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TITLE: Prototype of Joint Evacuation and Transport Simulation (JETS) System
Currently known as "Joint Emergency Trauma Simulation" (JETS)

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RECIPIENT: U.S. Army Medical Research and Material Command
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14.ABSTRACT

The DoD owns thousands of medical simulators and simulation support systems ranging from simple part task trainers to full body mannequins and holographic training suites. To assist the DoD with more effectively and efficiently utilizing the resources it already owns, or may acquire in the future, IVIR Inc. has created and demonstrated the Joint Emergency Trauma Simulation (JETS) system. The core functionality of JETS is that it allows current, commercial off-the-shelf, medical simulations, and simulation support systems, to communicate with each other, in a federated network, over a standard Internet or intranet connection. This allows multiple simulation components to be combined to create a training system that can range from representing a single, customized simulated patient, to larger networks allowing simulated patients to be digitally transferred, from combat simulations, or to other patient simulators, as an analog of the transfer of real-world patients through the various MHS Roles of Care.

15. SUBJECT TERMS
Medical simulation, casualty care, high level architecture, federation object model, capability development document, training

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PHASE III: FINAL TECHNICAL REPORT

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Phase III: Final Technical Report

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1. INTRODUCTION

1.1 BACKGROUND

IVIR Inc. began research on JETS in 2016, when it was awarded a contract from the U.S. Department of Defense (DoD) (W81XWH-16-2-0064) to conduct research on a "Joint Evacuation and Training System of Systems with the focus on Patient Handoffs and Transfers." The study and design effort focused on developing an architectural design for a system of systems for joint en route care (ERC) training specific to patient handoffs and transfers. The specific aims of this effort were as follows:

- Provide for a more realistic representation of casualty handoffs and transfers that occur in the joint en route continuum of care with improved mechanisms for training, test and evaluation to reduce medical errors and adverse events occurring before, during, and/or after patient handoffs and transfers.
- Add to the current body of knowledge by identifying and addressing gaps in joint en route care training, and construct a top-level interoperable architectural framework for a training system of systems that can track individual and team performance correlated to patient outcomes.

The objective was to provide live, virtual, constructive, and gaming (LVCG) simulations to assess and evaluate the patient handoffs and transfers, in a controlled and standardized way, to help address these areas. The architectural design for a comprehensive simulated system of procedures represented casualty handoffs and transfers occurring in the joint en route continuum of care, including improved mechanisms for training and test and evaluation.

In 2018, IVIR Inc. was awarded a follow-on contract from the DoD (W81XWH-15-9-0001) to develop a "Prototype of the Joint Evacuation and Transport Simulation System." The intent was to design an architecture that integrates existing commercial simulations into one cohesive system of systems for joint en route care training. The architecture focused on communication between the providers, en route care, patient movement, patient handoffs, transfers, and logistics. The focus on open architecture and robust standards allowed for all subsystems, such as simulation devices, mission planning, rehearsal components, and inter-component qualification systems, to integrate with the architecture. This allows the systems and devices to integrate while avoiding the need to develop specific integration strategies between them. The architecture accounts for all necessary training and simulation data and is expandable to cover future training needs.

Also in 2018, IVIR Inc was awarded a separate contract from the DoD to research and develop a "Prolonged Field Care Training No Evacuation, Now What (PFCT: NENW) System (W81XWH-18-C0176). The DoD defines Prolonged Field Care (PFC) as, "Field medical care applied beyond doctrinal planning time-lines in order to decrease patient mortality and morbidity. Prolonged field care uses limited resources and is sustained until the patient arrives at the next appropriate level of care." The current DoD standard is to evacuate a wounded or seriously injured soldier, from point of injury to higher echelon of care, within one hour. PFC assumes that a local tactical situation is preventing medical evacuation for up to 72 hours. Since military first responders are currently only trained to provide immediate care for severe trauma injuries for about an hour, PFC represents a major paradigm shift and significant training challenge. To help meet this need, the DoD challenged IVIR Inc. to create a prototype simulation system to support competency-based training for both individuals and teams with the following characteristics:

- compatible with existing and future Tactical Combat Casualty Care (TCCC) training systems;
- realistic in terms of feasibility for military use and implementation;
- adaptive to the needs of individual learners and teams based on performance;

- as a long-term goal, include the Physician, Physician Assistant, Nursing scenarios;
- team performance training and different diseases/pathologies, as applicable, along with updated instruments and tools that are supplied with the military healthcare;
- support such as additional communication, logistical, and security training in addition to the medical components as part of a modular design;
- provide for learner tracking and assessment and should be able to be used in austere environments interoperable with any and all training systems, learning management systems, assessment systems, and tracking systems.

The requirements for the JETS and PFC projects pushed IVIR Inc. to consider a modular approach that allows commercial human patient simulators, part-task trainers, Learning Management Systems, physiology engines, and standardized patients to be digitally connected to create bespoke training exercises. Because PFC focuses on military first responders providing care for up to 72 hours, this required the creation of a microsystem, combining the components discussed above into a single, bespoke patient for individual or collective training. JETS requires the ability to take these microsystems and spread them throughout the Roles of Care (higher echelons with increased medical care capabilities) by creating a macro system, that replicates the transfer, and evacuation, of a patient.

While the goals of the original JETS and PFC projects were different, it became obvious that they represented different aspects of the same continuum of care, so it made sense to merge the technologies into a single, technology ecosystem. Thus, with the concurrence of the DoD, IVIR Inc. shifted the focus of JETS to the creation of a technology ecosystem that could facilitate the integration of clinical simulations, the Joint Emergency Trauma Simulation system was born.

The core functionality of JETS now is that it allows current, commercial off-the-shelf, medical simulations, and simulation support systems, to communicate with each other, in a federated network, over a standard internet or intranet connection. This allows multiple simulation components to be combined to create a training microsystem representing a single, customized simulated patient. It also supports combining these micro systems into a macro system in which simulated patients can be digitally transferred to other patient simulator micro systems as an analog of the transfer of real-world patients through the various Roles of Care.

1.2 PROJECT MISSION

The original mission of the program was to develop architectural models that will be used to guide the construction of integrated simulations and training modules for en route care training (ERC). During JETS Phases I and II, studies were conducted that aimed to add to the current body of knowledge by identifying and addressing gaps in joint ERC training and constructing a top-level interoperable architectural framework for a training system of systems. As discussed above, the scope of JETS broadened during Phase III, from a narrow focus supporting ERC training, to creating a technology ecosystem system that facilitates a major paradigm shift in how clinical simulation is used. That is to say, creating a system that allows clinical simulations, originally designed to train a specific set of individual clinical skills, to be digitally combined into a micro system creating a bespoke clinical experience. These clinical micro systems can then be combined into a macro system as described above, that facilitates true multi-echelon training, in a manner similar to, and compatible with, that which can be currently achieved in simulated strategic and tactical training.

Phase I focused on creating prototype knowledge products that will interoperate and integrate with future programs within the Medical Simulation Enterprise (MSE). The program produced designs for an overarching architecture, including a common, objective, and engineering-oriented lexicon, along with a governance strategy, a definition of shared services, and Application Programming Interfaces (APIs) for interoperability. A collection of architecture views was developed and integrated into the Capabilities Development Document (CDD). Phase II of the program focused on the Point of Injury Training System (POINTS) architecture. Phase II included additional front-end research and updated Department of Defense Architecture Framework (DoDAF) views for both the JETS and POINTS architectures. Phase II also included a preliminary Medical Modeling and Simulation (MMS) federation object model (FOM).

The intent of the Phase III effort was to design and develop a demonstration system for the MMS FOM, as a component of a JETS/POINTS and Prolonged Field Care Training (PFCT) system of systems, using Commercial Off the Shelf (COTS) and Government furnished equipment (GFE) components, and create and initiate a multiple channel marketing plan for the MSE.

2. KEY WORDS

Roles of care, patient handoffs/transfers, ERC, aeromedical evacuation, patient movement, point of injury (POI), point of demand (POD), high level architecture (HLA), federation object model (FOM).

3. PROJECT DESCRIPTION AND ACCOMPLISHMENTS

3.1 PROGRAM GOALS

What follows is a restatement of the formal program goals and objectives and a summary of the research and results related to each goal.

3.1.1 GOAL #1: Design, develop, conduct, and document demonstrations for the MMS FOM as a component of a JETS/POINTS system of systems.

- *Objective 1.1: Select functionality for implementation in the demonstrations, ensuring that audience interested capabilities of the architecture are demonstrated. This will include integration with tactical architectures that the Government provides access to in a timely manner.*
- *Objective 1.2: Identify networks, both DoD and civilian, to host demonstrations.*
- *Objective 1.3: Design the demonstration federation, including selecting individual federates (systems) for use, identifying the architecture requirements needed for demonstrations, and developing test plans.*
- *Objective 1.4: Develop demonstration and integrate the federates by expanding the FOM that was created in Phase II and developing required gateways for interoperability.*
- *Objective 1.5: Perform the modular demonstration, using COTS and GFE components, to demonstrate the ability of the architectural construct to operate synchronously and asynchronously over echelons of care.*
- *Objective 1.6: Create technical documentation that describes the demonstration and provides instruction for re-creation.*

Description of the JETS System

Discussing the Goals and Objectives of this project first requires a description of the JETS system as it now exists. The JETS system, created by IVIR Inc. during this project, is a digital architecture to connect and combine dissimilar medical simulation and simulation components. Individual systems that adhere to the HLA standard and use the MMS FOM communicate with each other using a run-time infrastructure. This collection of systems on the architecture is called a federation, which allows commercial live, virtual, constructive and gaming (LVCG) systems to communicate.

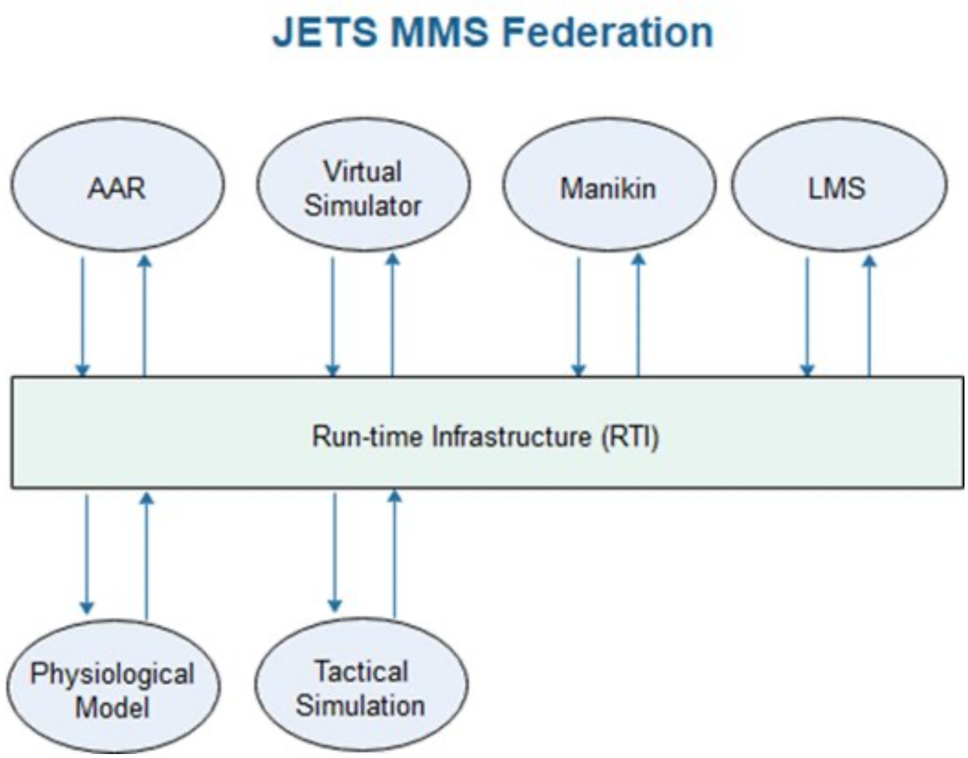

Figure 1 – JETS MMS Federation Example

JETS uses HLA. HLA is a networking technology that enables all participants to have a shared view of the simulated world. HLA is currently used in many tactical and strategic simulations, and it is a standard maintained by the Simulation Interoperability Standards Organization (SISO) which is a NATO standards partner. Because of its wide use in combat simulations, its use in medical simulation makes it natively compatible with these types of simulations. The use of "bridges" allows HLA to maintain compatibility with future networking technologies.

HLA uses Federations that consist of:

- Federates: Participants in the federation (AAR, virtual simulators, etc.)
- Run-time Infrastructure (RTI): The service that coordinates data exchange and federate operations
- Federations use a Federated Object Model (FOM) that provides a data standard which ensures system compatibility

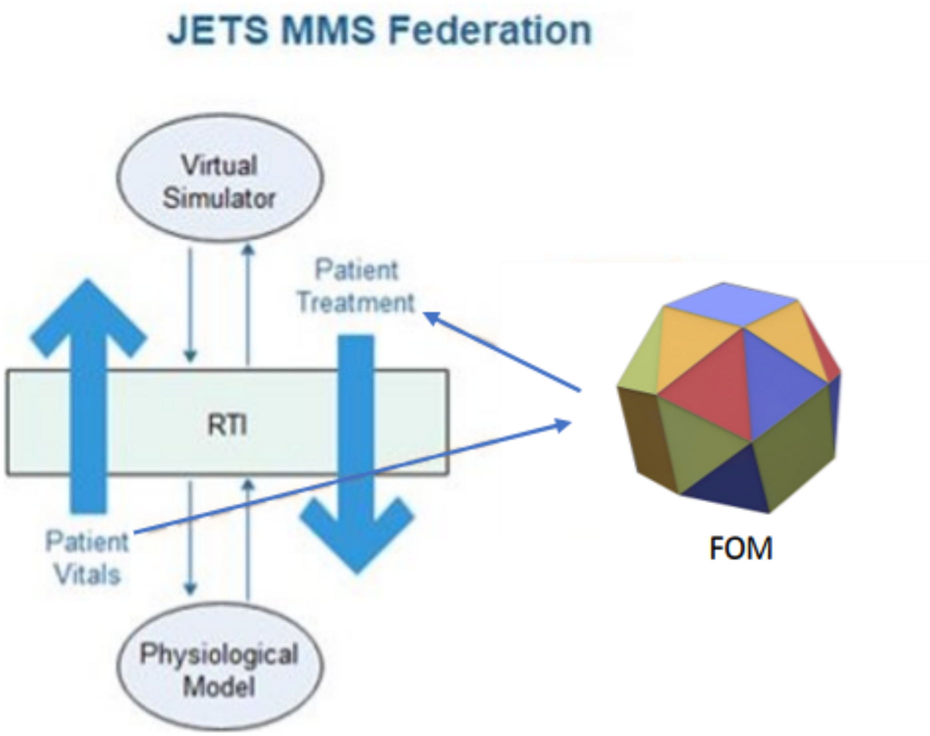

Figure 2 - JETS Federation and the FOM

The FOM is a data dictionary used to define the language of the federation. It allows systems to translate their data into common definitions which enables different systems to interact, and it describes what information can be sent over the federation, The data dictionary defined in the MMS FOM can be used by other standard simulation architectures. The HLA federation and its use of a FOM, were chosen for the JETS project because of its unique applicability to patient simulation, its ability to connect commercial simulations without compromising IP, and its ability to connect to combat simulations via a bridge.

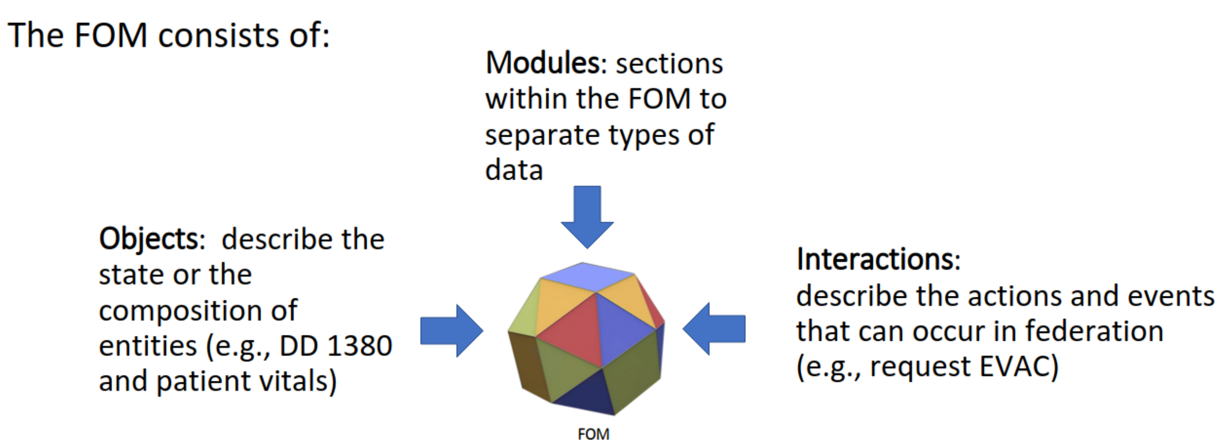

Figure 3 – FOM Components

The FOM consists of Objects, Modules and Interactions. Taken together, these components describe the information that can be transmitted over a federation. Figure 4 below shows an illustration of the type of information that can be transmitted to simulation federates on the JETS network.

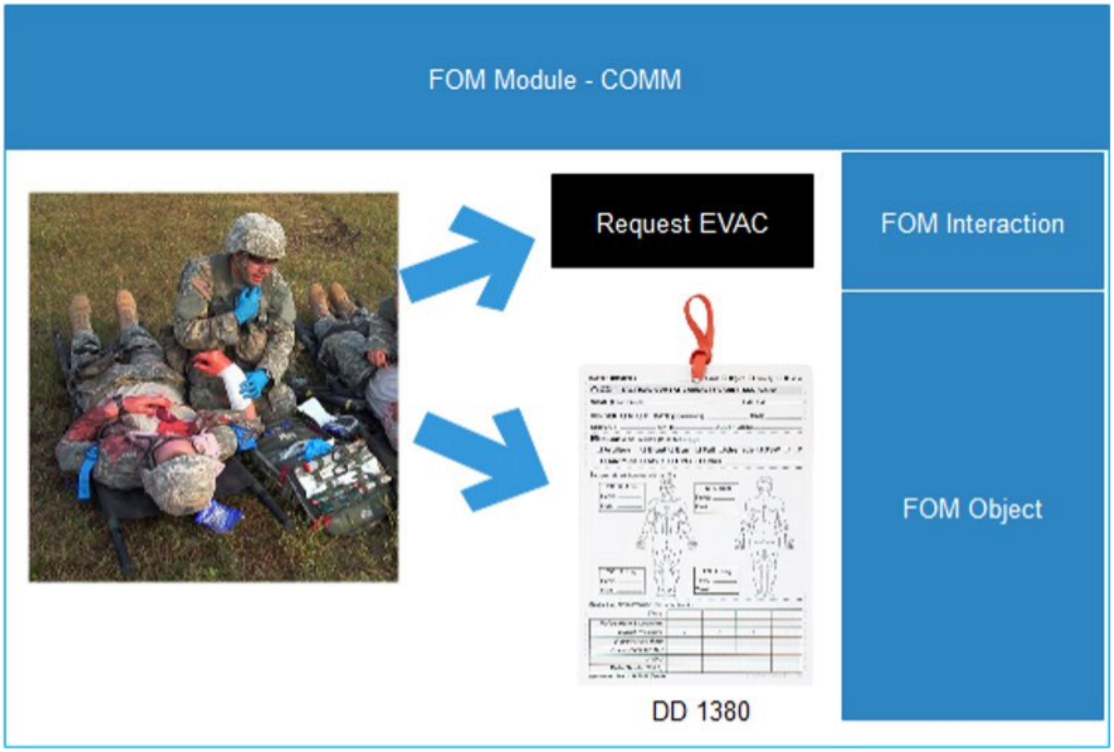

Figure 4 – FOM Module Example

In the example above, the information being transmitted is in regards to an EVAC request and the transmission of a DD 1380 which is the standard form used to document the patient status and history during a handoff. This example is from the "TransferPatient" module created by IVIR Inc. for JETS. Figure 5 below shows a chart with all the FOM modules created by IVIR Inc. for this project.

Module	Purpose
Patient	Represents ground truth of the simulated patient
Instructional	Used for capturing training data unrelated to the patient
Facility	Characteristics of mobile and fixed medical facilities
TransferPatient	Patient movement objects and interactions, including MEDEVAC
MedicalLogistics	Used to support larger scale logistics simulations
Communications	Represents various patient forms and verbal patient status reports
SimControl	Federation-wide control interactions

Figure 5 – FOM JETS Modules

Each of the FOM Modules facilitates communicating key data to the other federates in the JETS federation. For example, the patient module focuses on describing the simulated patient data:

- Physiology attributes (vitals, lung volumes)
- Signs and symptoms
- Injury descriptions (type, severity, location)
- Treatments (physical treatments, medications)
- Neurological parameters (consciousness, glasgow coma scale (GCS))
- Patient demographics
- Blood, urine, human chorionic gonadotropin (HCG), and blood type labs

As shown below, an extensive amount of FOM content was added for Phase III. Additional technical information on the JETS FOM can found in Annex A.

- Expanded enumeration sets for medications and treatments
- Improved support for blood and urinalysis labs
- Updated Event object for multi-site/patient support
- Added MEDEVAC request interactions
- Added Federation State object for late joining systems
- Added patient-specific control interactions
- Added instructional-specific control interactions
- Added document byte array support (to transmit pictures)
- Added timescale support

IVIR Inc. has identified four levels of JETS functionality – Individual Component, Micro System, Macro System and Mega System.

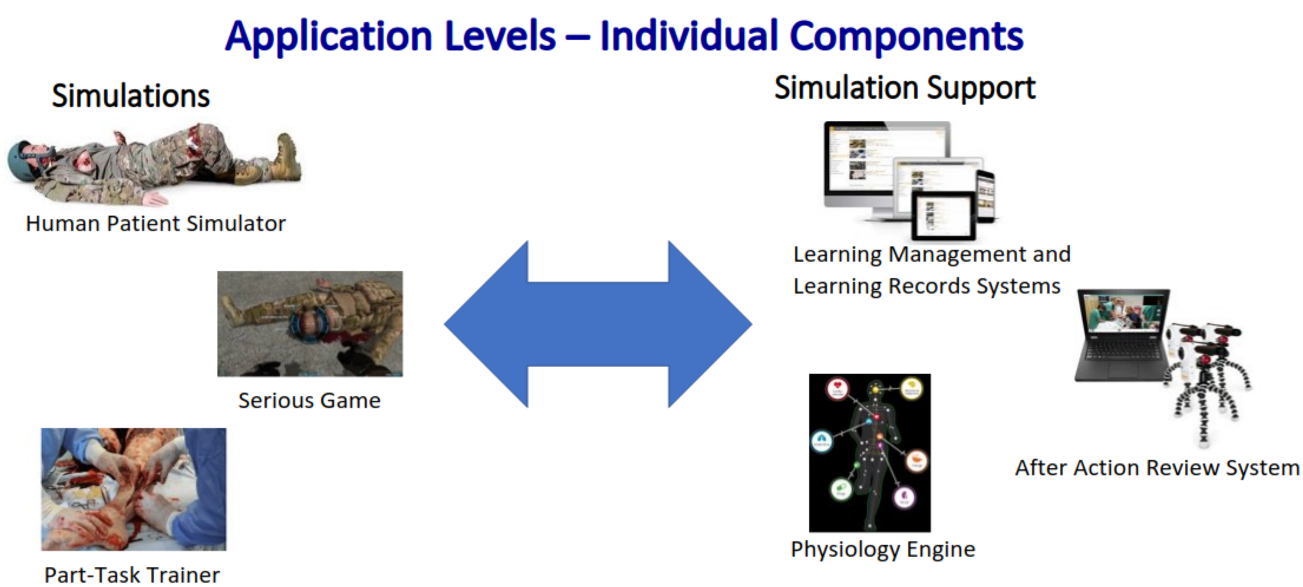

Figure 6 – JETS Individual Components

The individual component level is made of individual training and simulation systems such as patient simulators, serious games, after action review systems, and learning management systems. These components function independently as originally intended. Some simulations may be able to natively interact with some simulation support systems and some may even have embedded simulation support systems. Any system that can operate on a network can likely be adopted to connect to a JETS network.

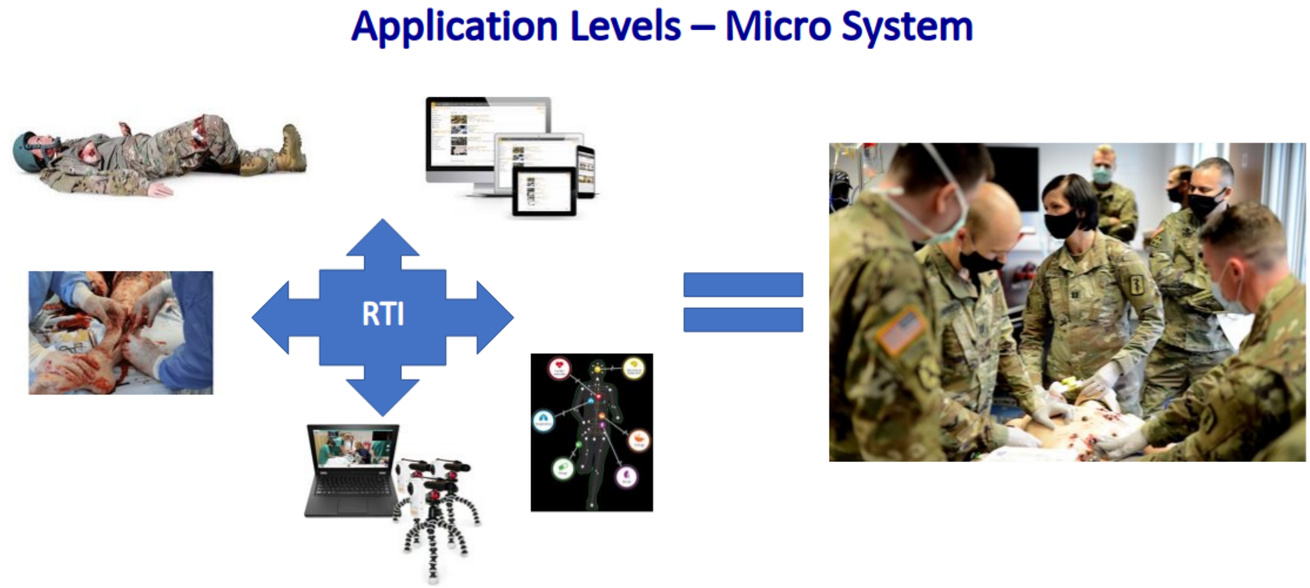

Figure 7 – JETS Micro System

The micro system level consists of multiple simulation components interacting together to create a single patient or localized training event. An example of a micro system would be a patient simulator, data recorder, a local LMS, physiology engine software, and an after-action review system. JETS enables intercommunication between these local components to create a cohesive, interoperable system. One application of this level would be to enhance capabilities of an existing patient simulator by adding integration to a physiology engine and after-action review system. IVIR began work on the Micro System during JETS Phase II and expanded on the concept during its Prolonged Field Care Training (PFCT) contract, while JETS Phase III focused on expanding to the macro system level.

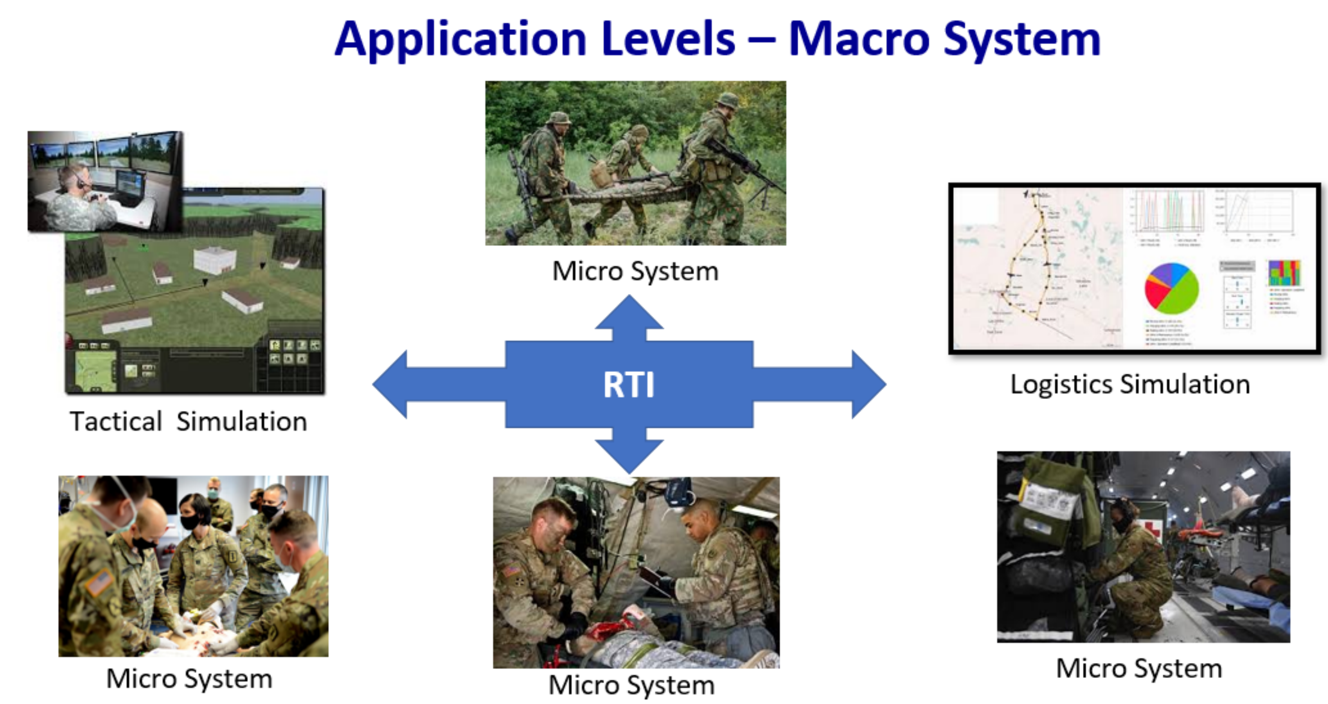

Figure 8 – JETS Macro System

At the macro system level, JETS enables multiple components and micro systems to interact. In addition to the medical simulation components and micro systems, integration can include tactical or strategic combat simulations and logistics simulations. By integrating multiple micro systems, training events located at different sites can be linked to form one large, cohesive exercise that enables live patient handoffs between the different sites and echelons of care. JETS would allow handoff information and patient status to be transferred between sites, enabling live handoff training without having to travel between the locations.

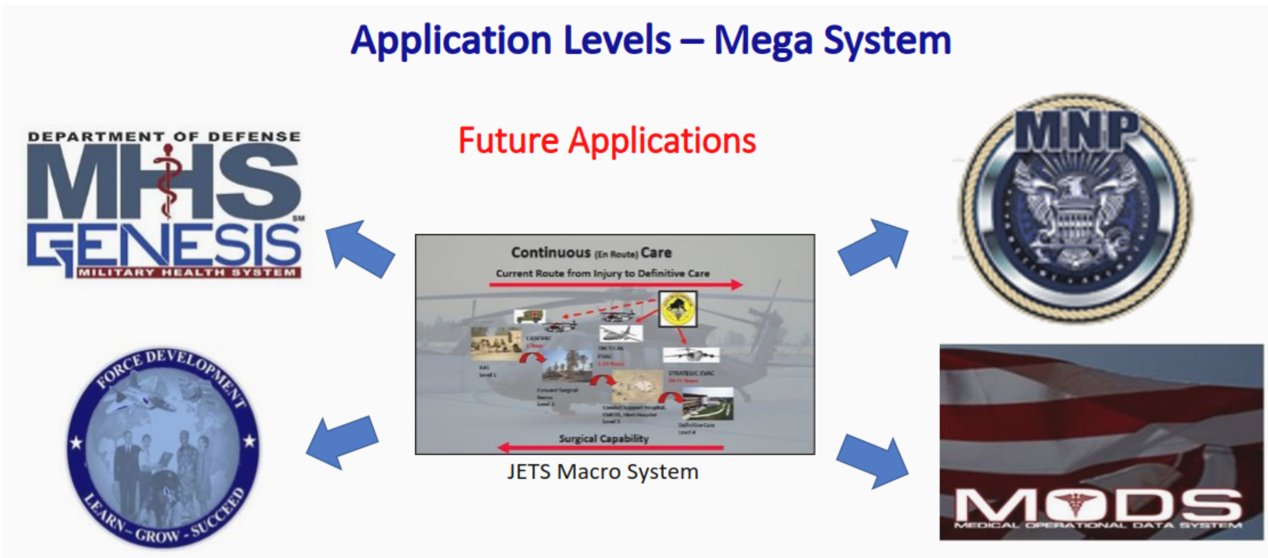

Figure 9 – JETS Mega System

The mega system level is a future application. It is the combination of multiple macro systems as well as integration with major DoD support systems such as the MHS GENSIS system, the Operation Virtual Health system, and the learning management systems of the Services. IVIR Inc.'s integration of the Learning Record Store and xAPI will facilitate this mega level integration, particularly as it relates to large database systems. Developing a Mega System is a potential future vision for the JETS System.

Additional technical information on the JETS Application Levels can found in Annex H.

JETS Phase III System Demonstration

This effort covered tasks related to the design and development of an expanded demonstration of the MMS FOM, initially developed during Phase II and expanded during Phase III. This included the selection of scenarios, software and hardware integration, and system demonstrations.

The final JETS III demonstration was separated into four different modules. The first module took place at the "Ship in the Box" facility at JBSA-Fort Sam Houston on 23 February 2022. The second module in the auditorium at the ROC Drill facility at JBSA-Fort Sam Houston on 25 February 2022 and the third module took place via the Internet on 10 March 2022. The fourth module consisted of several smaller demonstrations that showcased specific features not present in the other three modules.

The general design goals for the expanded demonstration were to:

- show multi-echelon, clinical simulation training, in a single exercise, using micro and macro systems;
- illustrate how a micro system can consist of a set of modular systems that are integrated through the JETS architecture;
- show a macro system, with multiple components, and how one or more micro systems can interact;
- demonstrate the functionality of the learning record store (LRS);

- show integration of multiple clinical simulation technologies to include patient simulators, physiology engines, learning management systems, After Action Review systems (AAR) and part-task trainers;
- show an admin-level global view of the federation during runtime;
- demonstrate concurrent distance training with sequential and parallel training events.

What follows is a summary of the final JETS III demonstration. More detailed information can be found in Annex H.

Demonstration Module 1 – Asynchronous Demonstration – 23 February 2022

The general design goals for the Asynchronous Demonstration were to create a local, customized, patient treatment training experience and to show how a JETS micro system can operate as a local network, asynchronously, with the results available at a later date.

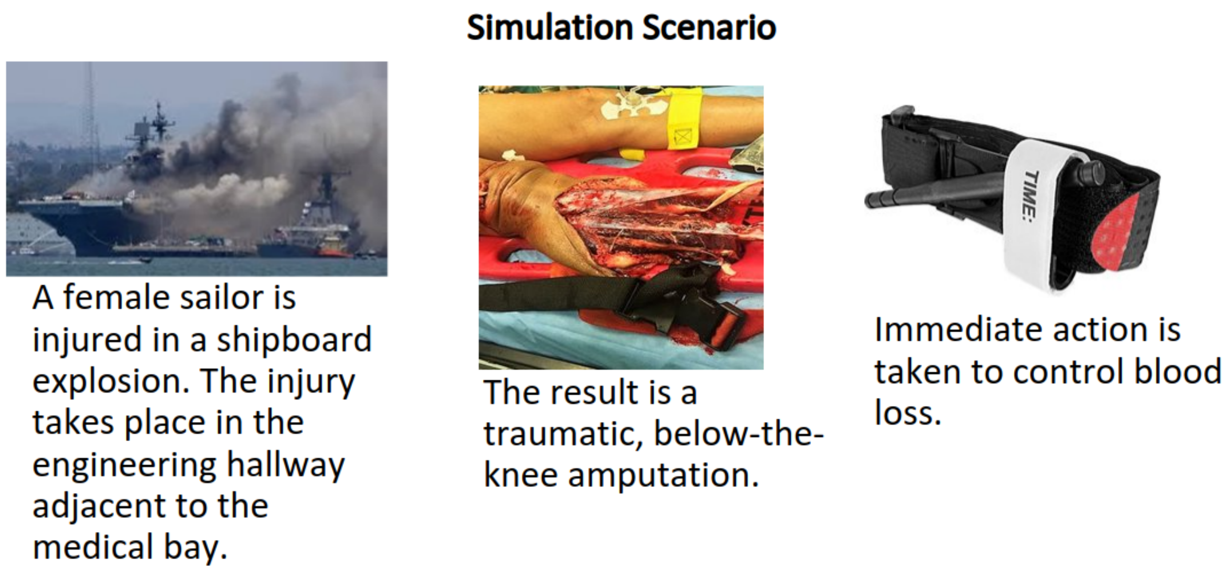

Figure 10 – Asynchronous JETS Demonstration Scenario

As shown in Figure 10 above, this simulation scenario involved a wounded female sailor with polytrauma from shipboard explosion and a traumatic, below-the-knee amputation. Despite taking immediate action to control blood loss, the continued precipitous drop in blood pressure and pulse indicated that a REBOA was required and needed to be performed.

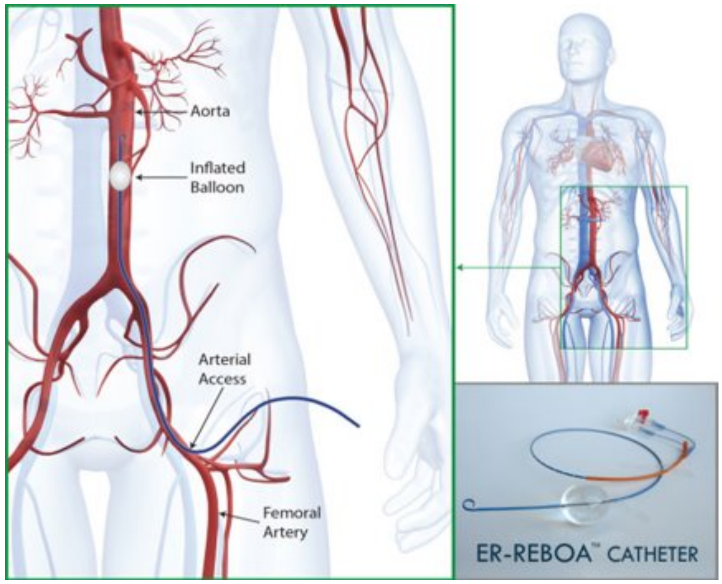

Figure 11 – REBOA

The primary simulation systems used for Asynchronous JETS Demonstration Scenario were the OEI Female TCCS+ Manikin and the Simbionix ANGIO Mentor with REBOA software.

Figure 12 – Micro System Configuration for Asynchronous Demo

The micro system environment used for this Demonstration Module was self-contained and operating in isolation. Local versions of all necessary systems were federated on a local network. Local data, including the local LRS data, patient history, and learner performance were packaged for export, on a USB drive so that it could be exported to the main federation.

<u>Demonstration Module 2 – Synchronous Demonstration – 25 February 2022</u>

The goals of the Synchronous Demonstration were to show:

- support for diverse settings where clinical simulations are currently used by the DoD;
- the ability to handle multiple casualties, in two different macro systems, operating simultaneously;
- interoperability between echelons of care;
- the ability to support point of demand training provided by existing GFE platforms;

- interoperability with selected tactical and combat simulations (as provided by the Government in a timely manner during the Period of Performance [POP]);
- the ability to support multi-echelon training.

The Synchronous Demonstration featured two macro simulations operating simultaneously. One was a trauma patient who was initially treated at Point of Injury (POI), handed off for air evacuation and en route care, with a second handoff to a Role 2 facility for treatment. The second scenario involved two patients at Role 1 Sick Call. Both were transported via ground evacuation to Role 2 for further evaluation and treatment.

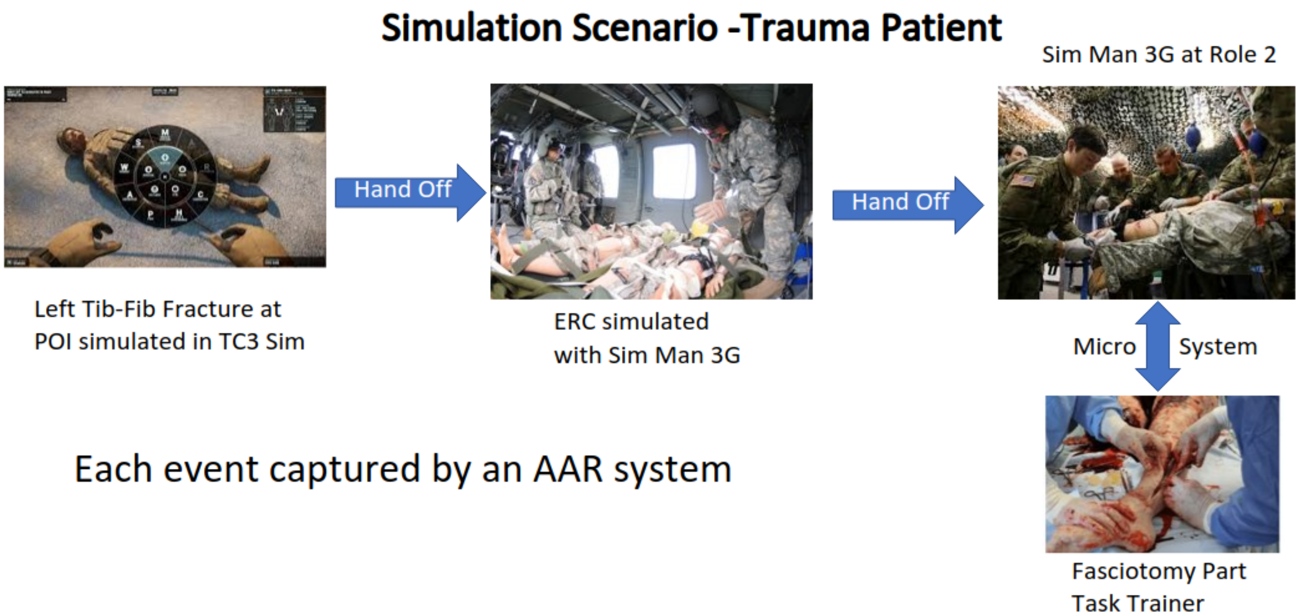

Figure 13 – Synchronous Trauma Patient Scenario

The scenario started with the learner medic treating a wounded soldier, with a left tib-fib fracture, in the TC3Sim serious game. This is a self-contained, screen-based simulation. The medic was monitored by an instructor. Once the medic completed treatment, he called for a MEDEVAC via the instructor and completed a paper DD1380. The instructor then digitally transferred the patient, and the DD Form 1380, to the next part of the LRS for later retreival at the en route care training station. The instructor at this station downloaded the patient data and DD1380 from the LRS, then printed out the DD1380 and presented it to the flight medic. The patient data was loaded into a local HumMod model which fed vitals to the SimMan 3G over the federation. The flight medic commenced en route care until arrival at Role 2.

On arrival at Role 2, the patient (represented by the SimMan 3G) was physically transferred to the Role 2 facility. The receiving Role 2 provider determined, based on a pronounced swelling of the patient's left leg, and his vitals, that a fasciotomy was required. The instructor paired the fasciotomy part task trainer, with the SimMan 3G to form a micro system and the Role 2 provider performed the fasciotomy.

Throughout this entire scenario, learner performance data was captured in three ways:

- via auto generated events from the various simulation systems;
- instructor manual inputs via digital checklist;
- visual and audio data captured in the AAR system.

The autogenerated events were used to create bookmarks in the AAR system to facilitate discussion with the learner during debriefing. The instructor also had a digital procedure performance checklist with which to evaluate the learner. The results of this checklist were stored in the LRS. Additional information on the performance assessment system, and the LRS can be found in Annex H.

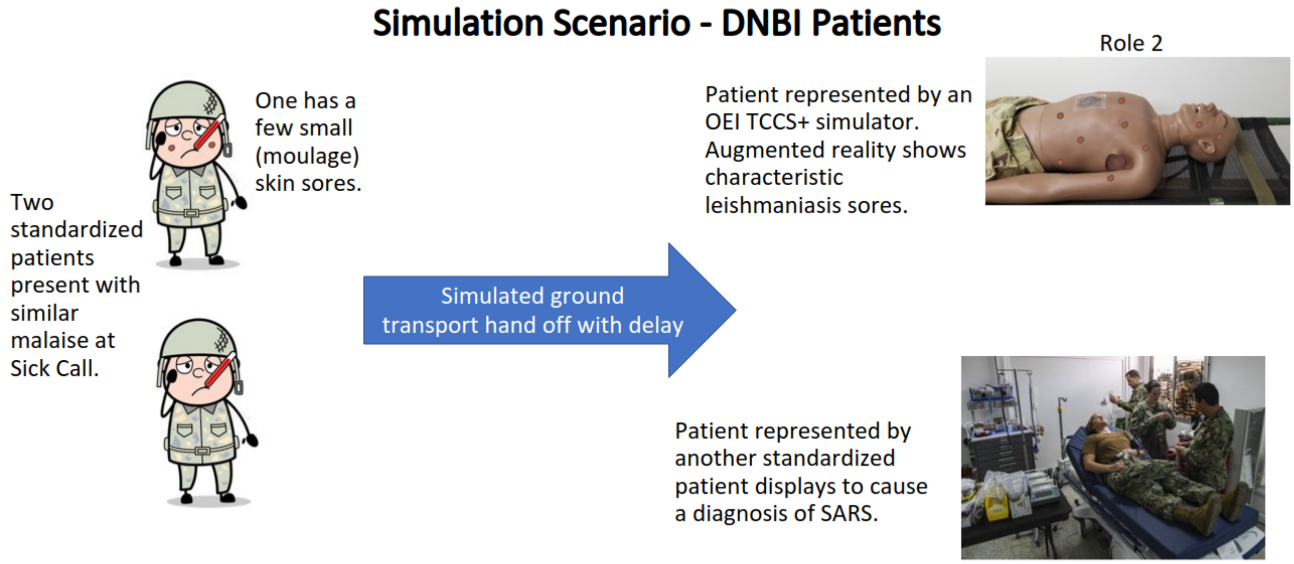

Figure 14 – Synchronous DNBI Scenario

This scenario is capable of running concurrently with the trauma scenario and the learner medic evaluating two soldiers (standardized patients – one with moulaged skin sores) presenting at sick call with a similar general malasie. The instructor was responsible for manually controlling the vital signs for each DNBI patient to allow the learner to better diagnose each patient. Once the medic completed an initial evaluation, he completed a DD Form 1380 on each soldier. The soldiers each carried their own DD1380 form to the next role of care, where the forms were given to the Role 2 instructor and learner. Because these patients are on the same federation throughout the transfer, the physiology vital signs set by the sick call instructor were maintained at the Role 2 event, where the Role 2 instructor could update them further if needed.

The patient without the skin sores was instantiated as a standardized patient. The vitals monitor displayed the vitals that represented a patient with SARS and the patient wore a simulation vest that caused the medic's simulated stethoscope to replicate the auditory outputs of a SARS patient.

The patient with the skin sores was instantiated in an OEI TCCS+ manikin. The skin sores were generated using augmented reality and viewable with an Android tablet positioned over the manikin. The performance capture system also functioned as it did during the trauma scenario providing a detailed record of learner performance.

Demonstration Module 3 – Remote Demonstration – 10 March 2022

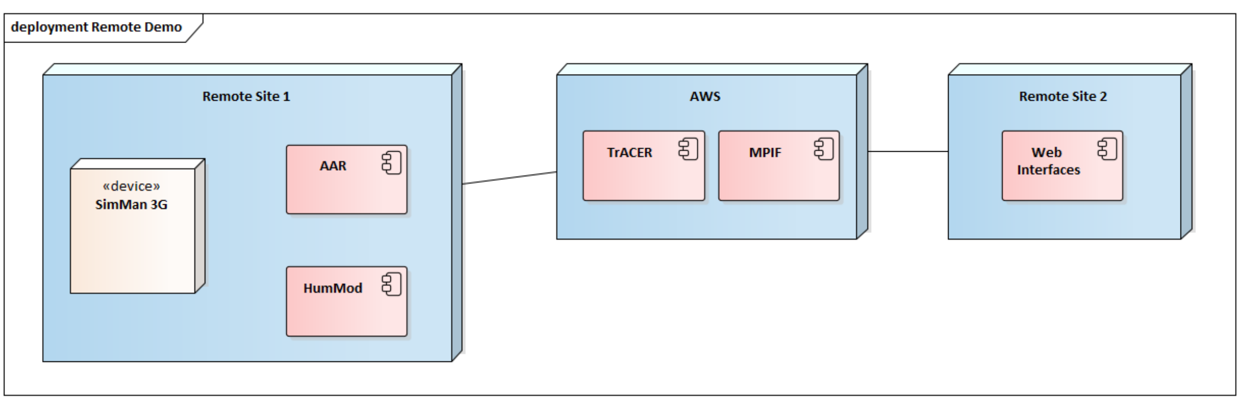

Figure 15 – Remote Demonstration Configuration

The remote instruction demonstration was configured to connect two remote sites using the JETS federation. A central AWS server hosted cloud versions of TrACER along with one instance of MPIF, the backend for the MMS Control software. The first remote site is where the learner and one operator were located and includes a micro system consisting of a SimMan 3G, AAR system, and HumMod. The second remote site is where the instructor was located. The instructor accessed TrACER and MPIF (MMS Control) via web browser.

The instructor had access to a screen share of the AAR system, allowing the instructor to see all of the learner's actions. The instructor then used the web interfaces to both assess the learner and to control the federation through the MMS Control interface.

Demonstration Module 4 – Individual Features – Presented 25 February

In addition to the Trauma and DNBI scenarios, three other side demonstrations were created and presented. The first was a short technical demonstration. IVIR Inc. demonstrated that a user can set a desired time scale for a physiology engine on the JETS federation, using control software IVIR Inc. developed. The physiology engine will then run at the set time scale, modeling the patient in faster than real time operation. This functionality was created during the PFC project and improved during JETS III.

The next side demonstration involved integration with OneSAF. This was chosen as an analog for the Army STE program to show how medical simulation can be directly connected to combat simulations. In this regard, IVIR Inc. showed two main capabilities: casualty generation and vehicle movement controls.

When OneSAF generates a casualty, it can send the relevant information, like injury type and severity, to JETS. JETS will handle the high-fidelity medical training and report casualty vital signs back to OneSAF. JETS can send MEDEVAC requests to OneSAF and OneSAF will dispatch a vehicle, provide ETA data and notify JETS of vehicle arrival.

The third side demonstration involved showing a logistics model, AnyLogic, that was used to model an infectious disease scenario in a Role 2 facility. If the SARS patient from the DNBI scenario was not properly diagnosed and quarantined, that patient would be able to spread the disease in the facility. The AnyLogic disease model was used to show how a single infected patient could spread disease to a provider, who then continues spreading the disease to other patients.

Design Considerations for the JETS Demonstrations

IVIR Inc. created scenarios that illustrate the capabilities of the JETS system and demonstrations that match the interest of the military clients. As part of this effort, IVIR Inc. coordinated with the sites chosen to host demonstrations of the system, investigated each site's networks and network capabilities, and identified any specific needs for each site.

Once the capabilities and scenarios were defined, IVIR Inc. designed the system federation. This step included the design of the overall system and each of the federates that are used in the demonstration, including where each federate will be located. During this step, the following was done:

- Researched and selected the federates to be used in a demonstration, then designed the required modifications for each federate and investigated the interoperability of mismatched fidelity levels between simulations
    - Each federate was analyzed to determine what data from the MMS FOM it could publish to the federation and what data it could subscribe to from the federation. Each federate was given specific code to enable the right set of published and subscribed data once the federate was on the federation.
    - The patient scenarios were matched to individual federate capabilities, and mapped to the relevant MMS FOM objects and interactions.

  - When necessary, federates were modified to support the specific patient scenarios used in the demonstration, including altering patient history text and mission objectives.
- Provided an open source, cross-platform HLA Run-Time Infrastructure (RTI) implementation to support the operating systems and programming languages used in modern medical and military simulations
  - The Portico RTI was chosen for its capabilities on a distributed network, along with its open source nature.
- Identified synchronous and asynchronous instances within a demonstration where appropriate
- Identified the types of data that will be transferred at each point during each event
  - Aside from the data shared on the federation within each micro system and each training site, the design accounted for data that had to be shared across the distributed macro system. This focused on patient status, learner performance assessment, and patient handoff forms.
- Investigated and designed a multi-layered architecture approach, including identifying capabilities best handled by HLA or a web-based technology such as REST
  - Some individual federates were not able to become directly HLA compliant due to the limited nature of the system's application programming interface (API). To address this limitation, the MMS Control software was developed to include non-HLA interfaces including a REST API and MQTT. This allowed non-HLA systems to still participate on the JETS federation.
- Designed the demonstrations to match the architecture design and identified difficulties with future implementation strategies
  - See next section "JETS Demonstration Design Challenges" for details.
- Investigated the capability to integrate with Army Synthetic Training Environment (STE). The STE medical working group was briefed on the capabilities of the JETS architecture for future possibilities
- Investigated and acquired a surgical simulation capability for inclusion into Role 3 event, to include HLA integration, data capture and documentation
  - The surgical simulation system was used for the REBOA procedure. The surgical system was able to receive vital signs from the federation, and publish treatments and events when certain key learner actions were performed.

After the demonstrations were selected and the federation was designed, IVIR Inc. built the system and integrated each of the federates. It also expanded the MMS FOM that was initiated in Phase II, continued modification of each of the federates to meet the needs of the demonstration and integrated the federates with the HLA federation. The team also developed the gateways, or integration points, between the different architecture layers or different architectures as needed for each event. While the local micro system integration points were handled with software bridges (like the REST API), integration between different micro systems spread across different sites required integration over an internet connection. To ensure that federations at each site could integrate with each other, a gateway and portal solution was used. Each site contained one gateway or portal, which could communicate with a centralized gateway located on a cloud server. With each site connected to the centralized gateway, the portals acted as federation traffic managers and allowed the necessary data to be shared among all local federations.

JETS Demonstration Design Challenges

During the development of the JETS architecture, the primary technical challenge faced involved the use of cellular hotspot networks. Building a distributed federation across multiple sites requires each site to have a connection to the internet in order to share data with the other sites. However, the JETS architecture does not currently have an Authority to Operate (ATO) on Government networks. As a result, the demonstration system utilized cellular hotspots for internet access at each site.

The Portico RTI requires a handshake process between all federates as they join the federation so that each federate is aware of the other federates on the federation. If this handshake process is interrupted or is not completed properly, it can result in several types of failures. One type of failure is limited to the single federate that attempts to join but fails the handshake in which case that federate can attempt to rejoin at a later time. The second, more significant failure, is when the handshake process fails to properly recognize that each federate's FOM is the same, creating a widespread communication failure between all federates. This second error requires a full federation reset.

Cellular hotspot networks have more instability than permanently installed networks, especially in areas with poor data network coverage. The cellular network can experience latency spikes and network brownouts that impact data transfer of the systems on the network. If these latency spikes or brownouts occur during specific parts of the federation handshake process, it can lead to one of the two issues described above.

Three solutions were designed to minimize this challenge. First, Portico settings were adjusted to be more tolerant to interruptions during the handshake process. Longer buffer timers were added to the process to give federates more time to complete each part of the handshake (increased from 1 second to 10 seconds). Additional logic was also added to Portico to better handle the FOM merging errors during the handshake with the intent to limit errors to the single joining federate rather than the entire federation. These Portico updates greatly reduced the frequency of these errors but still did not provide a high enough reliability in the process.

The second solution was for IVIR Inc. to develop a proxy portal solution. Each site would use a single portal as its access point to the central portal and all federation data would be shared through these portals to other sites. The primary intent of these portals was to reduce the number of handshakes required in a distributed federation. The original handshake process required a handshake between each individual federate across all sites. The new portal solution required a handshake once between each site. The portals also contained logic to temporarily store data from their respective local federations in the event of a network loss. The portals would then release that stored data to other sites once connection was restored preventing the loss of data during a training event. This portal solution was successful in resolving the handshake issues caused by hotspot network instability, however, it did not account for all possible failure modes including a portal shutting down in the middle of a simulation.

The third solution, which was used during the synchronous demonstration, was to keep the federations at each site as fully local federations. Rather than sharing all federation data through a live internet connection limited by hotspot networks, the critical data from each local federation was instead stored on a cloud-based LRS where it could be accessed by all other sites when needed. This solution was used in the patient handoff process for the trauma patient, from point of injury to en route care. The patient state was saved as a file at the end of the point of injury event and uploaded to the LRS. The learner's hand-written DD1380 was captured as a picture, and that picture was also uploaded to the LRS. Then, when the en route care event was ready to begin, the en route care federation downloaded the data from the LRS. The patient file was then loaded into a local HumMod instance while the DD1380 picture was printed. This solution allowed the patient to be seamlessly picked up by the en route care event, with all prior treatment history in tact.

Future Technology Recommendations

Based on lessons learned from this project, IVIR Inc. has two high priority technical recommendations for future efforts. The first is to decouple the federation join and resign process from a system's start and stop process. Currently, several of the systems in the JETS demonstration system automatically join the federation when the software is launched and resign from the federation when the software is closed. While this reduces the steps needed to federate, it prevents troubleshooting and recovery processes in the event of federation or network issues. Ideally, a system should be able to join or resign from the federation without affecting its system's operation. For example, if the HumMod or AAR federates needed to resign from the federation and rejoin later to resolve a network issue, the physiology model and AAR recording would have to stop completely causing an interruption in training. If these systems could resign and rejoin in the "background" of their main process, then the model or recording could keep running while the issue was being resolved.

The second recommendation is to improve customization of the MMS Control system. Currently, customization is limited to a few variables in text-based properties and scenarios files. While the user can edit these files, they require a higher level of technical expertise to properly edit. Instead, the MMS Control system can be enhanced to provide a setup page that allows the user to choose their modules, assign IP addresses more easily, and provide a more graphical based page for core system properties. These customized properties include identifying the sending and receiving system for a patient handoff, identifying an instructor station or a global view station, setting patient identifiers, and choosing which panels are available on the interface for each individual training event.

Future Technology Ideas

- Enhance integration with tactical systems (like OneSAF)
- Enhance integration with full logistics modeling (equipment, resource tracking)
- Add automation of checklist scoring, where possible (reduces instructor workload)
- Expand to a larger macro system setup where simulated data can feed into a more central command center type environment

JETS Program Considerations

The DoD should consider making JETS a program of record, because it has the ability to create multi-echelon training, including individual, team (Joint), and multiple Roles of Care, into a cohesive exercise, using COTS equipment, and without regard to time and distance. It can connect to tactical simulations as well as medical simulations.

JETS will only become a reality if the DoD adopts it as a standard and requires JETS compatibility as a requirement for future purchases. Although the simulation industry views JETS in a favorable light it will not adopt JETS as an industry standard unless the DoD fully embraces it.

An agency should be responsible for maintaining the JETS standard. SISO currently does that for NATO for HLA, which may or may not, be appropriate for JETS. DMMSO, or another, DoD agency, may be more appropriate.

System Licenses

The table below lists the licenses necessary for the JETS demonstration system.

JETS System Licenses	
Software	**License Type**
Pitch Developer Studio	Hosted on USB Key and txt file
Pitch pRTI	Hosted on USB Key and txt file
Pitch Talk Admin	Hosted on USB Key and txt file

Pitch Talk RPR-DIS Gateway	Hosted on USB Key and txt file
Pitch Visual OMT	Hosted on USB Key and txt file
Portico RTI	Open Source
AnyLogic	Hosted on USB Key
OneSAF v9.0	Government provided
TC3Sim	Government provided
Laerdal SDK, non-commercial	URL Download
Laerdal LLEAP	Embedded on hardware
SimulationIQ Mobile AAR	Embedded on hardware
TrACER	Embedded on hardware

Figure 16 – JETS Systems Licenses

System Technical Documents:
Reference Annex A: Medical Modeling & Simulation Federation Object Model (MMS FOM)
Reference Annex B: APIs and/or protocols, including development of the gateways
Reference Annex C: JETS system licenses
Reference Annex D: Demonstration User Manual
Reference Annex H: Demonstration Design Document

Instructional Design Expert System (IDES)

As discussed above, the simulation micro system is a key aspect of JETS and can consist of multiple commercial simulators and part-task trainers, a physiology engine, an after-action review (AAR) system, and a learning management system (LMS) from different manufacturers. While this creates a powerful, integrated instructional delivery system, success is still dependent on the ability of individual instructors to deliver and manage the instruction.

Military clinical instructors are often not experienced teachers before being assigned as instructors, as they are usually chosen based on their demonstrated clinical expertise. While some level of instructor training is often provided, the dynamic nature of military medicine today, particularly in terms of the clinical technology as well as the instructional technology, can create significant challenges for even an experienced clinical instructor. Although not within the original scope of this project, the need for the IDES was identified, and the development of an initial prototype was incorporated into this project.

What the IDES aims to do is to provide an instructor with a computer-based expert system, that guides the instructor in transforming clinical practice guidelines into an integrated lesson plan and performance assessment checklist. IDES can be used to support the planning, execution and assessment of any clinical training. The expert system is the first component of IDES. This will guide the instructor (or curriculum developer) in first creating the Instructional Goal (the task a learner is expected to perform in the real world under which conditions and to what standard) and the Terminal Learning Objective (TLO) which is the task (or observable behavior) the learner is expected to perform (under given conditions to a specific standard) after completing the instruction. The IDES will then continue to guide the instructor in creating the Enabling Learning Objectives (ELO) that a learner has to master in order to achieve the TLO.

As each ELO is created, the instructor will be guided in determining its nature (Attitudinal, Cognitive, Psychomotor, or Verbal Information). This classification will then be used by the expert system to provide suggestions to the instructor on how best to present the learning material for that ELO. After completing this process, the expert system exports the results into the Lesson Plan and associated Performance Checklist. This completes most of the Lesson Plan, and what remains will be creating the administrative instructions for initializing and using the simulation(s) and simulation support devices as well as any relevant notes. When completed, the Lesson Plan and associated Performance Checklist will be stored.

During a JETS-enabled training event, the lesson plan and performance assessment checklist are accessed as a web interface on the handheld tablet the instructor uses to control the JETS microsystem. During the delivery of instruction, the instructor can use the performance assessment checklist as an aid in providing the learner formative performance feedback. The timestamps on the performance assessment checklist are synchronized to the timestamps of the AAR video recording, so during the debriefing process the instructor can quickly reference key moments on video while reviewing the scored checklist. Currently, IVIR's web-based system, TrACER™, is used to administer the lesson plan and performance assessment checklist. The results of the scored checklists are stored as xAPI statements in an LRS.

The ability to bookmark the AAR recording is also available during the formal, summative assessment of the learner, and in addition, the TrACER system is capable of automatically recommend remediation to the learner for each failed ELO. By default, the results of each summative assessment will be stored in the TrACER database but are exportable to an LRS. Also, by default, the lesson and performance assessment checklist will be permanently linked to each learner's performance which IVIR believes will be useful in any future summative evaluation of the curriculum.

An initial prototype of IDES is being delivered with the final documentation for this project. For additional information, see Annex H.

3.1.2 GOAL #2: Create and initiate a JETS Website for dissemination of information.

- *Objective 2.1: Develop and, during the PoP, initiate and maintain a Website for the JETS program.*
- *Objective 2.2: Develop and, during the PoP, initiate and maintain a two-way, ongoing information exchange with MSE key end users to engage and interest them in current and future MSE activities and to receive and transmit their feedback on the MSE program to Government.*

Summary

The JETS website (https://jets-systems.com) was designed to be an information repository for JETS, for official use only, and to offer a forum for the Government to provide updates and receive feedback on the JETS concept, and opportunities for enhancing joint military medical training. This includes portions of the professional video taken during the JETS III demonstration as well as an animation that was created to better explain how JETS works. What follows below is an outline of the Website:

- The JETS Home Page provides a basic foundation for the program:
    - Site includes an approved JETS logo. The consensus was that the logo design and colors represented the program's initiative and were agreed upon by government entities such as JPC-6, MEDCOE, and DMMSO representatives.
    - In addition, the Executive Summary offers a brief overview of the research efforts to focus on education and training which entails optimization or learning from a cognitive perspective and into psychomotor skillsets.
    - There are five supporting objectives for JETS with subsets of information explaining what each objective provides:
        - Team and Capabilities Based Training
        - Maximize Casualty Care Treatment in Operational Theaters
        - Casualty, Evacuation and Transfer Medicine
        - Utilize Training Tools (Live, Virtual, Constructive, Gaming)
        - Implementation, Execution, Effectiveness and Safety
    - Supports Joint Medical Training: displays a list of agencies that the JETS architecture could possibly be integrated into while utilizing their current systems and COTS products.
    - A site map allowing access through the JETS website pages.

- Explanation on "What is JETS?"
    - Provides a Program Description
        - The summary explains that JETS enables standardized, integrated, state-of-the-art training through an interconnected web of systems designed to serve as joint simulations to track patient movement from the Point of Injury (POI) to a controlled medical area.
        - The second section explains how JETS is a system of systems and could be utilized to address, offer, support, leverage, and enable learning from the individual or group level to reduce ineffective training.
        - The third section lists a few of the DoD challenges that JETS, if implemented, could address.
        - The following section focuses on the Project Summaries
            - Project Summary 1: Within the MSE arena, various independent subsystems support Service and organizational-specific missions.
            - Project Summary 2: Proper medical training ensures that service component members are prepared for wartime deployment to support en route care for patients from the POI through several echelons to the Continental U.S.
            - The JETS Phase III Project Summary is the final section and explains how JETS could help with proficiency and use in the medical simulation industry support systems to communicate using a federated network over a standard internet connection. Thus, creating a microsystem representing a single customized patient.
    - Program Objectives:
        - Learning
            - Explains tailoring the JETS system to your training program to reduce the entities' costs based on their budgets.
        - Impact
            - This section shows the impact of what JETS could provide the end-user. Each section has a drop-down providing additional insights for each topic. Such impacts are:
                - Modularity, Flexibility, and Interoperability
                - Accountability and Cost-effectiveness
                - Enhanced Rigor
                - System of Systems and Platform Collaboration
                - Measurable Results
            - Implementation – JETS at maturity will provide the user with a learning tool that enhances medical training. The system could provide efficiency and unified training assessments and insights regarding training processes.
- Explanation of "How Does JETS Work?"
    - Identifies the JETS System Main Features
        - This area assists the reader in understanding the concept of JETS and how it can be used to create a federation among various medical devices, support, and learning management systems. JETS is projected to be linked with combat simulations in the Synthetic Training Environment. The system is modular and scalable and captures the training exercises' data.

            - The second section consists of features for JETS integration with existing training sites and equipment.
                - With current training sites and existing equipment
                - Deployment of POD training capabilities utilizing Live, Virtual, Constructive, and Serious Gaming training methods
                - Allows for Global Training which could decrease the need for additional training sites
                - Learning management system that is customizable and supports the learners' strengths and learning styles
    - Structures and Systems
        - Provides basic components of the JETS system and identifies the material associated, such as (Human Patient Simulators, Part task trainers, Physiology Engines, Learning Management Systems, After Action Reviews, Combat Simulations, etc.)
        - The second section describes the Micro, Macro and Mega Systems as they apply to JETS
- JETS in Action Page
    - Describes the JETS Phase III Demonstrations
        - The executive summary focuses on validating the architecture in previous phases. The system provides designs displaying the capabilities of the JETS system. The demonstration showed the connective tissue, evacuation, network capabilities, and roles of care the JETS architecture provides. Images and videos are provided to show the JETS system in action.
    - Use Case and Studies
        - Illustrates a collection of several independent demonstration segments that each showcase a key feature of JETS. In addition, the system collects data proving that information is captured to display overall performance (documentation, videos, etc.)
- Program Roadmap
    - Provides the timeline of the JETS program
    - Lists the major goals of the phase III program:
        - Evaluate the effects of evacuation and medical care applied outside doctrinal guidelines
        - Incorporate core capabilities medical personnel must possess to provide care in austere environments when evac is delayed
        - Examine the training needs of prolonged field care over requirements of Tactical Combat Casualty Care (TC3)
        - Offers a training system that will enable training execution, tracking, and assessment
- Frequently Asked Questions (FAQS)
    - The FAQS page lists questions and responses the user, learner, or reader may have. There are questions listed along with the answer provided. The answers could change as the JETS Program evolves.
- News Page
    - The news page includes information on events that have occurred during JETS Phase III.

- Contact Page
  - The contact page lists the entity or individual overseeing the JETS architecture and/or program. In addition, there is a contact box if an individual or entity may have additional questions or inquiries on JETS.

The delivery for the JETS website to the Government includes access to the site, domain name (valid through Oct 2022), administrative rights, all content to included images and videos presented on the site. See Annex E for details.

3.1.3 GOAL #3: Create a Multiple Channel Marketing Plan.

- *Objective 3.1.3.1: Create appropriate messaging that describes the JETS/PFCT modular systems.*
- *Objective 3.1.1.2: Create messaging through multiple channels as approved by Government.*

Summary

IVIR Inc. was initially tasked with conducting MSE propagation and advocacy so as to achieve "buy-in" from key stakeholders. This was to be accomplished by discussing content and process to demonstrate how the MSE program is a practical, achievable and desirable means towards achieving the goals and objectives of the organizations key stakeholders lead or represent. Joint Program Committee-6 (JPC-6), however, asked IVIR Inc. to instead move from an advocacy approach, to a multi-channel marketing approach, that addressed the modular nature of the JETS system and its ability to support identified DoD medical training gaps and challenges. To accomplish this, IVIR Inc. performed work as discussed below.

<u>Segment 1 - Created appropriate messaging</u>

IVIR Inc. worked with JPC-6 to create a name that appropriately describes the JETS modular system. The team agreed to change JETS meaning to: Joint Emergency Trauma Simulation (JETS) which better fits the current function and needs of the MSE mission.

Once name and meaning of "JETS" was settled, IVIR created messaging that communicates the following regarding JETS:

> *"As a modular system JETS allows COTS and GOTS components to be combined to meet individual, collective, multi-echelon and joint clinical training needs and is compatible with tactical simulations. The core functionality of JETS is that it allows current, commercial off-the-shelf, medical simulations, and simulation support systems, to communicate with each other, in a federated network, over a standard Internet or intranet connection. This allows multiple simulation components to be combined to create a training micro system representing a single, customized simulated patient. The program also allows simulated patients to be digitally transferred to other patient simulators as an analog of the transfer of real-world patients through the various MHS Roles of Care.*
>
> *JETS can support the full range of military clinical training to include TC3, PFCT, and care at Roles of Care 1 through 3 including patient hand-off and care during patient transfer.*
>
> *JETS is designed to reduce instructor workload as JETS focuses on ease of use and automation of many instructional tasks."*

On completion of the name and messaging a logo for JETS was created and approved by the Government as shown in Figure 17 below.

Figure 17 – JETS Logo

Segment 2 - Communicated messaging through multiple channels.

The messaging created in Segment 1 was transmitted through multiple channels approved by the Government. This was accomplished as follows:

- IVIR Inc. participated in multiple trade shows and conferences. JETS information has been shared over eleven military and/or public forums during Phase III.
- Two articles on JETS were written and published via Healthy Simulations (https://www.healthysimulation.com), which is a major, commercial, news website focused on the medical simulation industry and academic community. Together, the articles generated 2,500 views through Healthy Simulation and social media links. Banner advertisements, with the approved JETS message, were also published by Healthy Simulation. These consisted of three different image types, three different tagline types, with two different ad sizes per. Healthy Simulation reported, that together, generated 123,035 online advertising impressions.
- Bill Lewandowski, the IVIR Inc, COO met with simulation Original Equipment Manufacturers (OEMs), as well as the Society for Simulation in Healthcare (Mr. Lewandowski sits on its Governance Committee), to discuss JETS and its potential positive impact on the simulation industry if adopted. The OEMs included, CAE, EMS, Laerdal, OEI, Surgical Science, and TacMed Solutions.
- Bill Lewandowski also gave several presentations to NATO representatives to include Mr. Robert Seigfried, Chair of the NATO Modelling and Simulation Group (NMSG).

See Annex F for details of articles, publications, abstracts, and presentations.

4. PROGRAM SUMMARY

The Program summary includes the organization structure, program deliveriables and a month by month account of work performed summary. This content has been included as an annex since this information has been reported in various previous reports. See Annex J for further detail.

5. PRODUCTS

5.1 PUBLICATIONS/PRESENTATIONS/POSTERS/PANEL PARTICIPATION

The table below illustrates a list of articles, publications, presentations and abstracts that were submitted during the Phase III effort.

MEDIA TYPE	DOCUMENT	TITLE	AUTHOR(S)	SUBMITTED AND/OR PRESENTED TO	DATE
Slide Deck	MHSRS-19-01087_Tue_1300_Honold_.pptx	Enabling Joint Medical Modeling and Simulation Training with a Standard Data Object Model	Erin Honold, Damon Curry	MHSRS	August-19
Abstract	IVIR Abstract 2020 MHSRS	Medical Simulation in Support of Multi-Domain Operations	David J. Litteral	MHSRS	August-20
Slide Deck	SIW Modular FOM Presentation 2-17-20 UPDATED	Enhancing Simulation Composability and Reuse with Modular FOMs 2019-SIW-Presentation_013	Dannie Cuts, Damon Curry, Erin Honold, William E. Lewandowski II, David J. Litteral	SISO "Simulation Interoperability & Reuse through Standards"	February-20
Slide Deck	AMSUS Presentation Slides v.1	Development of a Prolonged Field Care (PFC) Training System: Harnessing the Federation of the Joint Evacuation and Transport Simulation (JETS) System	David J. Litteral	AMSUS Annual Meeting	October-21
Abstract	IVIR Abstract 2021 MHSRS v.3	Developing a Modular Medical Modeling and Simulation Training System for the Next Generation of Providers in Support of Multi-Domain Operations	David J. Litteral	MHSRS 2021	August-21
Abstract	ITSEC 2021 v.2-final	Developing Micro and Macro Simulation Systems for Training Tactical Healthcare Personnel	David J. Litteral	I/ITSEC	December-21
Abstract and Paper	IVIR Paper_IITSEC2021v.1	Developing Micro and Macro Simulation Systems for Training Tactical Healthcare Personnel	David J. Litteral	I/ITSEC	December-21
Abstract	MODSIM 2022_DAVID LITTERAL_26	Introduction of the Joint Emergency Trauma Simulation (JETS) System	David J. Litteral	MODSIM 2022	May-22
Slide Deck	AMSUS 2022 PPT v.1	Developing Modular Micro and Macro Simulation Technology for Training Tactical Healthcare Personnel	David J. Litteral	AMSUS	January-22
Article	JETS Article	U.S. DoD JETS Project Connects Multiple Commercial Clinical Simulation Systems Under One Dashboard	William Lewandowski	U.S. DoD JETS Project Connects Multiple Commercial Clinical Simulation Systems Under One Dashboard | HealthySimulation.com	Published October 13, 2021
Article	Instructional Design Expert System (IDES)_ An Instructional Support System for Medical Simulation Instructors _ HealthySimulation.com	Instructional Design Expert System (IDES)_An Instructional Support System for Medical Simulation Instructors_Healthy Simulation.com	William Lewandowski	https://www.healthysimulation.com/35602/ivir-instructional-design-expert-system/	Published 2/19/2022
Slide Deck	IVIR JETS III Pres_23 Feb 22	Joint Emergency Trauma Simulation (JETS) Previously Prototype of Joint Evacuation and Transport Simulation (JETS) System Technology Demonstration Asynchronous Demonstration System	William Lewandowski	JPC-6 Previously JPC-1	February-22
Slide Deck	IVIR JETS III Pres_25 Feb 22 Final	Joint Emergency Trauma Simulation (JETS) Previously Prototype of Joint Evacuation and Transport Simulation (JETS) System Technology Demonstration Synchronous Demonstration	William Lewandowski	JPC-6 Previously JPC-1	February-22

5.2 OTHER REPORTABLE OUTCOMES/PRODUCTS

The following are the products generated during the course of the Phase III program:

- Programmatic:
  - Phase III Project Plan in MS Project
  - Phase III QCP
  - Phase III WBS
  - Weekly Program Meeting Minutes
  - Monthly Program Meeting Minutes
  - Monthly Program Status Reports
  - Quarterly Program Status Reports
  - Annual Program Status Reports

  - Final Technical Report
- Traceability Matrices
  - Tactical Field Care – Patient Simulators Capabilities Matrix Included in Annex K
  - JETS Stakeholders Matrix – The Matrix resulted in contact with 43 different DoD agencies that have a medical training requirement which the JETS system can impact. These agencies fall across all military organizations (Army, Navy, AirForce, Reserves, National Guard, Operational, etc.). Stakeholder Matrix is included as Annex G

6. ACRONYMS

Reference APPENDIX A: ACRONYMS for a listing of acronyms contained in this Phase III Final Technical Report.

7. EXTERNAL DOCUMENTS

Annex A: Medical Modeling & Simulation Federation Object Model (MMS FOM)

Annex B: Integration Code, APIs, Protocols and Gateways

Annex C: Licensure to Reuse Technology

Annex D: Demonstration User Manual

Annex E: JETS Website Access

Annex F: Articles, Publications, Abstracts and Presentations

Annex G: Stakeholder Analysis Matrix

Annex H: JETS Extended Demonstration Design Document

Annex J: Program Summary

Annex K: Simulation Matrix-Tactical Field Care

APPENDIX A: ACRONYMS

ACRONYMS	MEANING
AAR	After Action Review
AFMMAST	Air Force Medical Modeling and Simulation Training
AMSUS	Associations of Military Surgeons of the United States
AOR	Area of Responsibility
API	Application Program Interface
ATO	Authority to Operate
CASEVAC	Casualty Evacuation
CDC	Centers for Disease Control
CDD	Capabilities Development Document
CDMRP	Congressionally Directed Medical Research Program
CDRL	Contract Data Requirements List
CESI	Cole Engineering Services, Inc.
CONUS	Continental United States
COTS	Commercial Off the Shelf
COVID-19	Coronavirus Disease 2019
CW	Content Workshop
DA	Distribution Agreement
DECM	Delayed Evacuation Casualty Management
DHA	Defense Health Agency
DMMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
ECS	Engineering and Computer Simulations
ERC	En Route Care
FAQS	Frequently Asked Questions
FOM	Federation Object Model
GCS	Glascow Coma Scale
GFE	Government Furnished Equipment
HCG	Human Chorionic Gondadotropin
HLA	High Level Architecture
ID	Identification
IDES	Instructional Design Expert System
I/ITSEC	Interservice/Industry Training, Simulation, and Education Conference
IMSH	International Meeting for Simulation in Healthcare
IPR	In Process Review
IVIR Inc.	Information Visualization and Innovative Research, Inc.
JETS	Joint Emergency Trauma Simulation

ACRONYMS	MEANING
JPC-1	Joint Program Committee-1
JPC-6	Joint Program Committee-6
JPM	Joint Program Manager
LMS	Learning Management System
LRS	Learn Record Store
LVCG	Live, Virtual, Constructive and Gaming
M&S	Modeling and Simulation
MCOE	Medical Center of Excellence
MEDEVAC	Medical Evacuation
MHS	Military Health System
MHSRS	Military Health System Research Symposium
MMS	Medical Modeling and Simulation
MRMC	Medical Research and Materiel Command
MSE	Medical Simulation Enterprise
MSIS	Medical Simulation and Information Science
MTEC	Medical Technology Enterprise Consortium
NAWCTSD	Naval Air Warfare Center Training Systems Division
NCE	No Cost Extension
NDA	Non-Disclosure Agreement
NMMAST	Navy Medical Modeling and Simulation Training
NTSA	National Training & Simulation Association
OEM	Original Equipment Manufacturer
OIICS	Occupational Injury and Illness Classification System
PFC	Prolonged Field Care
PFCT	Prolonged Field Care Training
PMMST	Program Manager, Medical Simulation and Training
POC	Point of Contact
POD	Point of Demand
POI	Point of Injury
POINTS	Point of Injury Training System
POP	Period of Performance
QCP	Quality Control Plan
REBOA	Resuscitative Endovascular Balloon Occlusion of the Aorta
ROI	Return on Investment
RPR	Real-time Platform Reference
RTI	Run Time Infrastructure

ACRONYMS	MEANING
SISO	Simulation Interoperability Standards Organization
SIW	Simulation Innovation Workshop
SME	Subject Matter Expert
SNOMED-CT	Systematised Nomenclature of Medicine-Clinical Terms
SOTR	Subcontracting Officer's Technical Representative
SOW	Statement of Work
STE	Synthetic Training Environment
TC3	Tactical Combat Casualty Care
TLA	Total Learning Architecture
TRANSCOM	Transportation Command
USAMRMC	United States Army Medical Research and Materiel Command
USAR	United States Army Reserve
USUHS	Uniformed Services University of the Health Sciences
VA	Veterans Administration
VPN	Virtual Private Network
WAN	Wide Area Network
WBS	Work Breakdown Structure
xAPI	Experience Application Program Interface