Considering Training as a Service within the Acquisition Strategy

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ABSTRACT

Recently, the US Army Human Dimension Concept (2014) and US Army Warfighting Challenges (2017) have called for a more flexible, adaptive, and effective training strategy and technologies that accelerate acquiring collective team skills to keep pace with rapidly changing, and complex warfare requirements. Currently, reviews of the Army's non-system training devices indicate large footprint training simulators target just a small portion of collective skills, have high sustainment costs and low usage rates, and training effectiveness is difficult to track (United States General Accounting Office, 2016). To address these issues the Army has proposed the single Synthetic Training Environment with the vision of providing greater training flexibility at reduced cost through low footprint, mobile, reconfigurable, immersive simulators that provide the right level of cognitive fidelity tailored to learning requirements specified by end-users at the Point of Need (PoN). The purpose of this paper is to discuss the requirements for an effective PoN capability. We describe how the Training as a Service (TaaS) paradigm could support the PoN and argue for an innovative concept of TaaS within the acquisition strategy. For example, providing evidence of training effectiveness could be built into the requirements for delivering a service, and could be employed as procurement selection criteria. To illustrate, we describe a use case example and a concept for a Collective Training Management Architecture (CTMA) that we propose will be necessary to implement TaaS to achieve a PoN solution.

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INTRODUCTION

For the last 15 years, the Army has been in persistent conflicts that are characterized by quickly changing training requirements from commanders who are deployed or are preparing to deploy that has resulted in attempts across the doctrine, organization, training, materiel, leadership and education, personnel and facilities domains to rapidly respond and provide the necessary capabilities. This has resulted in multiple standalone (nonintegrated) training support packages and training products in a myriad of media and domains that exist on various portions of the live, virtual, constructive, and gaming environments. Commanders struggle through developing, and tailoring the myriad training products and resources to account for unit unique requirements. Many of these products and resources require additional effort to integrate them to achieve the commander's desired training outcome. Furthermore, recent assessments of the Army's non-system training simulations by the United States General Accounting Office (2016) concluded large footprint simulators target just a small portion of collective skills, lifecycle management has high sustainment costs, usage rates are lower than expected, and tracking training effectiveness is difficult to achieve.

As the result of these issues, the US Army Human Dimension (HD) Concept (2014) and the US Army Warfighting Challenges (WCs) (2017) have called for a more flexible, adaptive, and effective training strategy and technologies that can accelerate acquiring collective team skills to keep pace with the rapidly changing, and complex warfare requirements. The HD Concept states that small unit leaders and teams must receive the proper training necessary to develop strategies that enable them to make effective decisions under stress, and that it must help to mitigate the long term physiological and psychological effects of stress. It recommended that research should focus on ways to accelerate learning and identifying new technologies (tools and methods) that optimize learning experiences. Likewise, the WCs specify in WC #8 a requirement to enhance realistic training by determining "how to train Soldiers, leaders and units to ensure they are prepared to accomplish the mission across the range of military operations while operating in complex environments against determined, adaptive enemy organizations." The WC#8 recommends determining how the Army should advance the Integrated Training Environment to enable adaptive, effective, realistic training for Soldier, Leader and unit proficiency and readiness, including improving unit training management and readiness reporting.

To address these requirements, and also achieve reduced life cycle costs and a smaller infrastructure, the Army has proposed improving collective training by way of a concept called the single Synthetic Training Environment (STE). Part of the vision is to provide greater training flexibility at reduced cost through low footprint, mobile, reconfigurable, immersive training with the right level of cognitive fidelity based on particular learning requirements specified by users at the Point of Need (PoN). The STE will be:

> "A cognitive, collective, multi-echelon training and mission rehearsal capability" for training "ground, dismounted and aerial platforms and command post at PoN. The STE will interact with and augment live training; the primary training approach for the Army. *This concept will allow the Army to provide a single STE that delivers a training service to the PoN.* The capability will allow the training audience to train all warfighting functions and the human dimension, across all echelons ….in the context of Unified Land Operations. The scope includes the training and mission rehearsal capability, …and interfaces to live training instrumentation…..STE Virtual Military Equipment that leverages Commercial Off The Shelf (COTS) and Government Off The Shelf (GOTS) hardware will provide an immersive and semi-immersive training capability to the training audience. The STE, a software solution, will not have a production line to produce custom hardware. Instead, it will have an integration line that integrates COTS and GOTS hardware" (Program Executive Office Simulation, Training, and Instrumentation, 2017).

By making training available at Point of Need (PoN), the STE has the potential to increase and track training effectiveness. Specifically, a seamless PoN solution should support a larger number and variety of collective training requirements; increased consistency in the instructional process; use of intuitive tools for generating scenarios and scenario support; automated performance measures; increased capability for data collection; and adaptive training and tutoring for learning acceleration and remediation. Therefore, the purpose of this paper is to discuss the requirements for an effective PoN capability. We describe how the Training as a Service (TaaS) paradigm could support the PoN and argue for an innovative concept of TaaS within the acquisition strategy. To illustrate, we describe a use case example and a concept for a Collective Training Management Architecture (CTMA) that will be needed to effectively implement an expanded set of exercises at PoN.

ARMY COLLECTIVE TRAINING MANAGEMENT PRACTICES

To fight and win in a chaotic, ambiguous, and complex environment, the Army trains to provide forces ready to conduct unified land operations. The Army does this by conducting tough, realistic, and challenging training. Units obtain effective training when they create a realistic and challenging training environment. A training environment is an environment comprised of conditions, supporting resources, and time that enables training tasks to proficiency. An effective training environment enables an individual or a unit to achieve proficiency in the individual and collective tasks trained. The commander sets the conditions of the tasks selected to train with as much realism as possible as defined in Army Regulation 350-1: Army Training and Leader Development (US Department of the Army Headquarters, 2014).

Unit and individual training occur all the time—at home station, at combat training centers, and while deployed. Each commander has to determine what is essential and then assign responsibility for accomplishment. The concept of Mission Essential Tasks (METs) provides the commander a process to provide the unit its battle focus. A MET is a collective task on which an organization trains to be proficient in its designed capabilities or assigned mission. A mission-essential task list is a tailored group of mission-essential tasks. Each MET aligns with the collective tasks that support it. All company and higher units have a mission-essential task list (METL). Units based on a table of organization and equipment have an approved and standardized METL based on the type of unit by echelon (US Department of the Army Headquarters, 2014).

Proficiency in individual, leaders, and collective tasks is measured against published standards. Proficiency is recognized as complete task proficiency (T), advanced task proficiency (T-), basic task proficiency (P), limited task proficiency (P-), and cannot perform the task (U). A unit's training readiness is directly tied to its training proficiency. That proficiency naturally fluctuates over time and in response to various factors. Each unit encounters and adjusts to these factors, including training frequency, key personnel turnover, new equipment fielding, and resource constraints. Well-trained units seek to minimize significant variances in achieved training proficiency over time. This is training in a band of excellence. This common sense approach precludes deep valleys in proficiency that occurs when units lose their training proficiency. Failing to sustain proficiency requires more resources and time to retrain the unit. Training within a band of excellence is the key to sustaining long-range training readiness. Effective commanders take the unit from a training start point, attain the required training proficiency, and maintain that proficiency over time. Once training proficiency is attained, the unit strives to maintain that proficiency within a band of excellence. The commander who understands factors that negatively affect training proficiency can better plan so that unit training skills do not atrophy to a less than acceptable level (US Department of the Army Headquarters, 2014).

To adjust to the anticipated highs and lows of training proficiency, commanders continually assess training plans and strategies to keep the unit mission-ready over long periods. This assessment may cover individual memory degradation, skill degradation, unit personnel turnover, changes in crew assignments, and changes in key leadership. Maintaining high levels of proficiency may prove more difficult than building proficiency from a training start point. By understanding and predicting the factors that affect training proficiency, commanders can mitigate those effects and maintain higher levels of training readiness longer (US Department of the Army Headquarters, 2014).

Commanders plan and resource training events while limiting potential distractions. They ensure participation by the maximum number of Soldiers. Although commanders cannot ignore administrative support burdens, commanders can manage those burdens using an effective time management system. Additionally, commanders must support subordinates' efforts to train effectively by managing training distracters and reinforcing the requirement for all assigned personnel to be present during training (US Department of the Army Headquarters, 2014).

Commanders rarely have enough time or resources to complete all necessary tasks. Supporting resources provide the tools that enable modifying those conditions to be more challenging and complex for Soldiers and the entire unit. Without the right resources, effective training will not occur. Available resources directly affect unit training readiness. Each commander and staff understands the resource coordination and synchronization cycle on the installation on which units conduct training. Commanders leverage available resources, to include the mix of live, virtual, and constructive training enablers. Commanders and staffs coordinate and synchronize procedures for the normal classes of supply; training aids, devices, simulators, and simulations (TADSS); integrated training environment considerations and resources; and available training facilities. At a home station, all training resources are limited and shared with other units on the installation. Commanders and staffs aware of an installation's resource cycle are more likely to secure the right training resources when they are needed to train. When used properly, resources create a powerful training multiplier that more closely replicate an actual operational environment. The time available to train is a critical resource of which there is never enough. Training within the limits of the planning horizon drives when the unit or individual is expected to be proficient in the tasks selected to train. Careful development of a training environment can produce exceptional results and ultimately increase training readiness (US Department of the Army Headquarters, 2014).

The Army Training Management System (ATMS) is the Army enterprise program automating management of unit and individual training (US Army Combined Arms Center, 2017). Though centrally managed, the data collected from the ATMS belong to the commander. ATMS consists of Web-based applications and centralized databases. The ATMS suite of applications automates routine command, unit, institution, and individual training and processes. ATMS enablers directly support Army doctrine publication 7-0, Army doctrine reference publication 7-0 and other relevant Army doctrine and policy guidance. The centrally managed enterprise databases—such as the individual training record—organize, store, and make available data for displays, reports, queries, and data sharing.

TRAINING AS A SERVICE

A PoN delivery solution for non-system TADSS must support commanders in charge of training their Soldiers and the coordination processes needed with the ATMS. We propose a TaaS model has the potential to be a more efficient delivery strategy for addressing the PoN requirements that enables end-users to directly define training requirements to be tailored to their needs when they request training functionality. TaaS is an on-demand training delivery model in which simulation and training software and associated data are centrally hosted in a cloud computing environment (which typically involves using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer) and is accessed by users using a so-called thin client, normally a Web browser over the Internet (Lanman & Linos, 2013; Lanman, Linos, Barry, & Alston, 2016). The TaaS strategy is to build simulation and training services (i.e., Web services) and the supporting infrastructure (i.e., networks, communications, sensors and computing hardware) according to service-oriented design principles and practices. TaaS is envisioned as a cloud-based environment with a deployable software service infrastructure to support a fully integrated training environment.

The TaaS framework would provide one-stop integration of training products that would allow commanders anywhere, anytime to select, tailor, execute, and assess individual to collective training and conduct mission rehearsal. Army forces require that unit commanders have a reconfigurable, scalable framework for Army training and education. This framework would be the provider and integrator of all training products that are made available and that evoke the unit and individual behaviors necessary to achieve Army training standards and desired leader, training, and education outcomes. TaaS would provide the actors, environment, scenarios, and training events that allow the commander to challenge the unit with realistic tailored training.

For example, TaaS has the potential to enable product development teams to build common Army training apps and software services for internet web browsers, desktop computers, and mobile devices (e.g., smartphones, tablets, laptops, etc.) in the cloud environment. Army units and individual soldiers can access software applications such as a Global Positioning System (GPS) tracking app for land navigation and exercise control monitoring, tactical engagement simulation apps for laser and simulated fire engagements, and instrumented range apps for fixed live fire targets. TaaS will have the potential to support up to brigade and battalion level force-on-force instrumentation and home station training with constructive (i.e. OneSAF) data feeds and battle damage assessment. TaaS could integrate with mission command systems and include the fully immersive live, virtual, and constructive simulation and training environment.

Delivering effective training to PoN with TaaS leads us to argue that TaaS should also be part of the acquisition strategy. In addition to training delivery at PoN described above, we propose that to address training effectiveness TaaS could include contracting for services from private sector vendors using a Performance-Based Services Acquisition (PBSA) approach. PBSA is defined as contracts that are "structured around the results to be achieved as opposed to the manner by which the work is to be performed." (Defense Acquisition University, 2009). PBSA strategies strive to adopt the best commercial practices and provide the means to reach world class commercial suppliers, gain greater access to technological innovations, maximize competition and obtain the best value to achieve greater savings and efficiencies. By implementing a PBSA strategy with the procurement of simulation and training services (instead of the traditional practice of a Service acquiring and owning simulators and training devices, software, and teaching materials), the military can incentivize contractors to achieve performance levels of the highest quality consistent with economic efficiency that reflect value both to the government and to the contractor.

Contractor performance assessments (the process known as "quality assurance") would focus on outcomes, such as training effectiveness, rather than on contractor processes. These outcomes (non-functional requirements) can be defined in capability requirements as Key Performance Indicators and defined in specifications as Quality of Service (QoS) metrics to measure training effectiveness. QoS is the description or measurement of the overall performance of a service, such as a computer network or cloud computing service, particularly the performance seen by the users of the network. To quantitatively measure QoS, several related aspects of the service are often considered, such as latency, throughput, reliability, availability, etc. However, to measure training effectiveness, both a quantitative and qualitative approach may be considered with focus on learning results, usability, resiliency, operability, etc. When the training requirements change the responsibility falls to the outsourced training provider to maintain currency.

While moving to a TaaS environment is within reach, the paradigm requires development of innovative training management capabilities that ensure training effectiveness can be delivered as a service. Next we describe a use case to illustrate training effectiveness requirements at PoN.

TRAINING EFFECTIVENESS REQUIREMENTS AT POINT OF NEED: A USE CASE

To address the HD and WC call for developing resilience in teams, the Squad Overmatch (SOvM) research program developed, tested, and evaluated an Integrated Training Approach (ITA) to developing team skills (Brimstin, Higgs, & Wolf, et al., 2015; Milham, Phillips, Ross, et al., 2016; Townsend, Milham, Riddle, Phillips, Johnston, & Ross, 2016). The following five learning domains were developed in the ITA:

- Tactical Combat Casualty Care (TC3) employs medical tactical priorities, roles, communication, and decision making in managing combat casualties in: care under fire, tactical field care, and casualty collection and evacuation.
- Advanced Situation Awareness (ASA) employs pattern and threat recognition and decision making, to include identifying and interpreting non-verbal cues to determine deception, physical distances among people to determine who is in charge, voice patterns and sweating to determine whether a person is a threat or under stress, terrain and cultural features to determine where and how people are moving and acting; and applying decision heuristics to assess any anomalies that could trigger a need to take action.
- Resilience and Performance Enhancement (RPE) maintains tactical effectiveness under combat stress to include application of acceptance, "what's important now," deliberate breathing, self-talk and buddy-talk, grounding, and personal AAR.
- Team Development (TD) employs teamwork to include information exchange, communication delivery, supporting behavior, and initiative/ leadership.
- Integrated After Action Review (IAAR) employs the team self-correction method in order to facilitate squad initiative, leadership, and ownership in the conduct of the AAR processes and outcomes.

SOvM ITA studies implemented instruction, Simulation-Based Training (SBT), and live team training exercises close in time, and in a sequential manner over four days. Classroom instruction on days 1 and 2 was immediately followed by skills development in the SBT, then practical skill application in live training exercises at an outdoor urban complex on days 3 and 4. Initial results from a SOvM experiment in 2016 demonstrated significant improvements in TC3, ASA, TD, and IAAR skills during two live training exercises, compared to the control condition squads who participated for one day on the same two exercises (Johnston, Gamble, & Patton, et al., 2016).

Classroom-based instruction defined and developed knowledge of the important cognitions and behaviors in each domain. Instruction focused on refreshing existing knowledge and skills, and introducing new knowledge for developing squad performance. On Day 1, Subject Matter Expert (SME) instructors taught the TC3 and ASA modules, then on Day 2 they taught the RPE, TD, and IAAR modules. Instructors conducted one hour sessions that engaged participants with mixed media, videos, and hands on practice. For example, hands-on practice with the Improved First Aid Kit II (IFAK II) and a Medical Simulation Training Centers (MSTC) trauma manikin enabled refreshing skills using the combat application tourniquet (CAT), chest decompression needle (CDN), and the nasopharyngeal airway (NPA).

A key factor in the ITA was adhering to the principles of effective SBT that develops team member skills in applying the cognitions and behaviors in event-based scenarios (Rosen, Salas, Tannenbaum, Pronovost, & King, 2011). The SBT approach adopted the military *Plan – Conduct - Assess* procedure, but further developed the planning phase to conduct an event-based approach to training scenario design to ensure that complex skills are acquired by tightly linking critical tasks, task stressors, learning objectives, exercise design and execution, performance measurement, and feedback. An important feature in designing training based on an event based approach is including as much of the knowledge-rich environment in the training as possible so that pre-specified cue-strategy relationships are embedded in events. The six steps in SBT are:

1) Specific instructional strategies are derived from the Learning Objectives (LOs) so that team skill development is optimized.
2) Training strategies enable defining training simulation requirements, scenario scripts, and scenario events.
3) Events are scripted into a scenario that allow for performing the targeted skills.
4) Diagnostic performance measures are developed and used to determine if the LOs have been mastered.
5) Once diagnoses are defined, a structured after action review (AAR) can be constructed and delivered so that trainees have a basis on which to improve in subsequent scenarios.
6) To close the loop, performance information is incorporated into adapting follow-on training sessions to ensure they build on what they have already learned.

TC3 task stressors were gradually increased in scenarios so that squad members could systematically practice utilizing ASA, RPE, and TD skills during TC3. SMEs created an overarching chronological story line for five scenarios that takes place over several weeks. Two scenarios were developed for SBT (B1 and B2) and three for live training (M1, M2, and M3). The scenarios gradually increased problem complexity and stressors with key events inserted to deliberately elicit TC3, ASA, and TD tasks, and RPE behaviors. The scenarios presented typical stressors experienced by Soldiers during combat (e.g., combat casualties to civilians and Soldiers, improvised explosive device (IED) explosions, and sniper fire). Scenario events included conducting a key leader engagement, encountering hostile actors that are observing unit movement, a car bomb detonation followed by a complex ambush; an enemy actor that attempts a failed suicide bombing; and a sniper attack on civilians and Soldiers. Live training exercises provided skills practice under more realistic, simulated conditions, employing simulated TC3 stressors in a controlled and safe setting.

On the afternoons of Days 1 and 2, each squad trained together as a team on skills development with the Army Games for Training Virtual Battlespace v3.0 (VBS3). VBS3 is deployed throughout Army training sites including the Maneuver Center of Excellence and is used to train squads how to practice collective movement, shooting, and communication. The VBS3 classroom is configured to support squad training via networked, desktop PCs. It provides an interactive "first-person" shooter virtual environment in which squad members talk with each other through an embedded voice communications system. Each squad member was assigned a virtual avatar they controlled throughout a scenario. The urban training complex was modeled in the simulation to support skills development and transfer to the live environment. A VBS3 controller/administrator performed scenario management throughout the B1 and B2 exercises and also acted as a role player. Several role players managed voice and control of avatar characters in the scenarios. On days 3 and 4, live training on scenarios M1, M2, and M3 was conducted at the urban training complex that was instrumented with:

- A scent generator that created bread and incense smells that provided olfactory cues for developing a baseline of the village's pattern of life.
- Non-pyro technical devices that simulated explosions for IEDs, gunshots, suicide bombs, and booby traps;
- The IFAK II that included the NPA, CDN, CAT, dressings, TC3 card, and bandages;
- Moulage devices for suicide vests, IED blast effects, through-torso gunshot wounds and active bleeding;
- MSTC trauma manikins with simulated injuries requiring the NPA, CDN, CAT, occlusive dressings, TC3 card, and bandages;

- Popup targets and simulation avatars of three levels of interactivity (no interaction, limited dialog through voice recognition, full interaction through live actor control) that required squad members to observe behaviors and cues exhibited during interactions, and to use these cues to develop a baseline of situational awareness, enable identification of anomalies, and accomplish mission objectives.
- A prototype, smart-phone based, Multiple Integrated Laser Engagement System (MILES) Casualty Display Device (MCDD) that was used in place of the paper casualty card and was integrated with the MILES Individual Weapon System vest. MCDD is a dynamic casualty displayed on the smart phone touch screen providing MIST - mechanism of injury, injury type and location including a realistic video of the specific wound (e.g., gunshot wound), signs and symptoms and reflecting treatment provided; and the individual's tactical capabilities as a result of the specific injury (move, shoot, communicate). The display provided dynamic updates of casualty status over time. If wounds were correctly assessed and treated through self, buddy, combat life saver (CLS) or medic care in a timely manner, the squad member or civilian stabilized and, if not, the display depicted a "Died Of Wounds" condition.

Following each scenario in VBS3 and live exercises, squads developed skills in guided team self-correction in AARs conducted by a Platoon leader and several of the learning domain SMEs. This IAAR approach encouraged team members to practice and perform targeted behaviors, conduct systematic AARs using specific, performance-based feedback; and led the feedback sessions using guided team self-correction methods. The result was team members learned how to take personal responsibility for identifying behaviors that need correction, develop team cohesion, and set goals for improvement. For the first 20 minutes, squads participated in the IAAR in a critique of their tactical performance using video snippets of the critical events collected during the exercise. Then each domain SME spent about 5 to 7 minutes leading squad members in identifying tactical triggers, behaviors, solutions, and outcomes as they reflected on each of the areas, sometimes reviewing video snippets. Finally, the Platoon leader led the squad members in setting goals for improvement in the next scenario. In this manner, the teaching points were reinforced based on practical application.

In summary, the SOvM studies demonstrated how the WC's and HD requirements could be addressed employing a flexible ITA that leverages SBT and adapts low-cost training technologies for live training environments. However, fully implementing it is a significant challenge under current, stove piped training regimens, and the requirements for the large number of support personnel to achieve these improvements. About 15 core SMEs developed the classroom instruction, training, scenarios, measures of cognition and attitudes, conducted the ITA, assessed performance during the exercises, provided post training feedback collected data, analyzed the data, and generated post training results. In addition, about 20 support personnel were observer/controllers (OCs), role-players, technology managers (e.g., controllers the VBS3 environment), and managed the set up and conduct of live training (e.g., controllers for avatars, pyrotechnics, and MSTC manikins). To reduce the manpower requirement, the SOvM research team recently completed two SOvM Train-the-Trainer studies with Soldiers and Marines by replacing most of the external support personnel and SMEs with members of a platoon being trained and their internal support personnel.

A COLLECTIVE TRAINING MANAGEMENT ARCHITECTURE

In order for STE to provide a PoN solution to delivering effective collective training such as SOvM, while reducing manpower and costs, an *automated training management toolset is needed*. We propose TaaS will need a highly intuitive and intelligent Collective Training Management Architecture (CTMA). The CTMA concept is drawn from a conceptual architecture for embedded team training developed by Stretton, Johnston, and Cannon-Bowers (1999) in response to improving the efficiency of its combat team training exercises at reduced cost through increased automation of training management technologies. The study conducted by Stretton et al. (1999) resulted in a set of recommendations for moving from the static Plan-Conduct-Assess strategy to a dynamic *Plan-Conduct-Assess-Adapt* model shown in Figure 1 that employs a data analytics strategy.

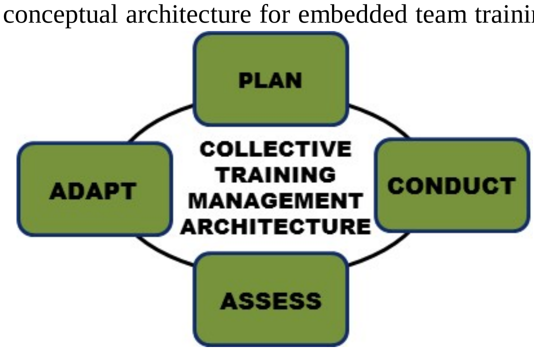

Figure 1. Plan-Conduct-Assess-Adapt

We applied their recommendations to develop the CTMA capabilities as an initial concept for automated methods and tools for STE training managers to enable delivering a tailored simulation capability at PoN. Absolutely critical to its success will be an intuitive instruction management interface that supports end-user needs. The CTMA should require very little learning to use it. Display layering should be minimized, automation developed where possible, controls grouped by function, and novice users supported through well-defined work processes and help functions. Using the SOvM example, we illustrate how the following CTMA attributes could automate the process at each phase of the model.

Plan

Step 1. Training Requirements

For the SOvM study, a set of dismounted squad Mission Essential Tasks (e.g., conduct stability and support operations, zone reconnaissance, and key leader engagements) were selected that could provide the context for learning the five domain topics. It was determined that some Soldiers had ASA and RPE classroom courses, and the majority had Combat Life Saver (CLS) training, but no one had the full TC3, TD, or IAAR curriculum. Furthermore, none of the skills were being taught together in an ITA, using simulation and live exercises. Therefore, we concluded that the ITA would provide some CLS, ASA, and RPE refresher training, but that it would mostly need to be an entirely new curriculum. In addition, it was determined that at least semi-intact, experienced squads were needed to participate because they had to have some previous experience in executing squad tasks. The SOvM curriculum was not focused on teaching tactical skills; but it was expected that tactical skills refresh would be part of the training for which the Platoon leader was responsible. A CTMA would automatically use information on current unit task requirements and past unit performance to ensure that training requirements are matched to the needs of the unit. Past performance would include such information as previous performance on similar scenarios, demographic information, experience, qualifications, etc. With these inputs, CTMA would select a mission and some condition definitions to initiate Step 2.

Step 2. Learning Objectives

The SOvM LOs listed above included knowledge and skill development, and were generated based on the level of knowledge and skills it was estimated the squads would have. The CTMA would automatically produce LOs based on the specifications derived from performance history, task lists, and mission definition databases in Step 2.

Step 3. Scenario Event and Performance Objectives Definition

Leveraging past research data products and scenario development methods, the SOvM program used the LOs to develop the five detailed, event-based scenarios with a cadre of at least five SMEs. An Operations Order was created detailing the set of related factors that set the context for friendly, neutral, and enemy; own force operations; intelligence information, etc.. Civil conditions included a context for operations and geopolitical situation (e.g., political, economic, military, and cultural issues). Tactical parameters conditions included a summary of current conditions with which the unit would need to know to provide stability and support operations. Embedded casualties and other events (e.g., sniper attack), created the stressful conditions needed for skills development. Scenarios ranged from 15 to 27 events. Table 1 presents a sample of scenario events developed for both the virtual and live scenarios. The event is described (e.g., Event A: Establish a baseline of human terrain activities), with the associated performance objectives for ASA, TD, and TC3. For example, Event A has three ASA and TD performance objectives (e.g., assessed human terrain, changes in tactical priorities are communicated to squad members). The CTMA would be used to support a user in authoring scenario and performance objectives products or would automatically create events and objectives.

Step 4. Training Simulation Configuration

As described in an earlier section, the SOvM program used the results from steps 2 and 3 to identify and employ non-system TADSS such as VBS3 and MILES, and developed new prototypes such as the MCDD for both virtual and live training. A CTMA would automatically use the data from Steps 2 and 3, and unit location and availability of technologies, to determine the required collective training events, recommend an optimal configuration of PoN training technologies (e.g., mixed reality for virtual training and augmented reality for live training), and then support delivering the appropriate training technology configuration(s).

Table 1. Example of ASA, TD, and TC3 event-based performance objectives for selected virtual and live scenario events.

Event	Description	ASA	TD	TC3
A	Establish baseline of human terrain activities	Assessed the human terrain situation in the village and compared the patterns to a normal baseline to quickly identify unusual activities	Changes in tactical priorities are communicated to squad members	
		Assessed non-verbal human terrain cues for the Key Leader	Information is passed among squad members about their observations of the town	
		Assessed non-verbal human terrain cues from villagers	Available information sources are used to identify the key leader and other people of interest	
B	Tactical questioning of High Value Target	Assessed non-verbal human terrain cues during tactical questioning	Back up is provided to squad member engaging in interviewing the High Value Target	
		Assessed that the person behaved consistently with expectations from intel		
C	Soldier receives GSW to arm and a civilian woman receives GSW to chest		Complete medical updates/reports were provided (MIST report, and 9-Line if applicable) - CD	Care under fire coordinated response: Mandown reported, Provided cover, Secured casualty, Proper care with Tourniquet only
			Information was exchanged between squad members about the casualty - IE	Tactical field care conducted: medical status info exchanged; medical needs info exchanged; advanced care provided

Step 5. Scenario Script and Performance Measures Generation.
The SOvM program generated detailed scenario event scripts for authoring in VBS3, and for specifying setting up the live training events in the MOUT. The event-based performance objectives were converted to checklists and that were imported into an android tablet that SMEs used to assess squad behaviors and communications during virtual and live training events. A CTMA would automatically create the scenario events that would be imported into the training environment, and would generate performance measures that would be collected from the training environment and integrated with observer assessments.

Conduct

During the conduct of each of the SOvM exercises, at least five SMEs observed squads and listened to their communications in order to assess whether they had performed the pre-specified performance objectives. During the live exercise, other support personnel were busy time-tagging events in the video and audio recordings for collation and use in the AAR. CTMA would automatically collect and collate performance assessments of observed actions and communications and simulation outputs to determine core knowledge and skill deficiencies by examining performance across tasks.

Assess

Following each SOvM scenario run, only a small amount of the Conduct data was collected together by SMEs for use during the AAR. VBS3 scenario replay and video/audio from the live exercises were hand crafted for the AAR. Lessons learned, sustains, and performance improvements were identified and written up, by hand, in real-time for the squad to agree on prior to the next scenario. A CTMA would automatically generate the Assess products to provide units with an AAR addressing performance diagnoses relative to pre-training performance objectives; would include automated scenario replay, performance summarized by events, guided feedback tools for the AAR leads to use, and other post training products as needed.

Adapt

The SOvM program did not address capabilities for adapting the training based on squad performance. Because this was a demonstration and experiment, all squads had to receive the same training. Nevertheless, adapting the SOvM curriculum would be highly desirable to ensure learning objectives were achieved. A CTMA would automatically recommend adapting and tailoring training to specific training needs based on unit performance.

SUMMARY AND NEXT STEPS

In this paper, we discussed how a TaaS paradigm could support the Army STE PoN strategy, and presented a use case example to illustrate requirements for a CTMA that will be needed to effectively implement the PoN solution for collective training. Since the Stretton et al. (1999) paper was published many promising, intelligent training support management technologies have been developed and demonstrated, however, it was beyond the scope of this paper to discuss them. Therefore next steps should include this review, and address the following topics to better understand how a CTMA can support delivering STE at PoN through a TaaS approach:

- Synthesize and assess existing individual and team training support management technologies using the CTMA capabilities as review criteria;
- Assess the effectiveness of existing technologies (e.g., usability, implementation, etc.);
- Assess the generalizability of the technologies to team training and across learning domains; and
- Determine research gaps, recommend research strategies, and develop technology demonstrations for trade off analyses.

While the concept of the STE is a good foundation to establish the future of Army training, this paper indicates that updating the underlying architecture of simulations is only part of the problem. An overarching management tool that allows training managers to track, manage and schedule training based on resources, such as access to training sites, computers or hand-held devices is critical to build and maintain proficiency. At the same time, a TaaS strategy focused on selecting vendors who can demonstrate training effectiveness in their training products and services will place responsibility on to the providers who will have training effectiveness metrics to adhere to. Finally, throughout this paper training effectiveness has been emphasized as a key element in TaaS; training is the goal of simulation tools, but the focus going forward must be on ensuring that the training is effective. This includes such HD skills as critical thinking and problem solving, teamwork, resilience, and leadership, and there must be a strategy to assess these skills if the training is effectively providing opportunities to build and demonstrate those skills.

None of the strategies mentioned in this paper will be wholly successful on their own. The authors recommend a comprehensive implementation of these strategies to provide a user-friendly tool to schedule and plan training and readiness, acquisition strategies that focus on procurements with demonstrable training effectiveness and simulation tools that support both of these strategies. The authors believe that these significant changes can ensure that we maintain world class Army training in an effective, cost-effective and highly usable manner.

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