Technical challenges and solutions in merging GIESim and JSAF

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ABSTRACT

The merger of the GIESim JTIDS simulation with JSAF added tactical communications modeling to JSAF, and posed several challenges that are overviewed along with solutions and lessons learned. Tactical communications play an increasingly critical role in military operations. JSAF is a large multi-forces simulation that is often employed for war-gaming, however JSAF currently does not model tactical communications. Also the merger of the JTIDS/Link-16 capabilities from GIESim with JSAF is a first step toward applying the GIESim rapid communications modeling approach to a large simulation environment.

This paper addresses the physical and logical simulation architectures, modifications of HLA interfaces and internal logic, determination of mission goals and scenario development, associated network design, and component integration associated with the GIESim-JSAF merger. Both JSAF and the GIESim JTIDS simulation were modified to allow JSAF to pass a message through the JTIDS simulation. Substantial work was required to make this happen. Perhaps the greatest challenge was that JSAF did not have logic to handle tactical communications at all. Furthermore, JSAF needed to drive platform position updates into the JTIDS simulation so that accurate radio propagation calculations and correct network transmissions would occur.

M&S interoperability between JSAF and the JTIDS simulation needed to be demonstrated in a way that tested interoperation and that had a quick impact on an observer. Therefore, an operationally relevant scenario was developed to demonstrate the value of adding communications modeling to JSAF. Current success and future possibilities will be presented.

Keywords: JTIDS, Link-16, simulation interfacing, scenario generation, model interoperability, operationally focused simulation, JSAF

1. INTRODUCTION

For the past three years AFRL's Global Information Enterprise (GIE) Simulation (GIESim) team has been building communications simulations by selecting the "best of breed" simulations and interconnecting them in a distributed simulation environment using HLA. Recently the GIESim team joined forces with the Joint Synthetic Battlespace R&D (JSB-RD) team to merge GIESim tactical communication capabilities into the Joint Semi-Automated Forces (JSAF) simulation. This paper describes the overall challenges and solution from the perspective of the GIESim and the JITDS simulation. A companion paper by J.H.Reaper, et. al.[1] presents similar material from the JSAF perspective. JTIDS stands for Joint Tactical Information Distribution System[2]. JTIDS and the newer Multi-Function Information Distribution System (MIDS) are the widest used, most sophisticated wireless tactical data systems currently in use by the joint services and coalition platforms. JTIDS is used for computer-to-computer communications, and supports a wide range of capabilities including: position and navigation, situation awareness, surveillance, weapons coordination and management, mission control, threat warning, platform status, etc. Some additional information on GIE and GIESim follows.

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The vision of the Global Information Enterprise (GIE) is to move, process, manage, and protect the C2ISR information that supports the functions of Global Awareness and Dynamic Planning and Execution. The mission of GIE is to link aerospace assets in-theater and globally, to integrate C3 & ISR networks, to defend critical information systems from cyber attack, and to develop new information processing and management techniques. Most large-scale force level simulations such as JSAF assume perfect communications. Lack of communications in a simulation environment can lead to the prediction of erroneous results. Tools are needed to bridge these communications modeling gaps.

The GIESim project vision is to define, design and implement a Modeling and Simulation (M&S) framework for the Global Information Enterprise (GIE). Within the GIESim framework users are able to execute, via a common interface, multiple communications and network M&S tools to most effectively and efficiently analyze candidate communications architectures and technologies. The GIESim can interface with other M&S tools (e.g., force-level simulations and detailed hardware system models) to provide the appropriate level of M&S fidelity and processing speed for the broad spectrum of M&S tasks. The GIESim user base spans advanced technology researchers to communications network architects to mission planners.

In FY 2004, the GIESim AFRL/IFGA leadership team set the goal of expanding on and drawing upon the expertise and lessons learned in building prior multi-simulation demonstrations. As a result, the GIESim capabilities were merged into the JSAF simulation at AFRL's Rome Research site in conjunction with the JSB-RD team. The merged GIESim/JSB-RD software added tactical communications modeling capabilities to JSAF by interfacing with the GIESim JTIDS/Link-16 modeling capabilities. JSAF is a JFCOM program that is used extensively for war gaming and large, man-in-the loop exercises. The merger of the GIESim/JSB-RD software leverages prior investments by the Air Force, and was therefore developed for substantially less funding and in significantly shorter time than had the effort been started from scratch. Also, the combined accumulated expertise of the merger team contributed greatly to our success and speed.

This work resulted in the successful merger of GIESim/JSB-RD software, and the merger team can now demonstrate the addition of JTIDS tactical communications to the enhanced version of JSAF using an enhanced version of the JTIDS simulation built by GIESim team member PSI.

With the advent of this merger, JSAF now has tactical communications to support critical Network Centric Operations (NCO) and Warfare (NCW) needed for the future evolution of the Joint Enterprise including the AF C2 Constellation Net, Army/USMC LandWarNet, and the Navy/USMC FORCENet. By virtue of the PSI Link-16 Network Management Tool Suite that our JTIDS simulation is part of, JSAF can now participate in network operational planning in addition to tactical operations training and exercises.

The GIEsim/JSB-RD had to overcome several challenges to successfully realize the merger. These challenges and their solutions are presented in the material that follows. Lessons learned and future program direction possibilities are discussed at the end of the paper.

2. GIESIM/JSAF MERGER REQUIREMENTS[3]

Figure 1 shows the steps that the GIESim/JSB-RD merger team took in merging the GIESim and JSB-RD software. This diagram was created to assist the team in maintaining focus on the steps that we had to follow. The merger requirements were determined over several meetings and email exchanges.

In most cases, we used a Keep-It-Simple (KIS) approach. For the merger, this meant maximizing re-use of prior investments to minimize new developments and to speed realization of the merger, and starting with a simple though effective scenario. The sections that follow in this paper largely follow the sequence in this diagram.

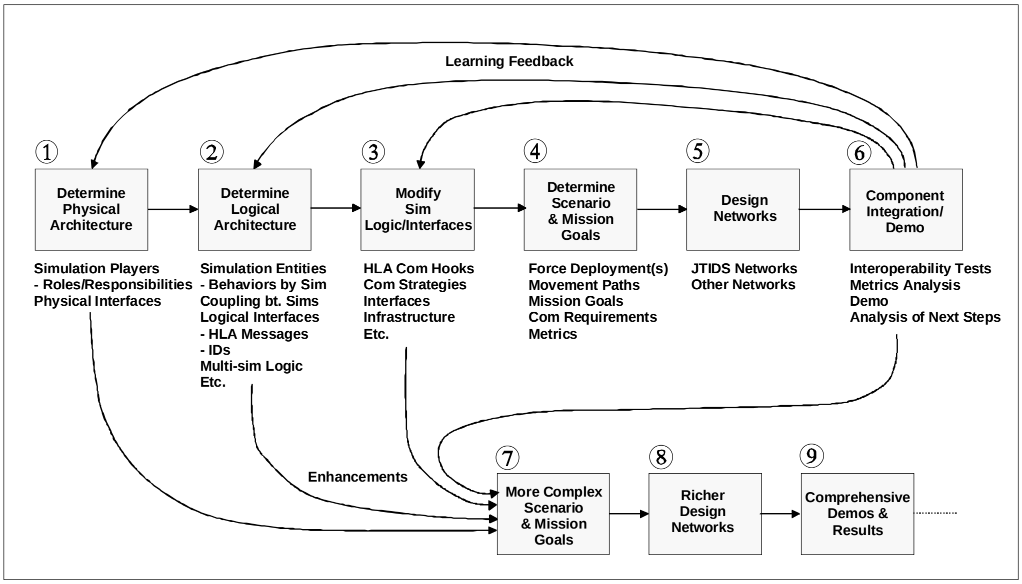

Figure 1 - Steps for GIESim/JSB-RD Software Merger

2.1 Physical Architecture

To determine the physical architecture, the merger team had to select from several GIESim components available. Since tactical communications seemed most important to add to JSAF, the team chose to use the JTIDS simulation from GIESim. This simulation would be interfaced to the main component of JSAF. This relationship is shown in Figure 2.

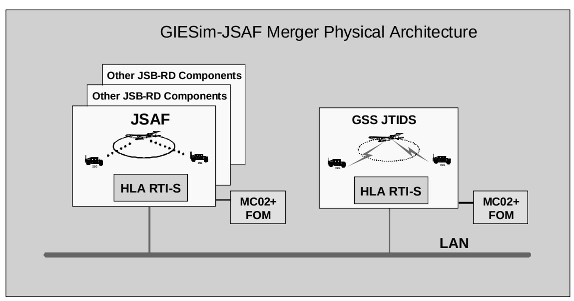

Figure 2 – GIESim-JSAF Physical Architecture

Since JSAF traditionally handles platform motion, we determined that JSAF would retain this role, whereas the JTIDS simulation would provide the tactical communications modeling.

2.2 Logical Architecture

The logical architecture of the merger required: 1) an analysis of the capabilities of JTIDS and the associated Link-16 message set, 2) an exploration of the "messaging" capabilities inherent to JSAF, and 3) behavioral relationships between the JTIDS simulation and JSAF. We had to consider the types of scenarios and missions that might be supported, and the volume of HLA traffic that might be generated. The general view that developed was that platform entities would communicate within JSAF by sending transmission requests to the JTIDS simulation, which in turn would provide a response if the target platform received the transmission. Approximately 40% of the Link-16 messages support destination addressing, so we agreed to provide a single address field in the transmission requests from JSAF to the JTIDS simulation. Link-16 also supports "broadcast" addressing, so we agreed to support a broadcast mode for future use. The team also agreed to initially limit the types of message transmissions to Command and Control, Mission Management, Mission Status and Threat Warning messages as these were deemed more "mission critical."

Both the JTIDS simulation and JSAF required enhancements to support this logical architecture. In addition, corresponding platform entities would have to be in both JTIDS and JSAF so there was a need for a common reference mechanism for referencing platforms across the simulations.

2.3.1 Simulation Interfaces

The merger team faced several trade-offs in development of the simulation interface. Both JSAF and GIESim used HLA. However, JSAF used RTI-S whereas GIESim used the DMSO RTI. Since JSAF has a huge software base, it seemed more cost-effective for GIESim to move to RTI-S. This provided to be more challenging than initially expected. To support messaging between JSAF and JTIDS, the merger team agreed to use modified versions of the HLA interactions that were developed for inter-simulation communication by the GIESim team. However, JSAF was already using the Millennium Challenge 02 (MC02) HLA FOM and used HLA Objects. This required a merger of these FOMs into a new FOM that became known as MC02plus. JSAF also had to make some conversion between HLA Objects and HLA Interactions to support the merger interface. Both GIESim and JSAF needed to, and eventually did, confirm correct operation with the MC02plus FOM.

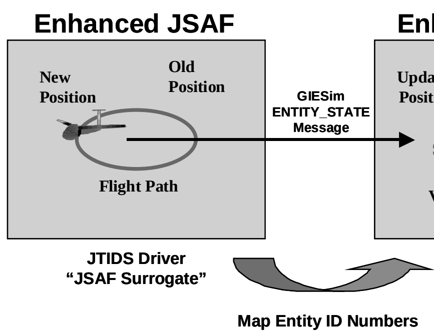

Figure 3 – JSAF Platform Position Updates into JTIDS

Figure 3 illustrates how JSAF sends platform position updates to the JTIDS simulation. Platform positions are critical in the JTIDS simulation for RF propagation calculations. A GIESIM_ENTITY_STATE HLA interaction is used that contains the platform entity ID, LAT LON position, altitude and heading. The entity ID is a unique number for each platform in the scenario that gets mapped to a simulation specific internal platform reference. This interface mapping approach allows each simulation to retain its own internal platform references. The merger team agreed that the JTIDS simulation would generate a hash file for use in JSAF. Note that a JTIDS Driver simulation was built that served as a surrogate for JSAF. This simulation proved invaluable in early testing of the enhanced JTIDS simulation and helped to isolate problems that occurred in early interoperability testing.

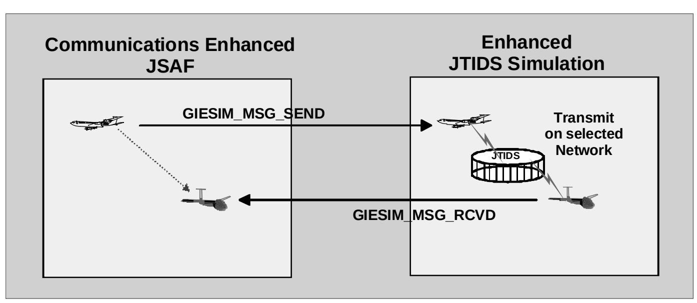

Figure 4 – Message Transmission Request and Response

Figure 4 illustrates a message transmission request from JSAF to JTIDS. JSAF sends a GIESIM_MSG_SEND HLA interaction with the sending and destination platform entity IDs, a JSAF message ID number and size, and a Net Type Number. See next section for details. If JTIDS can find an appropriate network, it will send the message. If the destination platform receives the message, JTIDS will send JSAF a GIESIM_MSG_RCVD HLA interaction with the destination entity ID, JSAF message ID, and accumulated latency.

Tactical communications may fail due to interference, distance, etc. Therefore, the merger team needed to determine how to handle this. Figure 5 shows handling of successful communications and communications failure. The top part of the figure shows successful communications. JSAF builds a message that is intended for a specific platform. Rather than sending the actual message to JTIDS, JSAF sends the message ID and its size to JTIDS with the appropriate addressing, etc. When the target platform receives the message in the JTIDS simulation, the simulation then sends a response to JSAF with the platform entity ID and JSAF message ID. JSAF then processes the message and takes some action.

When a transmission is lost, JTIDS does not send a response to JSAF. This is how communications work in the physical world. JSAF either times out or makes several retransmission attempts[1].

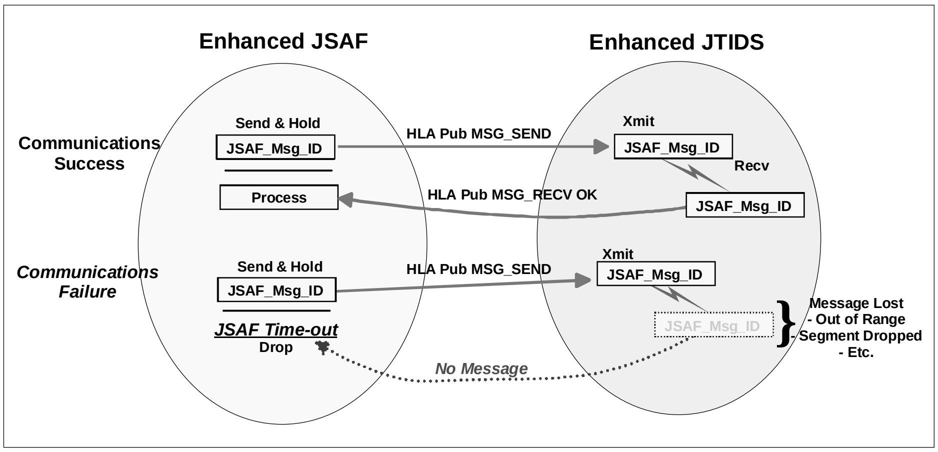

Figure 5 – Communications Message Handling

2.3.2 JTIDS Simulation Model Enhancements

The GIESim JTIDS simulation was modified to support operation with JSAF, which involved position updates and transmission requests from JSAF and message-received responses to JSAF[4][5].

Position Updates: The original JTIDS simulation dynamically updated platform positions from its own scenario file. To support platform updates from JSAF, models were added to take platform position updates externally over HLA. The GIESIM_ENTITY_STATE HLA interaction was used to supply the update data, and Table 1 shows the parameters for this HLA interaction within the JTIDS simulation. JSAF fills in the values for Entity ID, platform heading, platform position in the form of LAT LON data, and platform altitude. The other parameters were not used.

Table 1 – GIESIM_ENTITY_STATE HLA Interaction

ENTITY_TYPE_DETAIL		
1	ENTITY_TYPE	CHAR
1	DOMAINX	CHAR
1	COUNTRY_CODE	INDEX
1	CATEGORY	CHAR
1	SUBCATEGORY	CHAR
ENTITY_ID_DETAIL		**INDEX**
HEADING_DETAIL		**REAL**
WORLD_LOCATION_DATA		
1	**LAT**	**REAL**
1	**LON**	**REAL**
1	**ALT**	**REAL**
SPECIAL_EFFECTS_DATA		INTEGER

Entity IDs: JSAF and the JTIDS simulations each use their own representation of platforms and platform IDs. Rather than make substantive changes to either simulation, the merger team agreed to use a common set of platform reference

[1] J. Reaper, et.al.[1], describes JSAF message handling in the companion to this paper.

numbers or Entity IDs when exchanging HLA interactions. Each simulation would map an Entity ID to or from its own reference to a particular platform. The team agreed to use the unique Entity ID numbers produced by the JTIDS simulation. Hashing the platform names used in the JTIDS scenario file generated these numbers.

Transmission Request & Response: The area of greatest change in the merger was message handling in both simulations. The JTIDS simulation was designed to internally send messages to gather performance data on the quality of network designs. For the GIESim project, modifications had been made to the JTIDS simulation to allow certain messages to pass through the simulation. To support JSAF however, the JTIDS simulation messaging capabilities had to be generalized and significantly expanded.

JTIDS uses many networks between groups of platforms. Each network serves a specific purpose and satisfies specific communications requirements. While there are many networks, there is usually a small collection of network *types*, e.g., mission management networks vs. threat warning networks. The merger team agreed to assign a net type number to each category of networks. The enhanced JTIDS simulation outputs a NETMAPFILE file such that JSAF can reference the type of network needed for a message transmission. This approach attains a certain amount of useful decoupling between JSAF and JTIDS.

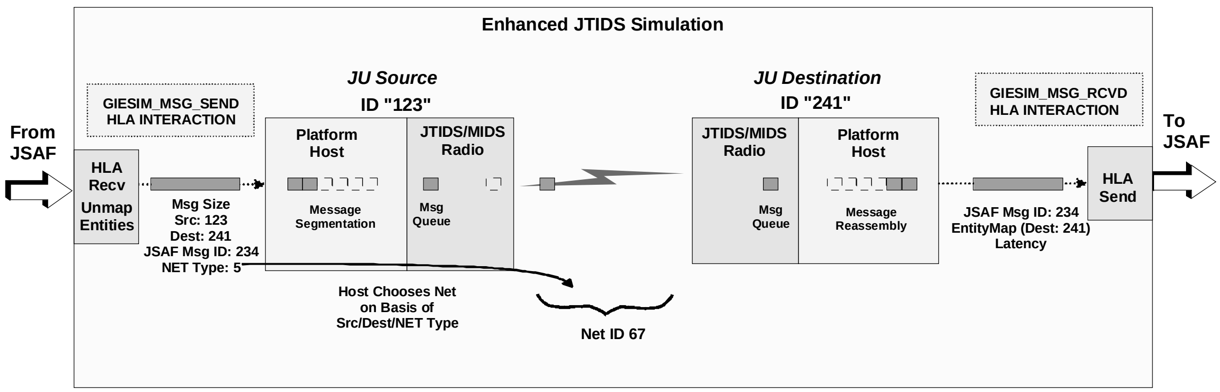

Figure 6 – Enhanced JTIDS Message Handling

Figure 6 illustrates the transmission message handling in the enhanced JTIDS simulation. When JTIDS receives a GIESIM_MSG_SEND interaction, it first attempts to map the entity IDs for the source and destination platforms to internal values. Transmission requests drop if IDs are bad. If entity mapping is successful, then JTIDS takes the NET Type number and looks up the associated text description. JTIDS then attempts to find a net based on the source and destination platform and the network description. If an appropriate net is found, then JTIDS puts the JSAF message ID and incoming latency into the JTIDS message payload. If the JSAF message size fits into the capacity of the selected network, it is sent as a single message. If the JSAF message is too big for the network, then JTIDS performs message segmentation and sends multiple segments. At the receiving end, segments are reassembled. When a whole message has been received successfully, JTIDS builds a GIESIM_MSG_RCVD response message that includes the entity ID of the destination platform, accumulated latency and JSAF message ID.

Several models and processes within the JTIDS simulation had to be modified and enhanced to support simulation interfacing with JSAF. One of the most significant changes was the addition of the JSAF "payload" to the internal data structures in the simulation. This change percolated through many parts of the JTIDS simulation.

The move from the DMSO RTI to RTI-S in the JTIDS simulation turned out to be challenging. The JTIDS simulation was built and maintained with the General Simulation System (GSS®)[6][7]. GSS is a high performance, rapid development language and environment developed by PSI for building models and running simulations and planning tools. Due to library name changes in RTI-S, a few minor, though tricky, changes were needed in GSS for the JTIDS simulation to run with RTI-S. Also, while RTI-S seems more robust than the DMSO RTI, it performs a check-sum on the FED files, which requires all FED files to match. The DMSO RTI allowed each simulation to use subsets of a larger FOM.

As mentioned earlier, PSI built a modified version of JTIDS to serve as a Driver surrogate for JSAF. This Driver simulation can send platform position updates automatically or manually, and can manually formulate message transmission requests. The Driver was invaluable for early testing of the enhanced JTIDS simulation for JSAF, and for exploring early interoperability problems with JSAF. The Driver also allowed testing and refinement of scenarios and networks.

2.4 Scenario Design and Mission Goals

Scenario development is one of the more challenging aspects for any distributed simulation environment. Figure 7 illustrates the layers of scenario development that the merger team considered while building the scenario for the initial GIESim-JSAF interoperability testing and demonstration.

Geography/Terrain

Dynamic Scenario
Equipment Deployments
Mission Deployments
Dynamic Movement Paths

Network Design
Allocation of Time Slots and Protocols to support all Mission and Communications requirements within a Scenario

Mission Threads
Define Flow of Comm Messages Associated with a particular Mission
Threads consist of multiple Links
Example: Time Critical Target

Dynamic Mission Events
Trigger the Flow of Tactical Comms At Specific Times/Places
E.g., Pop-up Threats

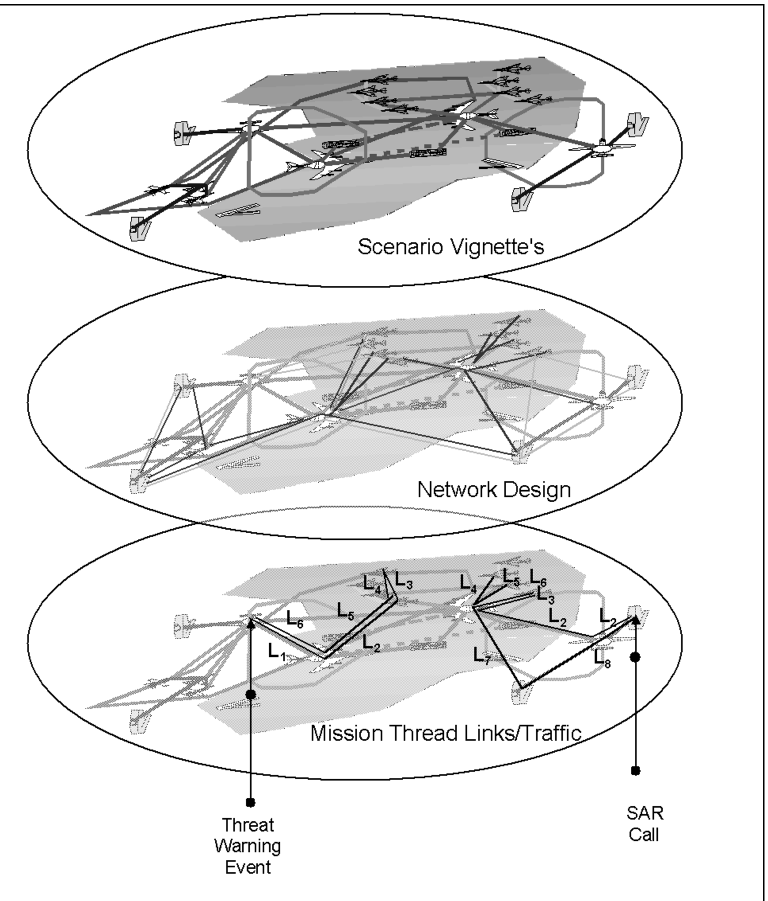

Figure 7 – Hierarchical Layers in Scenario Development

The dynamic operational scenario proved to be more of a challenge since the merger team wanted a scenario that was simple but operationally relevant, had visual impact, and could run fast enough for an effective demonstration. Therefore, the team agreed to use the Korean theater for our area of operation since this was currently used by GIESim and was readily available to the JSB-RD team for JSAF.

The scenario that became accepted involved a Special Operations Force (SOF) on the ground that observes a Time Sensitive Target (TST). A tactical F-15 STRIKER[2] aircraft receives a target message from the SOF and follows terrain during ingress to the target. Later on, the SOF detects a mobile SAM site and attempts to warn the incoming STRIKER.

[2] The term STRIKER is used to refer to tactical aircraft with the mission assignment of striking a target.

However, the SOF is now separated from the STRIKER by a mountain ridge.   The overall scenario became known as the "Wow" scenario. A screen shot of this scenario is shown in Figure 8 at the point where the F-15 is following terrain through a valley towards the target. There are three variations to the scenario that are intended to demonstrate the importance of tactical communications.

Scenario 1 – JSAF Only: The SOF "notifies" the STRIKER who evades the SAM. The STRIKER survives.
Lesson: The simulation is unrealistic, and worse, it erroneously predicts ***the STRIKER gets away.***
This is not acceptable for realistic simulation planning – ***people can get killed.***

Scenario 2 - JSAF w/ Comms but no Relay: The SOF uses JTIDS to send a threat warning to the STRIKER but the mountain range blocks direct radio contact. ***The STRIKER gets hit.***
Lesson: We need to account for distance, terrain and network design in realistic mission planning!

Scenario 3 - JSAF w/ Comms and Relay: Based on the results of the prior run, we turn on a JTIDS relay on a UAV. Now the STRIKER gets the relayed threat warning and evades!! ***The STRIKER gets away.***
Lesson: Communications modeling and advanced planning in support of operations is critically important!

Because the simulation detected communications failure, required adjustments can be made to the deployment and network design to ensure success of the mission.

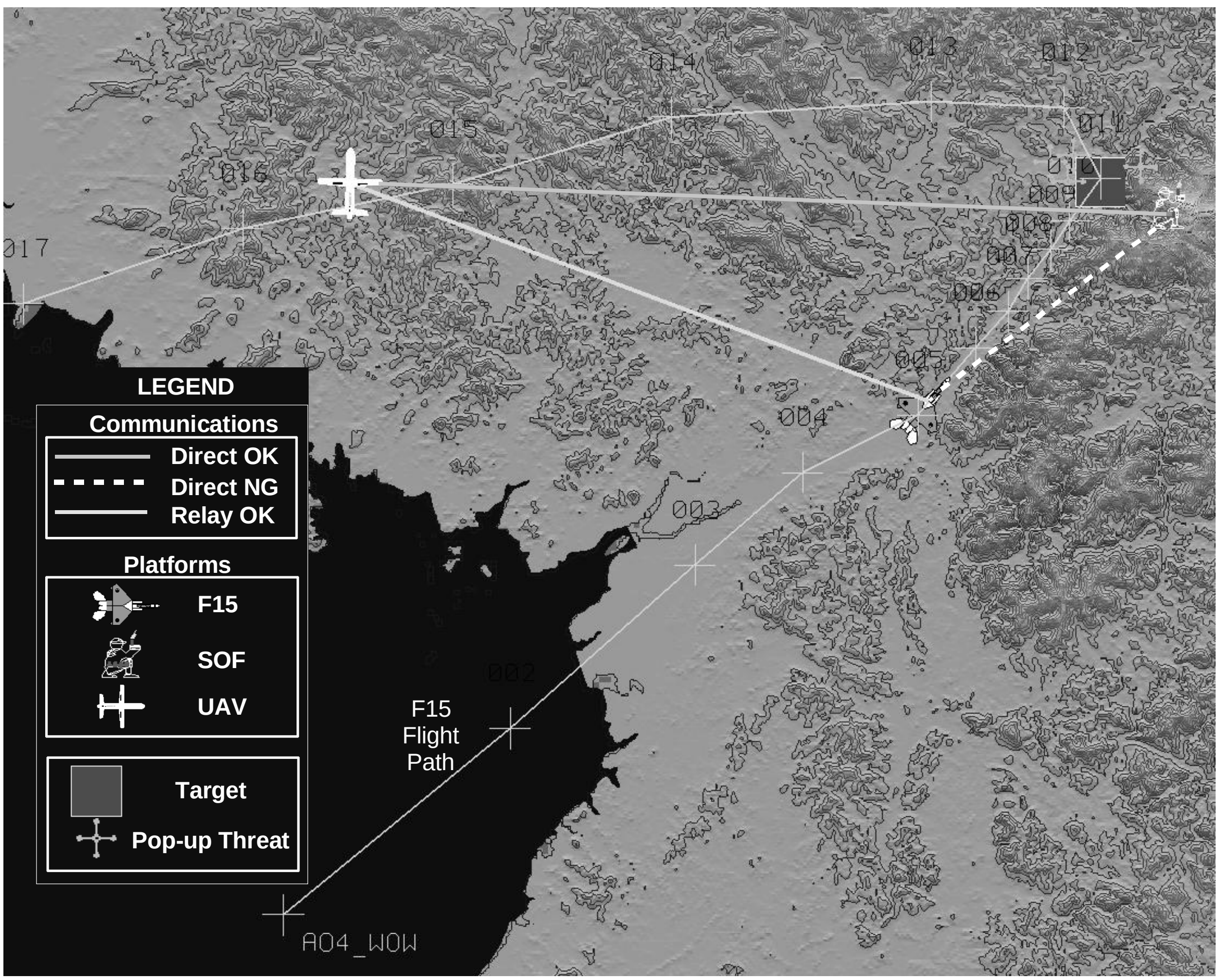

Figure 8 – SOF, STRIKER, UAV Relay, Time Sensitive Target and Threats in the "Wow" Scenario

The flight path of the F-15 STRIKER aircraft is shown in Figure 8. Crosses along the path indicate waypoints. The SOF is in the upper right near the TCT (square) and pop-up threats (crosses). The UAV in the upper left follows a flight path that keeps it near the area of operation. In Figure 8, the F-15 has entered the valley on its way to the target. The heavy dotted line indicates that direct communications with the SOF are broken due to the mountain range. The other heavy lines indicate good network connection between the UAV and the F-15 and to the SOF. Additional details on the design of the "Wow" scenario and its associated JTIDS networks are discussed in the next section.

2.5 Planning and Network Design

The "Wow" scenario was designed using the Link-16 Planning Tool. This planning tool is part of a Link-16 Network Management System (NMS)[8] designed and built by PSI for the Air Force under contract with AFRL's Wright Research site. It is important to note that the PSI Link-16 NMS illustrated in Figure 9 was, and continues to be, critically important to the success of the GIESim/JSB-RD software merger. The Link-16 Planning Tool was used to define the initial scenario and all Link-16 Networks used in the merger, and an enhanced version of the Link-16/JTIDS Simulation is the tactical communications component that we added to JSAF.

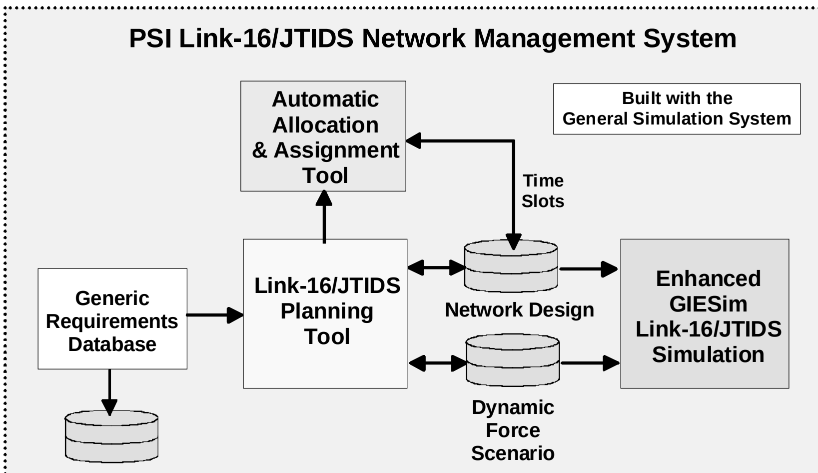

Figure 9 – PSI Link-16 Network Management System

The screen shot of the "Wow" scenario in Figure 8 was taken from the Link-16 Planning Tool. We first used the tool to determine the best location for the "Wow" scenario, then built a flight path for the F-15 that started high and then drops to follow terrain through the valley leading to the target. We also positioned the UAV relay such that RF links were always available to the SOF and to the F-15. We then "captured" the network requirements for the "Wow" scenario that had been agreed to by the team. Three networks were defined as shown in Table 2.

Table 2 – "Wow" Scenario JTIDS Networks

Net Purpose/Label	Net Type #	Link-16 Msg	Source	Destination	Access Mode	Response Time
Threat Warning	14	J15.0	SOF	F-15	Dedicated	1 Sec
Mission Control	15	J12.7	SOF	F-15	Dedicated	2 Sec
Engagement Status	16	J12.6	F-15	SOF	Contention	2 Sec

JTIDS/Link-16 is the preeminent tactical waveform today, and is the most complex. JTIDS uses a mix of Time Domain Multiple Access (TDMA), Frequency Domain Multiple Access (FDMA), and Collision Detection Multiple Access (CDMA), and therefore requires that networks be *custom designed* to support all platform communications requirements. The term "design" refers to *allocation* and *assignment* of appropriate time slots, which has been a complex and time consuming process. The PSI Link-16 NMS automates the time slot allocation process. As shown in Figure 9, the Link-16 NMS has a Generic Requirements Database manager that is used to define "generic" requirements. The Planning Tool is used to build dynamic scenarios, to capture and refine network requirements, and can launch the Automatic Allocation and Assignment Tool, which automates time slot allocation in minutes. The completed scenario and network design are fed into the JTIDS. Link-16 Simulation to assess network design performance by passing message traffic between Link-16 equipped platforms as they move. The data for the “Wow” scenario was exported and then imported into JSAF.

Key characteristics of the PSI Link-16 Network Management System include:

- Rapid generation of complex, dynamic scenarios against terrain.
- Accurate and fast radio propagation models that use 3D terrain data, and effects of transmitter power and antenna types, and that account for mutual interference and noise sources.
- Ability to visualize
    - 2D and 3D terrain and terrain contours plus political boundaries.
    - Movement paths and platform motion along the paths.
    - Dynamic RF link connectivity between platforms.
    - Network requirements (including relays) that are either satisfied or unsatisfied.
- Ability to capture and refine network requirements, and automation of time slot allocations.
- Ability to simulate message traffic by events in dynamic scenarios.
- Ability to dynamically assess network performance.
- Supports rapid iterative design and refinement of mission scenarios and network designs.
- Enhanced interface to JSAF for external position updates, and handling of network transmission requests and notification of received messages.

PSI has used the Link-16 NMS to design scenarios and networks of much greater complexity.

2.6 Component Integration

Figure 10 illustrates the integration of the JSAF and JTIDS simulation. The common scenario contains both the force deployments and their associated movement paths. The initial version of this common scenario was developed in the Link-16 Planning Tool. Each simulation environment then codifies the scenario for its force deployment. Movement paths are imported into JSAF. Based on the force deployment, the JTIDS simulation generates an Entity Map file that JSAF uses to encode platform references to JTIDS. JTIDS reads in the network file that contains requirements and actual network designs, i.e., time slot allocations, and generates a Net Types file that JSAF uses to specify a network in a transmission request. Both simulations use the MC02plus FOM. Once both simulations are started, JSAF sends position updates to JTIDS, and makes message transmission requests.

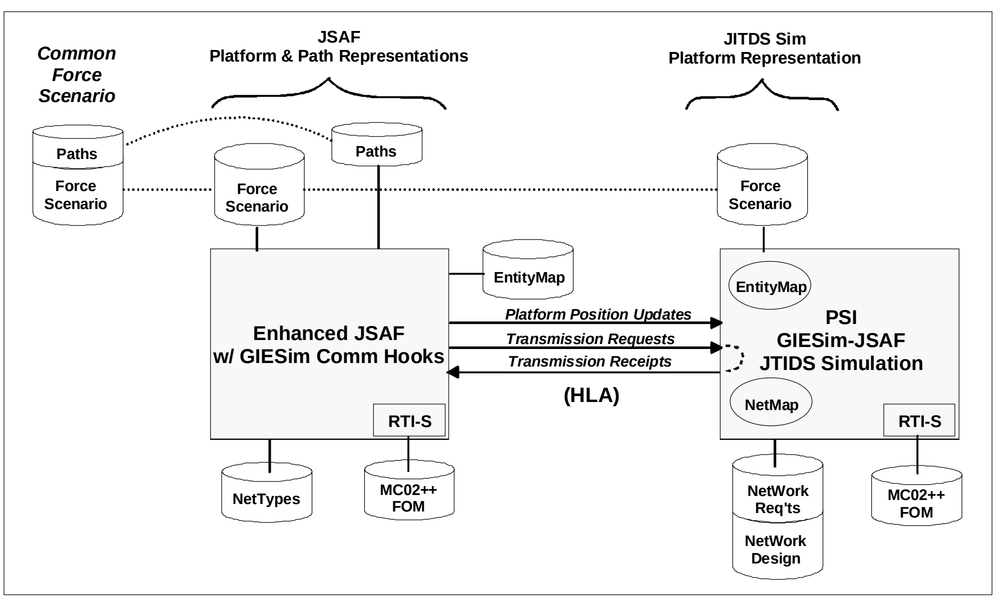

Figure 10 – Integration of JSAF and JTIDS simulations

We faced several operational challenges in getting the two systems to integrate, which took longer than expected. Challenges fell into two main categories: physical interoperability and scenario interoperability.

Initially the move to RTI-S caused some delay in the JTIDS simulation, which was discussed earlier. Face to face lab time was limited because the merger team was split over three distant geographical locations. One site did not have Linux or JSAF, and the nature of RTI-S, firewalls and security concerns ruled out testing over the Internet.

The ability to visualize scenarios in both JSAF and the JTIDS simulation helped immensely. Also the ability to manually construct and examine messages in both simulations proved to be invaluable. For the JTIDS simulation, manual message construction and examination were a legacy of prior GIESim work. Background diagnostic messages also facilitated rapid resolution of minor interoperability issues.

Scenario interoperability refers to the ability to get the simulation results expected. Recall that the original “Wow” scenario was designed with the Link-16 NMS planning tool. Scenario data was imported into JSAF where minor changes occurred, such as the position of the SOF. Also in a desire to shorten the demonstration run time, the flight path of the F-15 was shortened. In radio communications at 1 GHz (the operating frequency of JTIDS) minor position changes, particularly of ground radios in heavy terrain, can impact connectivity. These minor differences were quickly corrected. Interoperability success was finally achieved, and the team is now looking to apply the merged software to larger scenarios.

3. RESULTS & BENEFITS

The key result of the GIESim/JSB-RD software merger was a successful demonstration of the “Wow” scenario. The JSB-RD team members added new platform behaviors and enhancements to JSAF, and the GIESim team members successfully enhanced the JTIDS simulation. Another significant result was that the merger team really operated as a high performance *team*. The successful merger also demonstrates the value of leveraging prior development/system investments and investments in teams. The merger took far less time and capital because the effort leveraged prior AFRL investments and combined the collective experience and knowledge of both teams. Prior to the merger each simulation worked separately and had capabilities and limitations as shown in Table 3. After the merger, the two simulation components worked together, and the integration results are summarized in Table 4.

Table 3 – JSAF and JTIDS simulations before the merger

Before Merger	
JSAF	**GIESim JTIDS**
• Realistic mission execution	• Realistic network management
• Realistic movement & weapons modeling	• Realistic tactical communication modeling
• No communication modeling	• No mission behaviors

Table 4 – JSAF and JTIDS simulations after the merger

After Merger	
Enhanced JSAF ◀▶	**Enhanced JTIDS**
• Who needs to talk to who	• Builds tactical networks
• Moves the platform	• Updates communications links
• Initiates communications	• Resolves communications
Unifies mission and communications simulation within common force scenarios	

Additional benefits include greater war fighter relevance and realism, superior user interface and visualization, higher fidelity results, enables Network Centric Operations, and developed skills to support additional mergers. For planning, the merger supports what-if analysis oriented around communications capabilities; supports collaboration between mission and communications planners; and perhaps of greatest importance can measure the impact of communications on mission success.

Future work will be aimed at larger scenarios, additional message traffic, potential use of broadcast JTIDS messages, and at a higher level: testing and experimentation, additional communications modeling, distributed computation/HPC, and enhancements to the User Interface. Future efforts will benefit from building scenario vignettes and expert analysis to gain confidence as scenarios grow in complexity and as more tactical platform interactions take place.

4. CONCLUSIONS

The GIESim/JSB-RD merger of tactical JTIDS communications with JSAF is a success. Additional effort is required to take this accomplishment from a successful proof of concept demonstration to a fully scaled-up, robust capability for use in large war gaming. Larger scenarios must be explored with more complex tactical messaging. Cross-simulation scenario design needs to be made easier, and mission goals must feed network requirements. Furthermore, scalability must be explored to determine the computational architecture that may be required for high message traffic in large scenarios. While this may be complex, the merger team has laid the groundwork and established a foundation to make this happen rapidly.

The merger team has taken a large step that provides a forum for mission, communications and operations planners to work together in a distributed simulation environment. Network Centric Operations requires C3, and the merger has added communications to Command and Control to realize the needed C3. The merger has also opened the door to the integration of other tactical communications to JSAF. Training and gaming can now begin to take on communications challenges in a realistic way. The combined merger team has the experience to make this happen.

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