Using Multi-Player Games for Mission Planning and Rehearsal Exercises

Exercise Framework for Combining Learning Content and Games

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ABSTRACT

The challenging new environment in which United States Forces are required to operate, characterized by uncertainty, unpredictability and asymmetric threats, demands a shift from deliberate to adaptive war planning. The introduction of Game-based learning technologies in mission planning and rehearsal exercises will create the highly dynamic environment necessary to effectively prepare individuals, units, and staffs for these formidable challenges.

Immersive Learning Environments (ILES) is an online persistent exercise framework that incorporates individual and collective tasks across a complete training event life cycle from Mission Planning to After Action Review (AAR). The ILES framework traverses individual, small-team, and enterprise levels of education, training, and mission rehearsal activity. ILES uses a unique concept called an Event Sequence to assemble time-based activities with abstractions called Nodes, which can be assembled in a serial or complex manner. Decision and Inject Nodes are used to provide a highly dynamic environment that supports branches and sequels. Activity and Group Activity Nodes have a standards-based plug-in architecture for attaching training content, multi-player games, or simulations.

This paper will discuss a notional mission rehearsal exercise with four activity Nodes assembled in sequence with a simulation, content, or a multi-player game attached to each Node. The Mission Plan Node is used for planning the mission. Once the mission plan is completed by the Commander, the plan data is passed to a "collective" Mission Overview Node where players review the plan and selected resources. Then, this data is passed to the next multi-player game for mission rehearsal. Once the mission objectives are achieved, post-game data (such as the individual or collective assessment data) is transferred to the AAR Node for after action review. Using this approach, different mission plans with different mission conditions can be exercised and reviewed.

For passing data between games, we propose a technique where the game includes an associated XML (Extensible Markup Language) schema for post-game data. The framework passes the XML post-game data to the next Node using its inter-Node communication scheme. This approach can be extended for use across games regardless of the game developer or the game engine.

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INTRODUCTION

"One of the most important goals of Training Transformation (T2) is enhancing agility – the ability to change training rapidly to respond to changing conditions or requirements" [1]. In the current volatile threat environment where we face unconventional challenges, this goal applies not only to training but also to mission planning and rehearsal, and crisis action planning. Essentially, the goal, as stated in the Strategic Plan for Transforming DoD (Department of Defense) Training, is to, "Provide the Total Force with the training and education needed to be adaptable, operationally effective, and fully integrated with real-time, globally distributed mission rehearsal using operational information networks" [2]. DoD Contractors, a segment of the Total Force, must transform the way they think when implementing DoD training. We must exploit maturing technological advances such as multi-player games and simulations for DoD training while maintaining exceptional learning and training value provided by traditional training techniques such as Instructional Systems Design (ISD).

The Commercial Gaming Industry has done a superb job of capturing young (and old) minds by providing entertainment value through mentally challenging and engaging gaming environments. Through persistent multi-player game lobbies and low-cost but high-volume games, commercial Game Producers are attracting younger generations to work collaboratively for collective entertainment while providing mutually challenging experiences. Leveraging the digital persistent environment created by the Internet and the ubiquitous Broadband availability in homes, the Gaming Industry has created collaborative and persistent Communities of Interest (COIs) for entertainment. What can we learn from these approaches and techniques to find solutions for the unconventional training challenges we face today?

Fortunately, major T2 Initiatives, such as Advanced Distributed Learning (ADL) and Joint Knowledge Development and Distribution Capability (JKDDC), have already identified gaming as an innovative approach for transforming warfighter training. The JKDDC Program specifically calls for incorporating gaming technologies into JKDDC Learning Design [2]. The ADL Program and the Joint ADL Co-Laboratory (ADL Co-Lab) are among those leading the T2 community in this area by funding prototype efforts for identifying extensions required for the Sharable Content Object Reference Model (SCORM™) for using games and simulations in DoD training efforts [3]. (SCORM is the widely used Web-based content standard developed by the ADL Initiative that is becoming an international standard.)

This paper will discuss lessons learned in using a distributed digital exercise environment (developed for NORAD-USNORTHCOM (N-NC) under the Immersive Learning Environments (ILES) Program) for mission planning and rehearsal exercises. ILES, supported by the Office of the Deputy Under Secretary of Defense for Personnel and Readiness (OUSD P&R), is moving forward in developing a standards-based exercise framework environment that combines conventional training content with multi-player games [4]. This paper will specifically discuss lessons learned in addressing the following three challenges:

1. Using multi-player games and simulations within the ILES exercise framework for future mission planning and rehearsal exercises.
2. Changes and enhancements that could be applied to the SCORM specification for using games and simulations for training.
3. Linking the Joint Training System (JTS) to game and simulation development efforts for shaping a long-term strategy for developing a DoD-wide game development standard.

BACKGROUND

As previously reported [4], ILES is being developed to prepare individuals and small groups for large-scale national exercises. N-NC has been using a "user-centered rapid spiral development approach" to develop an exercise framework that could change the way distributed training events are conducted. ILES is a capabilities-based, digitally distributed exercise environment, that handles all phases of a training event life cycle from initial establishment of training objectives, standards, and conditions (based on Joint Mission Essential Tasks (JMETs)), to assessment and final After Action Review (AAR). This framework traverses individual, small-team, and enterprise levels of education, training, and mission rehearsal capabilities.

ILES Architecture

ILES can provide a unique approach to joint knowledge development and distribution that helps to overcome many of the deficiencies cited in the T2 Assessment Report [1]. Since ILES is an open architecture framework that builds upon the U.S. Joint Forces Command's (USJFCOM) Joint WarFighting Center's (JWFC) highly agile Mission Rehearsal process, it provides an unprecedented opportunity to develop more efficient and rapid techniques to capture and distribute joint knowledge as it is generated by personnel engaged in a Combatant Command's (COCOM) mission analysis, planning, and rehearsal processes.

Underlying the highly dynamic and agile JWFC exercise process, is a unique systems architecture that enables near real-time joint training support to mission planning, course of action selection, and mission rehearsal. It also allows for dynamic scripting, injects from opposing forces and observer/controllers, access to global simulation and information technologies, and real-time feedback from senior mentors and observer/controllers in support of COCOMs and Joint Planning Groups, including coalition and interagency forces at the Operational and Strategic level of war. As such, the JWFC Architecture is a critical systems design template that ILES has incorporated and adapted to the Homeland Defense and Civil Support environment at N-NC. Furthermore, ILES extends the JWFC architecture by blending distributed participants (observers and mentors) with digital exercise components to create a highly adaptable intelligent tutoring system.

The ILES exercise framework consists of the following five major subsystems:

1. **Event Sequence** – assembles time-based activities in a sequence using abstractions called Nodes, which can be assembled in a serial or complex manner for creating a highly immersive learning experience
2. **Reusable Training Objects (RTOs)** – training activity modules consisting of training content, including games and simulations that are attached to Nodes
3. **Common Tools** – provide access to operational tools required for completing training or mission-related activities
4. **Learning Management System (LMS**) – tracks training-related data such as training participant profile, performance level, and learning progress
5. **Data Repository** – provides exercise database management services

The Event Sequence uses Activity Nodes (Individual or Group) to represent activity chunks (training or mission activities) either at the individual or collective level. Group Activity Nodes are used to manage collective training activities, such as an online multi-player game or collaborative work effort. Activity Nodes are used to represent individual learning or mission activity. Inject Nodes are used for providing a highly dynamic "what-if" experimentation platform. While Decision Nodes are used to provide loops, branches, and sequels in the Event Sequence, Container Nodes are used to represent either hierarchical or functional roles of groups associated with the exercise. Shown in Figure 1 is an example of an Event Sequence.

RTOs (content that is attached to a Node) are standards-based learning content, or games, that provide capabilities for an individual or a group of players to complete a goal-driven training or mission activity. The ILES exercise framework expands upon existing Web-based content development specifications, such as the SCORM, for developing RTO guidelines. This extended guideline provides data communication schemes that allow many types of learning objects and multi-player games, as well as planning and execution tools, to use a common language through which they can interact and communicate without the need for human-applied engineering for their interaction. Using training content as RTOs has been reported previously [4], however, this paper focuses on lessons learned in using games and simulations as RTOs.

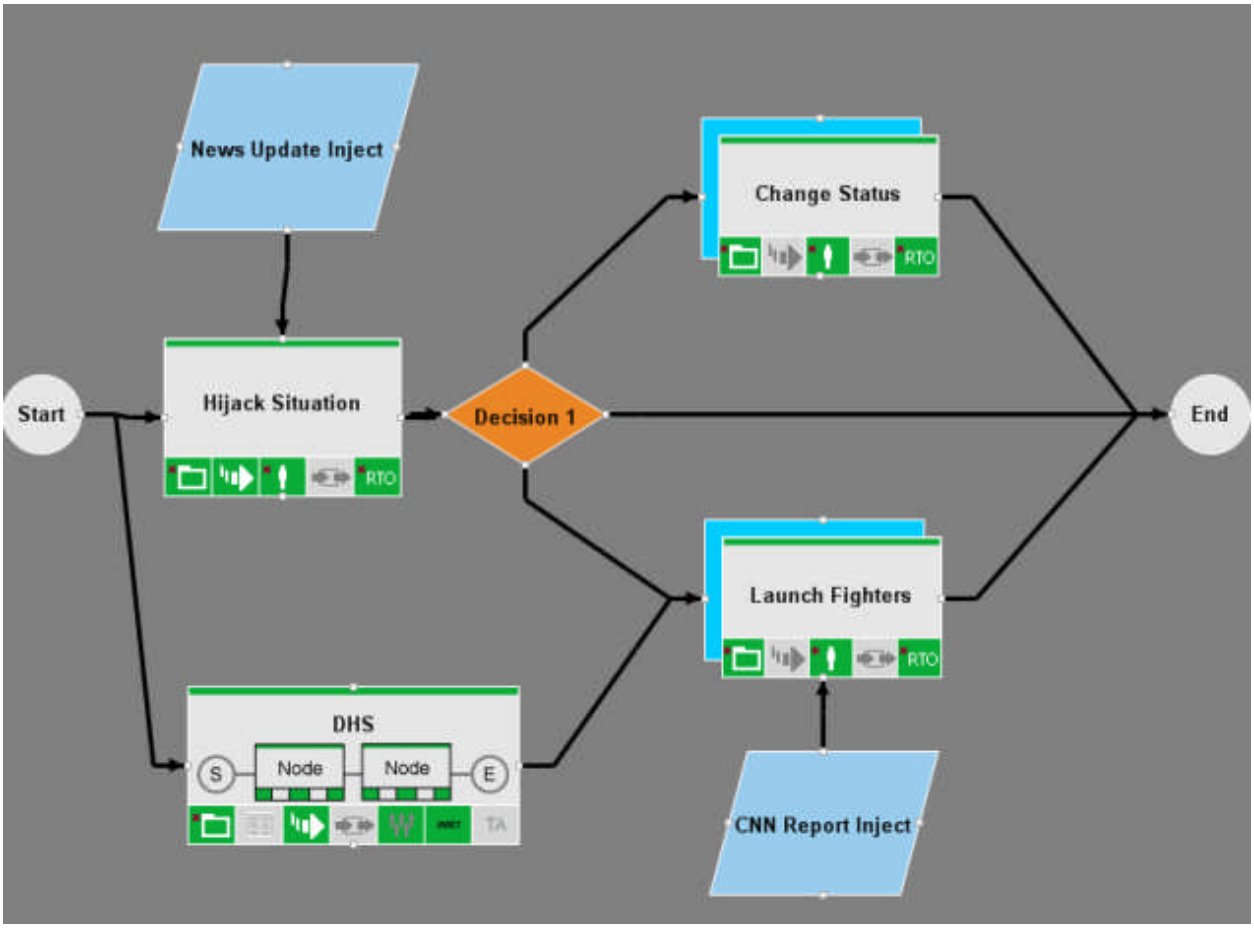

Figure 1. An Example Event Sequence with Individual Activity, Group Activity, Decision, Container, and Inject Nodes.

The ILES exercise framework uses the Event Sequence concept for developing digital exercises that are hosted through a persistent exercise lobby (each exercise has at least one Event Sequence). Based on system roles (Player, Exercise Controller, or an Observer/Mentor), ILES users can use a suite of tools (ILES Exercise Suite) for planning, designing, building, storing, distributing, playing, and managing training validation, mission rehearsal, course of action analysis, or crisis action planning exercises. The main driving forces for an exercise are JMETs, which form the basis for providing a capabilities-based joint training system and/or the Joint Master Scenario Event List (that lays out events for building a scenario for a mission rehearsal exercise). A User Profile is used to provide appropriate training based on training needs (provisioning) and the operational context.

ILES Status

As previously reported [4], the initial ILES prototype exercise framework was implemented, tested, and validated by the end-users at N-NC. This task was accomplished by holding various user tests in the form of facilitated pilot tests with audiences identified by N-NC's Joint Training Directorate (J7). For the Spiral One implementation, a sample exercise was manually created and hosted in the exercise lobby. Players logged into the Lobby, joined the exercise, and completed associated tasks using the Exercise Player module (this module is used to host content to all players). RTOs were built using typical instructional systems design tools. With this approach, a pilot test was successfully completed with participants from N-NC's Standing Joint Force Headquarters-North organization. This exercise focused on the art and science of Operational Net Assessment (ONA).

Subsequently, additional modules of the ILES Exercise Suite were developed and tested with the same training audience via facilitated pilot tests. After each spiral, the end user feedback was incorporated into the design process for making changes that satisfied the immediate needs of N-NC. In addition, an Integrated Product Team (IPT) was formed to obtain N-NC -wide participation and feedback for the user-centered rapid spiral development approach. As of the writing of this paper, plans are underway to implement a limited operational capability for using the ILES exercise framework to meet the immediate training and exercise needs of N-NC.

STRATEGIC APPROACH

There has been wide interest and enthusiasm in the use of online gaming technologies for military training [6], but significant challenges must be addressed in order to provide the type of dynamic, globally distributed training capabilities envisioned by the T2 Initiative. These challenges include the following:

1. Lack of research on the cost-effectiveness of the use of online gaming techniques to improve individual and team performance.
2. Lack of common architecture, data standards and interfaces with manpower, personnel, training, readiness and mission planning systems, including links to real-world Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR).
3. Lack of user friendly tools and techniques to rapidly configure training exercises and activities that are based upon specific training objectives and JMETs.
4. Lack of tools and techniques to assess individual and team performance including unit readiness, for specific missions.
5. Lack of common standards for interoperability and reuse of training scenarios, simulations, and associated components that are developed through use of gaming tools and technologies (although some efforts are underway by the Simulation Interoperability Standards Organization (SISO) for integrating simulation-based learning content to the SCORM specification [7]).
6. Lack of an open architecture framework and persistent environment of online games in DoD, such that any training or gaming developer can develop and host games for training (similar to SCORM standards which allows content developers to develop individual learning content that can be hosted on any SCORM conformant LMS).
7. Lack of standards for passing post-game data to be used by another game or incorporating post-game data to lessons learned databases.
8. Lack of methods and standards for integrating strategic, operational, and tactical levels of game play through human planning, analysis, rehearsal, and decision making.

Our strategic approach is to use lessons learned derived from the use of N-NC's ILES exercise framework to address these underlying and difficult to solve problems, and work with the T2 Community to create a training environment, potentially with the ILES exercise framework, that integrates realistic, adaptable, scalable, and reusable games to prepare our forces to meet the unconventional training challenges we face today.

TECHNICAL APPROACH

To recap, the major objective of this paper is to share lessons learned in using multi-player games for future mission planning and rehearsal exercises and to address general issues associated with using games and simulations for DoD training. Since ILES is being developed as a generalized exercise framework that can be applied in various contexts (tactical, operational, and strategic levels of war), our technical approach was to use a notional exercise with simulations, content, and multi-player games for passing data from one game or simulation to another in the context of a tactical-level mission rehearsal exercise. As such, the content, simulations, and games used in the notional exercise are for illustrative purposes only, however, the same methodologies are applicable to operational-quality mission rehearsal exercises with appropriate learning or rehearsal approaches. A high-level overview of the exercise with details on Nodes and content is provided below.

Notional Mission Rehearsal Exercise

The main objective of the notional (tactical-level) mission rehearsal exercise (hereafter referred to as ReCon 4) is to rehearse a mission for a reconnaissance team in which the team travels from a starting point in the area of responsibility (AOR) to a rendezvous point in order to capture or eliminate a high-value target. The four major steps used in this exercise are as follows:

1. Using a Mission Planning tool, the Commander plans the mission by selecting the patrol route, mission environment, conditions, and resources. The content used in this step is targeted for individual consumption.

2. Using a Mission Overview tool, the team (collective activity) reviews mission details such as the patrol route that they have to take to reach the target point. Mission data such as the patrol route details and conditions of the environment are sent from the previous step.
3. Using a Multiplayer Game, the team (another collective activity) rehearses the mission. Planned patrol route and environment changes are based on condition data that was sent from the first step.
4. Using an AAR tool, post-game data such as score, elapsed time, and actual patrol route taken (compared to planned) are displayed for the team (also a collective activity) to conduct the AAR.

The Event Sequence in the notional mission rehearsal exercise is shown in Figure 2 (the Event Sequence depicted is a simple linear sequence, however, the ILES exercise framework can support complex sequences with branches and sequels). RTOs (as content, simulations, or games) that provide different capabilities are attached to each Node.

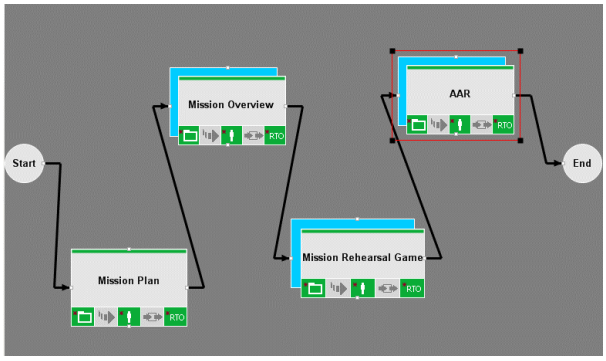

Figure 2. Event Sequence used in the Notional Mission Rehearsal Exercise. (Note: The first Node is an Individual Activity Node, while the rest are Group Activity Nodes.)

The number of roles defined in the notional exercise is four (4), but can be extended to use any number of roles. Notional role names are Commander, Squad Lead, ReCon 1, and ReCon 2, but the framework provides capabilities to define role names as required. The role assigned for the Commander uses the first simulation activity to plan the mission and participate in the other three team activities. The other three players participate in the last three activities.

One of the major advantages of this approach (organizing mission activities in a sequence) is the ability to test various mission conditions for rehearsing different missions. For example, this approach can be used to test two different missions using distinct conditions such as day or night operation, crowd situations, and enemy strength in the AOR. The main lesson learned is that, this approach could save a considerable amount of resources: creating different missions with different conditions can be achieved very quickly since missions are created virtually.

SCORM Extensions

The Event Sequence used in this exercise uses content (training content, game, application, check list, or simulation) tied to each Node to support the necessary activities the players must execute to complete their tasks. As previously reported [4], the ILES exercise framework uses the SCORM as the basis for developing RTOs that can be attached to Activity and Group Activity Nodes. The proposed RTO standard, or specification, is based on extensions applied to the specifications for Sharable Content Objects (SCOs) developed by the ADL Initiative, including additional metadata required for execution within the ILES framework. Currently, the framework uses these extensions to provide the additional information required to deliver extended SCORM content using the ILES ExPlayer software. Under the Client Server Architecture used to support delivery of the ILES exercise framework, collective activities are supported by running multiple ILES clients on different computers working with the sever software (ExServer) that coordinates collective activities.

It is important to mention other efforts involved in extending SCORM for delivering learning content in the form of simulations, games, or animations via a SCORM conformant LMS. In the work reported by C. Carlisle and B. Smith [3], the authors report lessons learned in using the SCORM metadata specification to specify simulation metadata without any additional extensions. This approach provides details in using the SCORM specification for delivering a game or a simulation via an LMS.

The approach presented in that paper was simpler and easier to implement, but had limited capability compared to the ILES exercise framework with its own client application (with ILES Run Time Engine (RTE)) with capabilities to load the SCORM metadata (imsmanifest.xml) in addition to the ILES framework metadata (iles-metadata.xml) for linking ILES exercises and JMETs. In addition, the framework loads metadata extensions required to support collective training capabilities (due to space limitations, details of the additional metadata are not provided here.). Additional

research must be conducted to assess whether ILES metadata extensions can be implemented within the current SCORM specification as reported in similar efforts [3] compared to having additional metadata files. That approach may open opportunities for using ILES content in SCORM conformant LMSs as well as for linking JMETs to learning content, games, and simulations.

Transferring Data between Games

One of the major requirements for conducting mission rehearsal in various conditions is the flexibility to transfer post-activity data from one activity to the next for changing the conditions on the fly. The Node abstraction (that facilitates activity chunking) provides opportunities for any game or content developer to develop content that is compatible with the framework. Provided below are approaches used for implementing post-game data transfer capabilities.

The ILES exercise framework introduces a specification for RTOs (recall that an RTO could be a game, content, or simulation that gets attached to an Activity or Group Activity Node) to receive input from (or send output to) another Node. The specification defines a schema for inputs and outputs using an XML Schema Definition (XSD) format. XSD is a file that defines a type of XML document in terms of constraints upon the elements and attributes that show their relationship to each other, and the types of data that may be in them. It is envisioned that this (optional) file will be defined by the game or content developer based on the requirement to have inputs or outputs. The schema can provide the flexibility to pass any data type whatsoever, provided the schema includes a name value pair for the framework to build the appropriate XML file on the fly. Provided below are details on how this schema is used in the ILES exercises suite.

During the exercise planning process, an Exercise Controller can use the exercise builder (ExBuilder) module to load the XSD file, and map input and output data of Nodes used in the Event Sequence (such as mapping a score from one game to another for changing the content based on the user performance). When the exercise is saved, the ExServer module generates the correct XML files based on the XSD file for receiving (or sending) data to another Node. The ExPlayer module passes (sends or receives) data to the RTOs via the ILES RTE, which is part of the ExPlayer module. This could allow the content development community to adopt a standard that would allow various learning systems to receive and send data between content and the RTE. It is our understanding that this approach can be used for SCORM conformant LMSs, provided extensions can be applied to the SCORM specification.

IMPLEMENTATION

In order to validate the concepts presented here, four different content products were implemented using Macromedia Flash and an open architecture commercial game development tool (Virtools, www.virtools.com) that was available for immediate use without purchasing a new game engine or contracting with a gaming company to develop the games. As mentioned before, the focus of this research was not the development of content or games, but rather to determine how the framework and games can be employed for mission rehearsal exercises. However, the methods reported in this paper should apply to any game or content development tool, provided specified recommendations are followed. Provided below are details of each content product.

Content Details

As mentioned earlier, the Mission Planning content is used to plan the mission. This is accomplished by providing a map of the AOR with a start point (shown as a yellow circle on the map in Figure 3) of the patrol route the team has to take to reach the desired end point. Using the Save Path button, the route and other mission parameters can be saved for transferring to the next Node. This content is built using HTML, Flash, and Virtools. Note that various screen manipulation tools can be used to lay out the route for the mission.

The RTO attached to the second Node, the Mission Overview content, is used to review the mission before the actual game is played. This content is developed using HTML and Flash. The Mission Plan content sends a screen capture of the AOR along with the route for the team to review (Please see Figure 4).

The third Node uses the Mission Rehearsal content, which is developed using HTML and Virtools software. This content is a multi-player game with a game server for coordinating multi-player activities between players (this server is an additional server required to support multi-player games). The planned patrol route from the Mission Plan is sent to this content from the first Node. The actual route taken by each player, along with score and other game parameters, are saved for the AAR content.

Figure 3. Route Plan Screen from the Mission Plan Content.

Figure 5. Screen Capture from the Mission Rehearsal Game (overhead view is shown on the bottom right).

Figure 4. Route Display Screen from the Mission Overview Content (additional screens for selecting environmental conditions are not shown here).

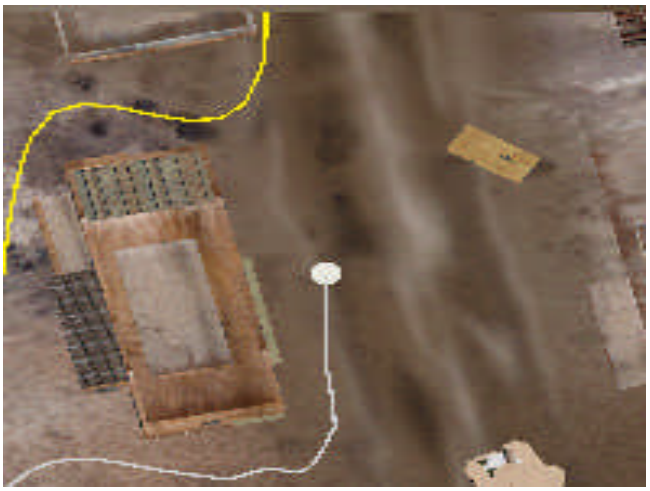

Figure 6. Screen Depicting the Planned and the Actual Path used in the AAR Content for Conducting the AAR

The last content product in the Event Sequence is the AAR content, which is built using HTML and Flash. This content loads post-game data such as the game score, ammunition used, and number of civilians hurt. In addition, the planned and actual routes are displayed for post-game review (Figure 6).

RESULTS

Once the content products were built, the ILES ExBuilder module was used to build the exercise (shown in Figure 7) and to distribute it using the ExLobby module.

Subsequently, the exercise was tested by changing environmental parameters using the planning module and running the exercise multiple times. At the time this paper was written, the inter-Node transfer schema was not fully developed, thus post-game data transfer was accomplished by transferring text files (it is expected to be completed in the near future). Shown in Figure 8 is a screen capture from the ILES ExPlayer module with the ReCon 4 Game displayed in the content area (Note: the ILES ExPlayer module provides capabilities for running the game in full-screen as required). The example game shown in Figure 8 illustrates nighttime conditions.

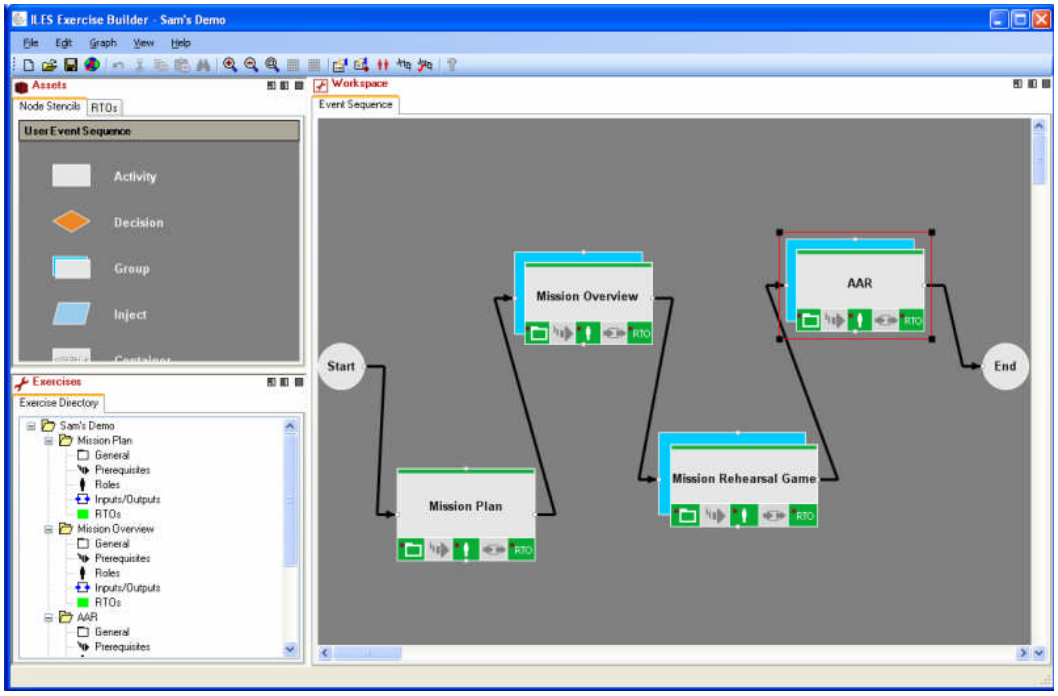

Figure 7. ExBuilder Module with the ReCon 4 Exercise.

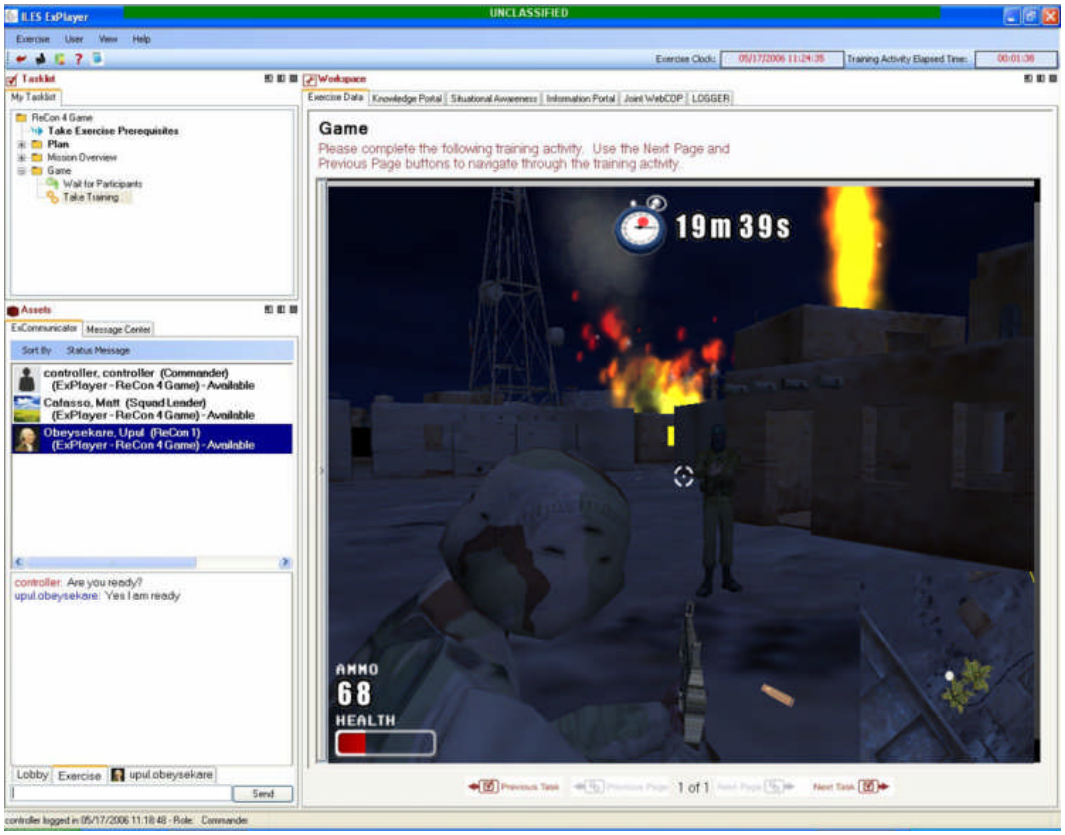

Figure 8. ExPlayer Module with the ReCon 4 Game Content.

SUMMARY

In summary, the main lesson learned from this effort is that the ILES exercise framework (that incorporates multi-player games, content, and simulations) can potentially used as the basis for developing a standardized exercise framework for use across DoD for mission planning and rehearsal exercises.

We observed that although games could be un-structured, using games and simulation in mission planning and rehearsal exercises is an effective, safe, in-expensive, and innovative method for solving some of the urgent training, exercise, and mission rehearsal needs of DoD. It is envisioned that the concepts, standards, specifications, and approaches (including SCORM usage and extensions) reported here could be used as the foundation for developing a standard for game and simulation development for DoD training. In addition, the XML-based post-game data transfer method reported here could be used as the basis for shaping a strategy for defining a new standard for post-game data transfer between games.

Additionally, while the exercise framework is a platform for providing distributed individual and collective training capabilities, developing SCORM conformant game content with links to JMETs, standards, and conditions is essential to reporting readiness to DoD-wide readiness reporting systems, such as the Defense Readiness Reporting System (DRRS) and Joint Training Information Management System (JTIMS) a component of the JTS. Collaborative efforts with the ADL Community to refine the SCORM specification to include JMET-based data in the metadata schema, should allow for outcomes of training or mission rehearsal events to be reported to readiness reporting systems, such as DRRS and JTIMS, which are currently being developed under the guidance of the OUSD P&R. We propose that the lessons leaned in this paper could support the efforts involved in linking readiness systems with learning systems.

Furthermore, one of the major challenges in developing assessment techniques for collective performance is having an architecture that can support assessment aggregation based on collective association in the mission (based on functional or organizational hierarchy). Abstraction adopted in the ILES exercise framework using Nodes, specifically Container Nodes, can be effectively used to aggregate assessment to any level where JMET-based assessment standards are applied.

Finally, we propose that the ILES Framework can be easily extended to combine tactical, operational, and strategic games due to the nature of its architecture of abstraction. Results from such implementation and experimentation will be reported as opportunities are provided in the future.

ACKNOWLEDGEMENTS

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