRL that is useful to the PoRs. Projects with small funding and short period of performance can produce good analysis but may not produce products/prototypes at acceptable TRL for technology insertion to the PoR.

## CONCLUSION AND WAY-FORWARD

This RRTB initiative has provided the Army Training M&S community a mechanism to breach the gap between R&D efforts and the transition of products produced by those R&D efforts to PoRs. One of the key reasons this RRTB process has been effective is the strong communication channels established between the S&T organization and the PEO, which facilitated clear understanding of PEO PoR needs and willingness of the S&T organization to address those needs. The RRTB initiative has also enabled the Army to address challenges and risks specifically related to the ITE. It has produced several products that have been transitioned to the PoRs. Efforts like this are essential to not only reduce risks for PoRs but to reduce the cost of addressing LVC&G interoperability capability gaps. Since its inception, the RRTB process has extended to include other research communities. PM ConSim is currently working with the Virtual systems and other research agencies such as MITRE and Johns Hopkins Applied Physics Lab in trying to use the same type of focused research process to address technology gaps. Finally, it has also captured the attention of other Army M&S communities and opened opportunities to develop cross-community solutions related to LVC&G interoperability. In the near future, the RRTB model and process may be evolved to a broader collaborative environment in support of not only the Army Training M&S community, but other M&S communities in or outside of the Army to streamline the technology insertion process in order to bridge the technology transition "Valley of Death."

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