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ADST
Feasibility Analysis Report for the Non Line of Sight – Combined Arms Simulator Upgrades in Support of the A2 ATD Delivery Order

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The document provides the results of an analysis of the requirements for the NLOS-CA simulators to support the A2 ATD Delivery Order and the simulator hardware and software upgrades thereby required.

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1 Introduction.

1.1 Purpose.

The purpose of this Feasibility Study for NLOS-CA in support of the Anti-Armor Advanced Technology Demonstration (A2 ATD) Delivery Order is to examine the simulator requirements and recommend the best alternatives in terms of costs, performance and schedule to facilitate NLOS-CA participation in Experiments 2-6 and meet the overall objectives of the A2 ATD program. The overall objectives for the A2 ATD include developing and demonstrating a verified, validated, and accredited (VV&A) Distributed Interactive Simulation (DIS) capability to support anti-armor weapon system virtual prototyping, concept formulation, requirements definition, effectiveness evaluation, and mission area analysis on a combined arms battlefield at the Battalion Task Force or Brigade level. Specific technical objectives include:

- Demonstrate DIS as an evaluation tool and verify, validate, and accredit simulators used in A2 ATD experiments, semi-automated forces, and the Battlefield Distributed Simulation - Developmental (BDS-D) simulation.
- Develop, demonstrate, and document techniques / analytical tools to evaluate the causes of simulation outcomes.
- Demonstrate the linkage of constructive models (e.g., Janus) to DIS.
- Demonstrate upgraded virtual prototypes [M1A2 Abrams Tank, M2/M3A3 Bradley Fighting Vehicle, Non-Line of Sight Missile system (NLOS-CA), Line-of-Sight Anti-Tank Missile system (LOSAT)], and virtual prototypes to be developed [Unmanned Aerial Vehicle (UAV), Javelin Anti-Tank Missile, RAH-66 (Comanche) helicopter, AH-64D Apache Longbow Attack Helicopter, Armored Gun System (AGS)].
- Leverage FY93 efforts to evaluate a Special Access Program (SAP) in DIS on a local area network to define (1) SAP / Top Secret communication requirements on a wide area network, (2) facilities upgrades, and (3) procedures for experiments at BDS-D facilities.

1.2 Scope.

The A2 ATD Phase 2 Delivery Order (Figure 1.2-1) will be upgrading, modifying, and/or building "soldier-in-the-loop" simulators and virtual prototypes of the M2/M3A3 Bradley

Fighting Vehicle, the Non-Line of Sight (NLOS-CA) missile system, the Line of Sight Anti-Tank (LOSAT) missile system, the Unmanned Aerial Vehicle (UAV), the JAVELIN anti-tank missile system, the RAH-66 Comanche helicopter, and the AH-64D Apache Longbow Attack Helicopter. Various combinations of these simulators linked through a DIS long haul network will perform five separate experiments, one per fiscal year quarter, beginning with third quarter, FY 94 and running through the end of FY 95. The modification and upgrade for four M1A2 simulators and the conduct of experiment 1 at the Mounted Warfare Test Bed at Ft Knox, Kentucky are part of Phase 1 of the A2 ATD program and are not part of this study, except for future modifications to these simulators that are recommended. Generally speaking, the simulator upgrades addressed include:

- Use level two image generation.
- Accommodate DIS 2.0 protocols, 3rd draft.
- Meet all verification, validation, and accreditation criteria established by AMSAA.
- Support participation in classified (Secret level) experiments.

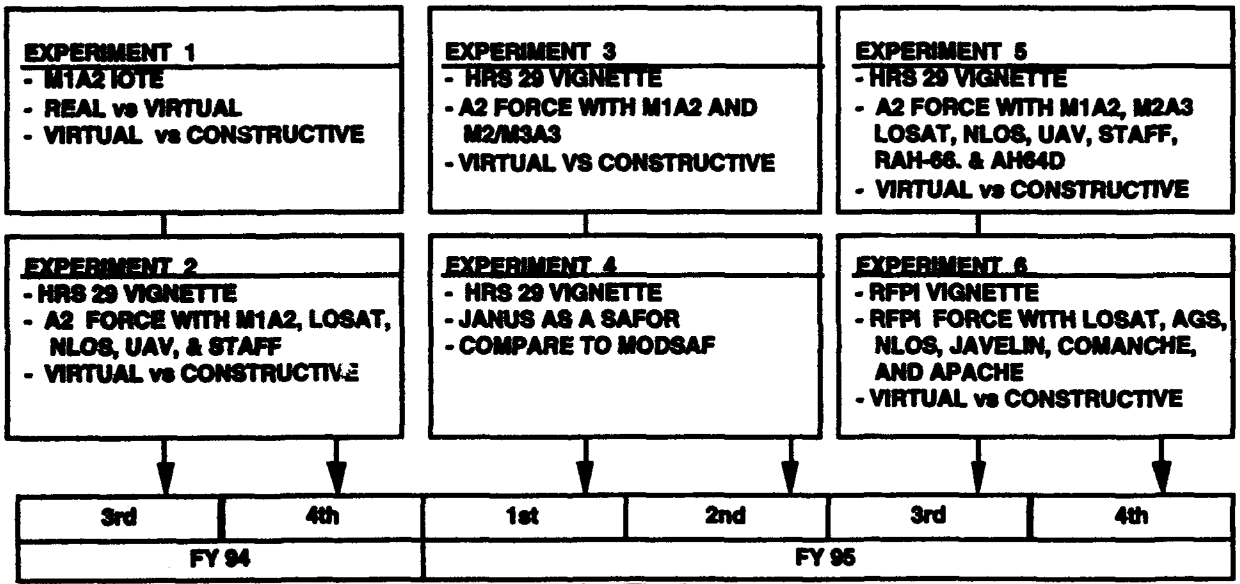


Figure 1.2-1 A2 ATD Experiments

Sites associated with the various experiments will be connected via the Defense Simulation Internet (DSI), utilizing DIS Protocol Data Units (PDUs). The physical connections typically are T-1 lines, with either Ethernet or Fiber Distributed Data Interface (FDDI) serving as the local network. Local networks will use DIS PDUs, however SIMNET compatible simulators may be linked via a Cell Adapter Unit (CAU). Sites examined as part of this study and the associated possible numbers and types of simulators are shown in Table 1.2-1.

Table 1.2-1 Simulator Distribution

Simulator	MWTB	AVTB	Ft. Benning	TARDEC	MICOM	Silkorsky	MDHC	CSRDF	STRATA
M1A2	4								
M2/M3A3	0/2/4	0/2		0/2					
NLOS-CA		0/1	0/1		0/1				
UAV		0/1	0/1		0/1				
LOSAT	1/2								
AH-64D		0/1/2					0/1		0/1
RAH-66		2/1/0				0/1		0/1	
Javelin		0/1/2	0/1/2		0/1/2				
AGS	1/2								

2 A2 ATD Delivery Order.

2.1 Overall Objectives.

The purpose of the A2 ATD is to develop and demonstrate a verified, validated, and accredited DIS capability to support anti-armor weapon system virtual prototyping, concept formulation, requirements' definition, effectiveness evaluation, and mission area analysis on a combined arms battlefield at the Battalion Task Force or Brigade level. Specific technical objectives include:

- Demonstrate DIS as an evaluation tool and verify, validate, and accredit simulators used in A2 ATD experiments, semi-automated forces, and the BDS-D simulation.

- Develop, demonstrate, and document techniques / analytical tools to evaluate the causes of simulation outcomes.
- Demonstrate the linkage of constructive models (Janus) to DIS.
- Demonstrate upgraded virtual prototypes (M1A2, M2/M3A3, NLOS-CA, LOSAT), and virtual prototypes to be developed (UAV, Javelin, Comanche, Apache Longbow, AGS).
- Leverage FY93 effort to evaluate a SAP program in DIS on a local area network to define (1) SAP / Top Secret communication requirements on a wide area network, (2) facilities upgrades, and (3) procedures for experiments at BDS-D facilities.

2.2 Simulator Participants.

Nine distinct types of simulators will participate in the Phase 2 experiments. This includes the Abrams M1A2, the Bradley M2/M3A3 (Infantry Fighting Vehicle-IFV) /M3A3 (Cavalry Fighting Vehicle-CFV), the Non-Line of Sight (NLOS-CA) system, the Unmanned Aerial Vehicle (UAV), the Line of Sight Anti-Tank (LOSAT), the Apache Longbow (AH-64D), the Comanche (RAH-66), the Javelin, and the Armored Gun System (AGS). Each simulator will either be developed (if one does not exist) or enhanced to the following general specifications:

- Level two image generation.
- Accommodate DIS 2.0, 3rd draft.
- Meet all verification, validation, and accreditation criteria established by AMSAA.
- Ability to participate in classified (Secret level) experiments.

2.3 Experiment Descriptions.

Five experiments are planned during Phase 2. They are scheduled approximately one per quarter and will utilize the simulator elements defined in Table 2.3-1 (the '/' indicates simulator quantity options).

Table 2.3-1 Simulator Requirements

SIMULATOR	EXPERIMENT #				
	2	3	4	5	6
M1A2	4	4	4	4	
M2/M3A3		1/2/4	1/2/4	1/2/4	
NLOS-CA	1			1	1
UAV	1			1	1
LOSAT	1/2			1/2	1/2
AH-64D				1/2	1/2
RAH-66				1/2	1/2
Javelin					1/2
AGS					1/2

Experiments 2-5 will be a scenario vignette from the High Resolution Scenario 29 (HRS 29) which has been developed for heavy forces anti-armor weapons evaluation experiments. This will be conducted on a South West Asia terrain representation. Experiment 6 will be a scenario (or vignette) developed for Rapid Force Projection Initiative evaluation called High Resolution Scenario 33 (HRS 33). This will be conducted on a Cuba terrain representation.

2.4 Facilities.

Execution of the above experiments will require close coordination of a number of different sites. The Mounted Warfare Test Bed (MWTB) located at Ft. Knox will serve as the cornerstone for the experiments. This site, in addition to providing various simulators, will provide required support equipment such as data logging and analysis, ModSAF, scenario command and control structure, combat support and service support elements, etc. Other potential sites that may participate (depending upon options chosen) include the Aviation Test Bed (AVTB) at Ft. Rucker; Ft. Benning; Tank Automotive Command (TACOM), Warren, MI; Missile Command (MICOM), Huntsville, AL; Crew Station Research & Development Facility (CSRDF) NASA Ames; the Simulator Training Research Advanced Testbed for Aviation (STRATA) at the Army Research Institute (ARI) Field Unit at Ft. Rucker, the McDonnell Douglas Helicopter Company (MDHC) Simulation Laboratory, and the Sikorsky Simulation

Laboratory. Table 2.4-1 shows the simulators being provided by each site (the '/' indicates simulator options):

Table 2.4-1 Simulator Distribution

Simulator	MWTB	AVTB	Ft. Benning	TARDEC	MICOM	Sikorsky	MDHC	CSRDF	STRATA
M1A2	4								
M2/M3A3	0/2/4	0/2		0/2					
NLOS-CA		0/1	0/1		0/1				
UAV		0/1	0/1		0/1				
LOSAT	1/2								
AH-64D		0/1/2					0/1		0/1
RAH-66		2/1/0				0/1		0/1	
Javelin		0/1/2	0/1/2		0/1/2				
AGS	1/2								

3 Study Methodology / Approach.

The study approach has two elements. The first element is a data collection process. The second element is a methodology for evaluating technical performance, risk, and cost options of the various simulators. It is these assessments that will drive the recommended approach for NLOS-CA simulator support to Phase 2 of A2 ATD. Steps associated with each element are as follows:

Element One :

- Gather data on specific simulators.
- Examine the functional requirements for each simulator.
- Examine the VV&A plan for each simulator.
- Determine various options for each simulator. This includes using existing simulators, modifying existing simulators, and building new simulators.
- On the basis of the above steps, develop a Scope of Work (SOW) for each simulator as a means of collecting information on the technical approach, schedule, work breakdown

structure (WBS), and cost. This typically applies to simulators that are under the control of other companies, government agencies, etc.

- Using the responses received from the various SOWs examine each approach and, for each simulator, select the most cost-effective approach. The process and criteria used for 'cost-effective' is discussed below.

Element Two :

- Using the detailed information pertaining to the preferred approaches, develop a final program-level schedule; WBS; cost; and assumptions and limitations document.
- Report findings / recommendations in a final report.

Figure 3-1 illustrates the study methodology / approach.

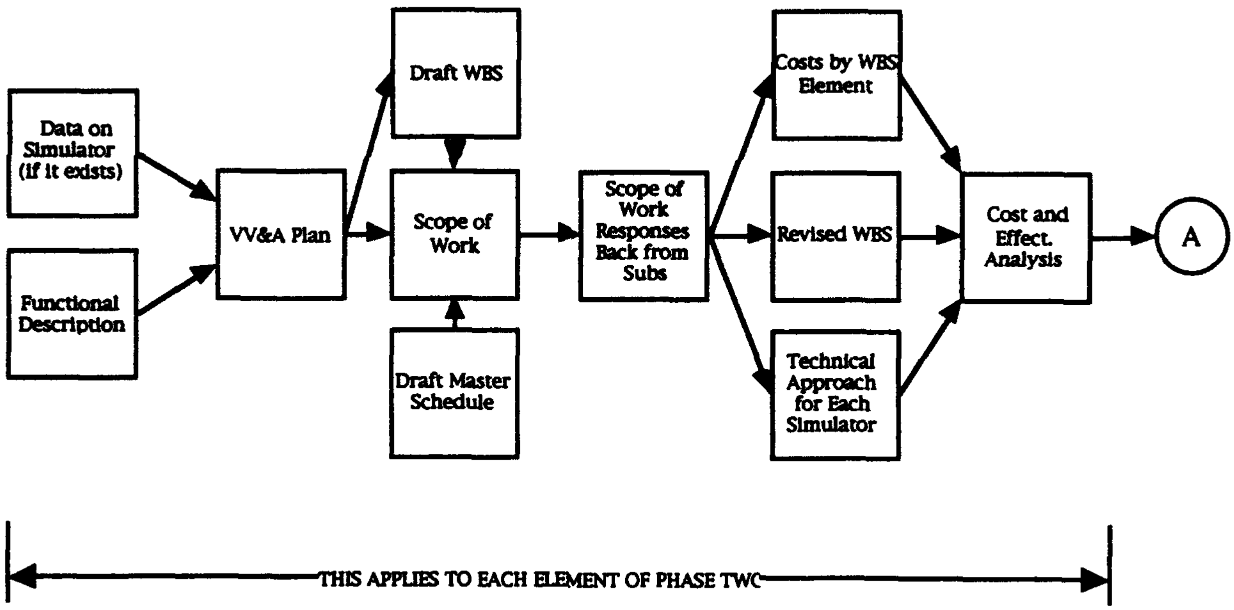
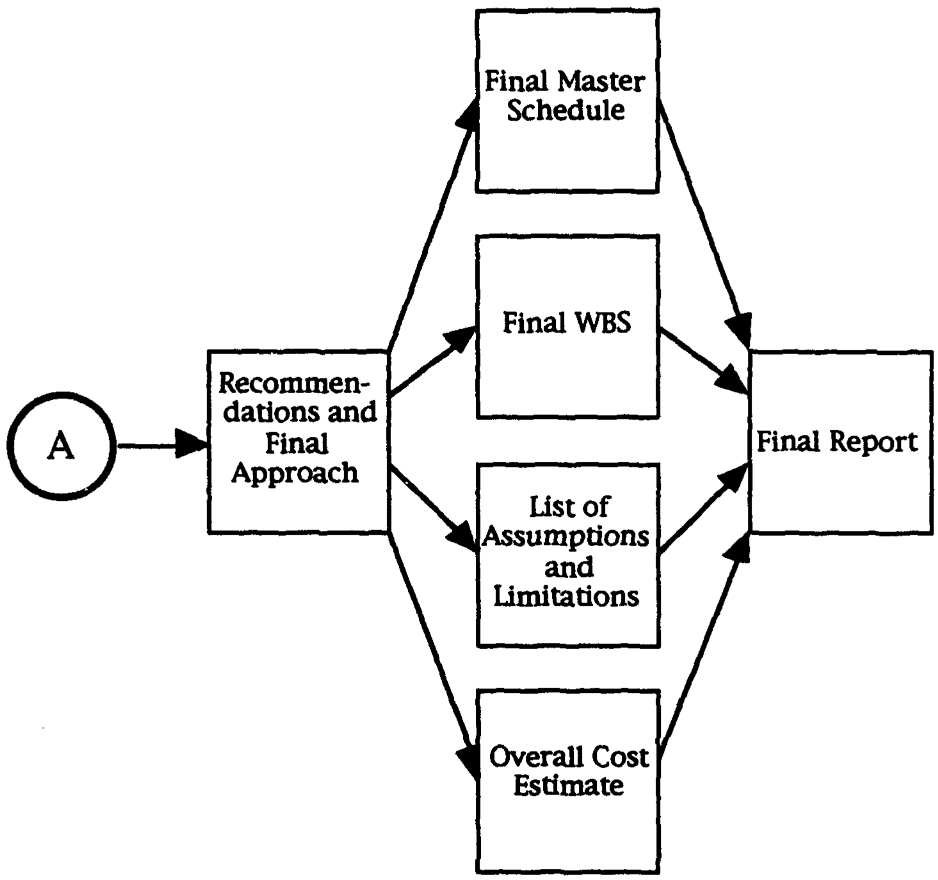


Figure 3-1 Study Methodology / Approach (1 of 2)



THIS APPLIES TO ALL OF PHASE TWO

Figure 3-1 Study Methodology / Approach (2 of 2)

3.1 Assumptions.

- CAU SW and HW (specifications) will be developed under another delivery order and available for use on A2 ATD.
- CIU SW and HW (specifications) will be developed under another delivery order and available for use on A2 ATD.
- DIS compatible Stealth and associated PVD will be developed under another delivery order and available for use on A2 ATD.
- ModSAF will be developed under another delivery order and available for use on A2 ATD.

- Data collection methodologies (e.g., DISAT) developed during Phase 1 will be sufficient and available for Phase 2.
- DIS compatible Session Manager (with at least the functionality of the current SIMNET Management, Command, and Control System) will be developed under another delivery order and available for use on A2 ATD.
- The Baseline simulator/simulation locations during A2 ATD are as listed in Table 3.1-1:

Table 3.1-1. Baseline Simulator/Simulation Locations

	MWTB	AVTB
M1A2	4	
M2/M3A3	2	2
LOSAT	2	
AGS	2	
ARWA (AH-64D)		2
ARWA (RAH-66)		2
Javelin		2
NLOS-CA		2
UAV		1
ModSAF	1	
Data Logger	1	1
DISAT	1	
DSI Gateway / CIU	1	1
Janus	1	
Session Manager	1	
PVD	1	1
Stealth	1	1

- DSI network is established at each site involved in the experiment and is provided as Government Furnished Equipment (GFE) / Government Furnished Information (GFI).
- Data Logging will occur at all participating sites.
- Data Reduction/Analysis for all experiments will occur at the MWTB.
- Pre-test activities are three weeks in duration.
- Test activities are three weeks in duration.
- Government will provide on-site Janus training to site personnel.
- Janus software will be provided as GFI.
- Simulator developers have included in their estimates training for site personnel. This training will be conducted during on-site integration.

3.2 Essential Elements of Analysis (EEA).

The general process followed for evaluating alternative simulator approaches was a series of Subject Matter Expert (SME) reviews, where a consensus, based upon the information presented, was reached. The results include the preferred simulator approach as well as the rational (with supporting documentation as applicable) for its selection.
This approach allows interested SMEs to examine the available data, make knowledgeable estimates when data are sparse, interact with one another to gain consensus, and document the decision process.

Examples of the type of criteria examined included (in no particular order or implication of importance):

- Does the system meet the A2 ATD requirements?
  - Experiment?
    - Scenario Requirements?
  - Technical?
    - IG Specifications
    - VV&A per AMSAA plans
    - DIS 2.0 3rd Draft
    - Classified Processing
    - Soldier-Machine Interface (SMI) Representation
- What is the level of risk for this approach?
  - SW Technical Risk
  - HW Technical Risk
  - Schedule Risk
- Does the simulator schedule impact the program schedule?
- Is the design flexible?
  - Hardware flexibility

  - Software flexibility
- What is the simulator's long-term availability?
- What is the total cost?
  - Labor Costs (Man years and $)
  - Travel Costs ($)
  - Material Costs ($)
  - Computer Costs ($)
- At what site will the simulator be located for the experiments?

3.3 Conclusions.

The conclusions of the NLOS-CA study have been broken down into two categories: Simulators and Answers the EEA.

3.3.1 Simulators.

For the NLOS-CA simulators to support A2 ATD there are hardware and software upgrades required. New software needs to be developed, to support VVA, upgrade the FOG-M missile dynamics, and to simulate the UAV. Additional hardware is required to upgrade the host computer processing power and the Computer Image Generators.

3.3.2 Answers to the EEA.

Question: "Does the system meet the A2 ATD requirements?"

Answer: The NLOS-CA simulators meet the requirements of the experiments and scenarios. PM NLOS-CA is assisting in defining their requirements for simulators, resulting in them being the same as A2 ATD. The simulators will have level II CIGs with databases correlated with other A2 ATD databases for visual, thermal, radar, and radio spectrums. The recommended devices will be VV&A'd by AMSAA, and then configuration managed by Loral. All options that were considered would have been DIS compatible and therefore this was not a discriminator. Classified processing was considered within the realm of removable media and intrusion detection. The requirements for each SAP are unique and could not be evaluated.

It was desired to provide an accurate representation of the SMI for the simulators. None of the recommended simulators have been compromised in this area. Certain options would compromise the SMI representation and were not favorably considered because of the potential of corrupted data as a result of using these devices.

Question: "What is the level of risk for this approach?"

Answer: All of the options presented in this study were evaluated for cost, performance, and schedule risk. It was determined that upgrading the existing devices has the least risk.

Question: "Is the design flexible?"

Answer: Flexibility of the design was accommodated for all of the recommended systems. These devices will be documented and configuration managed so that VV&A variance as a result of upgrades can be assessed readily and rapidly. The major expense is for establishment of the baseline configuration for BDS-D.

Question: "What is the simulator's long-term availability?"

Answer: Another concern is the long-term availability of the simulators for other BDS-D experiments. There is some risk that the software configuration would change between experiments, and therefore yield invalid data. Loral Configuration Management will ensure that this does not occur.

Question: **"What is the total cost?"**

Answer: Costs have been included in each of the above sections and summarized in Section 4.6.1. It must be emphasized that the cost are ROMs and that costs from government agencies are not directly accessible by Loral.

Question: "At what site will the simulator be located for the experiments?"

Answer: The most cost effective manner for conducting A2 ATD will be to limit the sites to the MWTB and AVTB. Any other solution adds costs to the program.

4 Non-Line of Sight (NLOS-CA) / Unmanned Aerial Vehicle (UAV).

4.1 Vehicle Description.

The Non-Line of Sight-Combined Arms weapon system is a highly mobile and lethal addition to the U.S. Army war fighting capabilities that defeats armor, rotary-wing aircraft, and high-value targets. The system allows the Maneuver Brigade Commander to extend his battle space, attack enemy forces at greater ranges, and assist in shaping the direct fire battle.

The NLOS-CA system consists of a fiber-optic missile, a High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) mounted fire unit containing a two man crew (gunner and driver). It will support future contingency force operations with precision long-range engagement of armor, helicopter, and other high-value targets. Target cueing is achieved primarily via target handover. Once commanded to fire, the soldier launches the missile which automatically flys to the target area. During flight, a jam-proof fiber-optic data link, dispensed from the rear of the missile, provides two-way communication with the control console located on the HMMWV. Using the control console, the gunner views the battlefield as seen by the missile's imaging infrared or TV camera and selects the highest priority target for missile track and kill. Figure 4.1-1 is an illustration of the NLOS-CA.

Figure 4.1-1 NLOS-CA

The UAV will provide the army commander the ability to reconnoiter enemy territory to at least 150 km beyond the forward line of own troops (FLOT). The UAV-Short Range (UAV-SR) is the baseline for the family of UAVs, which also includes close range, vertical takeoff and landing, medium range and endurance. The UAV-SR will carry a payload that will include daylight television, and forward looking infrared systems for nighttime and low-light-level reconnaissance. The UAV will give the commander virtually an all-weather reconnaissance capability, plus the added features of immediate response. The UAV will have a dash speed in excess of 110 knots and cruise or loiter speed of less than 60 knots. The SR will stay aloft eight to 12 hours while providing near real-time information under both day and night imaging conditions. Figure 4.1-2 is an illustration of the UAV-SR.

Figure 4.1-2 UAV-SR

4.2 Networked Simulator Description (Current).

The NLOS-CA simulator provides a two station (driver and gunner) mockup of the HMMWV cab. Four large projection screens display the out-the-window views as seen by the crew. This is provided by a four channel ESIG 2000 image generator. The gunner's station provides the crew member with a nine inch monochrome monitor which displays a two dimensional map of the local area. In addition, he has control panels on each side of the display, along with a left and right hand controller. The controllers are used by the gunner to both choose targets before firing and after firing to guide the missile to its intended target. Once a missile is launched, the monochrome display provides real time seeker video (TV or FLIR) to the gunner to facilitate manual guidance. Guidance may be either manual or automatic.

During the A2 ATD Delivery Order one NLOS-CA will undergo software modifications such that it will reflect the capabilities of an Unmanned Aerial Vehicle (UAV). Modifications will include redefinition of the switchology, missile flight dynamics changes to reflect UAV flight dynamics, and sensor payload changes to reflect a UAV payload. Other fidelity modifications will be made as required.

4.3 Experiment Configuration (Requirement).

Using the above described NLOS-CA simulator as a baseline, software modifications will be made to the system to accommodate the representation of a UAV. In addition, the resulting two simulators (NLOS-CA and UAV) will undergo additional fidelity / accuracy upgrades which will include:

- Accommodate DIS 2.0, 3rd draft.
- Meet all verification, validation, and accreditation criteria established by AMSAA.
- Ability to participate in classified (Secret level) experiments.

4.4 VV&A Requirements.

To date the VV&A requirements for NLOS are being defined by AMSAA. It is expected that they will include vulnerability, target acquisition, delivery accuracy, lethality, mobility, and simulator fidelity issues. In addition the simulator will be expected to meet the A2 ATD general requirements of a level two image generator, support DIS 2.0 (3rd draft), and the ability to participate in classified (Secret level) experiments.

4.5 NLOS-CA/UAV Simulator Modifications.

4.5.1 Technical Description.

The baseline NLOS-CA simulator will be upgraded to provide higher fidelity in the areas of vehicle dynamics, missile dynamics, and communications; will be modified to use DIS PDUs; and will be upgraded with new visual databases.

4.5.1.1. Host Software.

The NLOS-CA simulation host software will be modified to improve own vehicle modeling to improve the fidelity of the acceleration, velocity, and turning modeling. A new GFI six degree of freedom Fiber-Optic Guided Missile (FOG-M) model will replace the baseline model and be integrated into the system. Finally, after GFI visual databases are received and installed, the ground vehicle clamping previously required will be removed and data will be modified to properly handle visual models available in the database.

4.5.1.2. Image Generator.

The existing ESIG 2000 image generator will be upgraded with additional sensor processing hardware to improve the visual fidelity of the FOG-M's Infra-Red and Day TV sensor simulations.

4.5.1.3. IG Database.

The existing ESIG 2000 image generator will be upgraded with GFI visual databases for South-West Asia and Cuba. System testing will be performed to ensure compatibility with these new databases.

4.5.1.4. Crew Shell Hardware.

To provide a DIS compliant radio simulation, the baseline CB radio configuration will be replaced with the SINCGARS radio simulation described in Section 5.12 of this document.

4.5.1.5. Host Computer Hardware.

In the VME host computer, higher throughput processors will replace the baseline processors to support the software required to improve the fidelity of missile and vehicle modeling.

4.5.1.6. DIS Interface.

Throughout the baseline software, the generation of SIMNET PDUs will be converted to DIS PDUs.

4.5.2 System Integration.

The development and initial integration of the software and host computer modifications will be performed in the ADST System Development Facility (SDF). The initial integration process will be performed in as many discrete steps as practical. This will limit the number of new hardware or software items per step so that problem isolation is facilitated.

Upon completion of initial integration in Orlando, system integration with the crew shell hardware and Image Generator will be performed at the AVTB.

4.5.3 System Testing.

Full system testing will be performed at the AVTB following the completion of integration. Testing will verify that the system operates as required.

4.5.4 VV&A.

VV&A will be an on-going process conducted throughout software development. This will include examination of system lethality, vulnerability, mobility, and fire control. A final VV&A test will be conducted on site once the kit is installed and tested. This will insure proper fit, form, and function of the simulator for the experiments.

4.6. Recommendations.

It is recommended that the two existing NLOS-CA simulators be modified to meet the A2 ATD requirements as outlined above; and that a UAV software load be developed which will allow an NLOS-CA simulator to function as a UAV simulator.

4.6.1 Simulator Costs.

The upgrades to NLOS-CA simulators is estimated to be $0.13M in hardware for the host computer and CIG, with an additional $0.3M in software costs for a total cost of $0.43M. The UAV software costs are estimated to be $.08M and $0.1M in hardware for a total UAV cost of $0.18M. The total cost to provide the NLOS-CA/UAV is $0.61M.

4.6.2 Simulator Schedule.

The NLOS-CA simulator must be available for experiment 2, which is currently scheduled for 3 - 28 October 1994. These modifications are estimated to be 6 months in duration. See the program schedule in Section 9.

5 Environment.

The execution of an experiment involves more than just the manned simulators. A complete analytic environment needs to be formed to support the studies. This includes elements such as:

- <u>ModSAF</u>, which allows for the play of unmanned (machine intelligent) weapon systems.
- <u>Data Logging</u>, which allows for collection of network traffic (and hence information) on all simulation events.
- <u>Session Manager</u>, which allows initiation of an experiment as well as simulating combat support and combat service support elements.
- <u>Stealth</u> simulators, which allow for unobstructed, unobserved viewing of the virtual battlefield.

The network architectures for the experiments are included in Section 6.

Other systems / data collection methods may also be employed as part of the experiment environment and will be site dependent. Examples of this would be video taping of crews, manual data logging, etc.

5.1 Databases.

5.1.1 Approach.

BDS-D assets that will be modified or upgraded to support the A2 ATD experiments will be have either an Evans & Sutherland CIG 2000 (E SIG 2000) or SGI Onyx as CIGs. The databases for both of these CIGs will be developed concurrently for Experiment 2 (SWA) and Experiment 6 (Cuba). The source format will be S1000 and SIF with specific conversions for the two above named CIGs. Moving models will also be developed for both CIG configurations only once, integrated at the SDF, and then disseminated to the MWTB, AVTB and other experimental sites as required.

As mentioned in Section 4.1, the first 19 models for the Onyx system will be developed for Experiment 1. There presently is estimated to be 45 models required to support all of the experiments. The remaining 26 models for the Onyx CIG will be developed for Phase 2 of A2 ATD.

Presently the only E&S CIG 2000 operating in the BDS-D environment is for the NLOS-CA simulator. The following models are being provided as part of this program:

- M1A1
- M2/M2A2*
- T-72
- BMP-1
- HMMWV
- AH-64A
- MI-24

Model marked with an * is not required for A2 ATD, therefore 39 new models will have to be developed by E&S. Due to the software architecture of the E&S systems, each new database requires the integration of existing moving models which causes a small delta in cost to move these models.

Table 5.1.1-1 lists the known moving model requirements for A2 ATD.

Table 5.1.1-1 A2 ATD Entity Requirements

Entity	M1A2 Detection Tests	Ex. 1	Ex. 2	Bradley Detection Tests	LOSAT Detection Tests	Ex. 3	Ex. 4	Ex. 5	Ex. 6
T-72		X		X	X	X	X	X	
BMP - 1	X	X		X	X				X
M1A2	X	X	X	X	X	X	X	X	
LOSAT					X				X
AH-64A	X		X	X	X		X	X	X
AH-64D								X	X
NLOS-CA			X		X			X	X
M1A1		X				X	X	X	
Dismounted Infantry (Blue & Orange)					X	X	X	X	X
MI-24	X			X	X	X	X	X	X
Generic Missile			X			X	X	X	X
M60	X			X	X				
M2/M3A3	X		X	X	X	X	X	X	
M2/M3A2		X							
M113	X			X	X				
HMMWV Scout			X		X	X	X	X	X
HMMWV Avenger	X			X	X				X
HMMWV with Shelter	X			X	X				X
HMMWV-A (or F)	X			X	X				X
M35 (2/5 ton truck)	X			X	X				
AGS					X				X
FIST V			X		X	X	X	X	
RAH-66			X		X		X	X	X
120mm Mortar (US)			X		X	X	X	X	X
155mm SP HOW (M109A3)	X	X							
155mm SP HOW (M109A6) (Paladin)			X		X	X	X	X	
FAASV			X		X	X	X	X	
MLRS			X		X	X	X	X	
UAV			X		X			X	X
BTR-60 FO					X				X
BRDM		X			X				X

Table 5.1.1-1 A2 ATD Entity Requirements (Cont.)

Entity	M1A2 Detection Tests	Ex. 1	Ex. 2	Bradley Detection Tests	LOSAT Detection Tests	Ex. 3	Ex. 4	Ex. 5	Ex. 6
SA-13					X				
SA-18					X	X	X	X	
ZSU 23-4		X			X				X
120mm Mortar (Russian)					X	X	X	X	X
2S3 152mm SP HOW					X				
JAVELIN			X			X	X	X	X
M3A3 (Echo)			X			X	X	X	
BMP 2			X			X	X	X	
MTLB			X			X	X	X	X
2S6						X	X	X	
2S19 152mm SP HOW						X	X	X	
T-80	X								
M577		X							
2.3 BY 2.3 Meter Line pair Boards	X			X	X				

It is assumed that the detection tests for the AGS, NLOS-CA, Javelin, AH-64D, and RAH-66 will have the same model requirements as LOSAT and that additional models will not be required.

5.1.1.1 E&S 2000.

The following systems will use the E&S 2000 system:

- ARWA (AH-64D and RAH-66)
- NLOS-CA

5.1.2 Cost.

5.1.2.1 South West Asia (SWA) Database.

The SWA database will be provided for the VISTA_Works™ Image Generator as part of Phase One and will be GFE to Phase Two. Under Phase two, this database will need to be converted and correlated to run on the Evans and Sutherland ESIG-2000 Image Generator to provide a seamless visual appearance for NLOS-CA and the ARWA. The following tasks and associated costs will be necessary to provide these upgrades:

5.1.2.1.1 SWA Model Development.

A total of 45 moving models are required to support experiments 2-6. Of these, 19 moving models are being provided as GFE from A2 ATD Phase One. This leaves 26 models remaining to be developed. These models will be developed in S-1000 format prior to conversion to ESIG-2000 format. The cost for developing the 26 models will be $0.15M. Cost savings will be realized if some of the remaining 26 models can be provided from the LOSAT program as GFE.

5.1.2.1.2 SWA Terrain Database Conversion/Correlation.

The existing SWA database S-1000 source will be processed through a variety of methods to provide a polygonal correlated replica of the SWA database in a format compatible with the ESIG 2000. The conversion/correlation methods will range from use of software automated tools to hand-editing of database features. Care will need to be taken to optimize ESIG-2000 scene generation efficiency while still realizing a correlated product. Work has already begun in this regard on Phase One of A2 ATD through a systems engineering task to assure interoperability between all A2 ATD simulators. Additionally, Loral is factoring the visual system performance capability of the CCTT simulator systems into database design to provide compatible databases for each program. One of the assumptions of the database conversion task is that, the Application Program Interface (API) being developed as a tool to assist conversion between the Close Combat Tactical Trainer (CCTT) and S-1000 databases by the CCTT program, is provided to A2 ATD as GFE. Included in the cost for this effort is funding to purchase COTS database development and conversion software tools. The cost for conversion and correlation of the SWA database will be $0.08M.

5.1.2.1.3 Seamless Terrain Environment Integration.

During final integration of any set of dissimilar databases, there will always be some incongruencies. To complete the integration of a seamless virtual terrain environment between a SWA database developed in S-1000 and the same database converted and correlated to run on ESIG-2000, Loral will provide database engineering support for fine-tuning database correlation between the S-1000 version and the ESIG-2000 version. The cost of this task will be $0.008M. SWA database total conversion costs will be $0.238M.

5.1.2.2 Cuba Database.

The Cuba database will need to be developed from scratch to run on the VISTA-Works visual system in S-1000 format since no other Cuba database exists. In addition to initial development of this database into S-1000 format, this database will need to be converted and correlated to run on the Evans and Sutherland ESIG-2000 Image Generator to provide a seamless visual appearance for NLOS-CA and the ARWA. The following tasks and associated costs will be necessary to provide these upgrades:

5.1.2.2.1 Cuba Database Development.

The first step in providing a Cuba database will be to develop the database using Defense Mapping Agency (DMA) source data and other digital source data provided as GFE as well as other sources. The cost for developing the database will be $0.25 Million.

5.1.2.2.2 Cuba Model Development.

All 45 moving models required to support experiments 2-6 will exist as by-products of the SWA database development and conversion effort and will be provided as GFE. Integrating these models into the Cuba database will be a simple matter relative to the effort to build them from scratch. The cost of integrating these models into the Cuba database will be $0.008M.

5.1.2.2.3 Cuba Terrain Database Conversion/Correlation.

The Cuba database which will be built under the "S-1000 Cuba Database Development" task will be processed through a variety of methods to provide a polygonal correlated replica of the Cuba database in a format compatible with the ESIG 2000. The conversion/correlation methods will be range from use of software automated tools to hand-editing of database features. Care will need to be taken to optimize ESIG-2000 scene generation efficiency while still realizing a correlated product. Work will leverage off of lessons learned during the conversion tasks performed on Phase One of A2 ATD to convert the SWA database. The same systems engineering task performed on Phase One to assure interoperability between all A2 ATD simulators will apply to this database development and conversion as well. Additionally, Loral is factoring the visual system performance capability of the CCTT simulator systems into database design to provide compatible databases for each program. One of the assumptions of the database conversion task is that, the API being developed as a tool to assist conversion between CCTT and S-1000 databases by the CCTT program, is provided to A2 ATD as GFE. The same COTS database development and conversion software tools used for the SWA conversion will be utilized on this conversion. The cost for conversion and correlation of the SWA database will be $0.05M.

5.1.2.2.4 Seamless Terrain Environment Integration.

During final integration of any set of dissimilar databases, there will always be some incongruencies. To complete the integration of a seamless virtual terrain environment between a Cuba database developed in S-1000 and the same database converted and correlated to run on ESIG-2000, Loral will provide database engineering support for fine-tuning database correlation between the S-1000 version and the ESIG-2000 version. The cost of this task will be $0.008M.

Cuba database development and conversion total costs will be $0.316M.

Total costs to provide correlated SWA and Cuba databases, and the required moving models for both the ESIG-2000 and the Vista_Works™ visual systems is $0.554M.

5.1.3 Schedule.

The database development schedule is contained in Section 9.

5.2 SINCGARS Radio Simulator.

5.2.1 Actual Equipment.

The Single-Channel Ground and Airborne Radio System (SINCGARS) provides commanders with a reliable, easily maintained combat radio for command and control, and provides electronic counter-countermeasures against threat electronic warfare. SINCGARS configurations include manpack, vehicular (both low- and high- power) and airborne models.

Communications security (COMSEC) is integrated in currently produced versions of the ground and airborne models. The SINCGARS operates in the 30.00 to 87.975 MHz frequency band, and utilizes 2,320 channels over a range of 8 to 35 km.

5.2.2 Simulation Concept.

The following is a concept for the development of a digital radio simulation that can be used for new simulators and retrofit the existing SIMNET and AirNet devices. This concept is based on a reconfigurable approach that allows an existing Soldier-Machine-Interface (SMI) to be utilized to the maximum extent possible.

The SINCGARS radio simulator will provide crew station intercommunications, and a SINCGARS simulations. The system will digitize crew station voice signals for compression into the DIS 2.0x Transmit and Signal PDUs. The system will also decode and decompress the received communication PDUs for playback in the crew compartment. The appropriate Soldier-Machine Interface (SMI) will be replicated dependent upon the type of manned simulator. An attenuation model will be integral to the radio simulation module. This model will determine which radio signals will be displayed to the crew.

For A2 ATD, all manned simulators and SAFOR workstations should be DIS 2.0x compatible and simulate SINCGARS communications. Of primary importance is the implementation of "Signal" PDU's that contain encoded voice information. To support this effort, the M1A2, M2/M3A3, AGS, LOSAT, NLOS-CA, Javelin and ModSAF workstations will need modifications. The recommended system is modular so that various SW and HW components can be standardized. The radio simulation consists of four (4) components:

- SMI devices
- UIO Module
- Radio Simulation Module
- Audio Distribution

5.2.2.1 SMI Devices (Figure 5.2.2.1-1).

In the NLOS-CA simulators the front panel of a SINCGARS radio will be used for the SMI. This panel will have the functional controls listed in Table 5.2.2.1-1.

Table 5.2.2.1-1 ModSAF SINCGARS Radio

Transmit Power Select Knob	Selects output power of the radio - low, medium, high, and Power Amplifier
Channel Select Knob	Selects desired channel for transmit/receive - Manual Cueing, 1, 2, 3, 4, 5, and 6
Keypad Display	LCD Display for signal strength, frequency, etc.
Function Select Knob	Selects radio functions - Off, and Squelch ON, STBY, LD, Z-FH
Keypad	Input device for frequencies, time and keysets - 12 keys active
Volume/Whisper Knob	Adjust volume control
Mode Select Knob	Selects mode of transmission - SC, FH, FH/M
COMSEC Knob	Not Functional - cryptographic encryption
Audio Connector	Handset connection terminal (Active for non-vehicular installations)

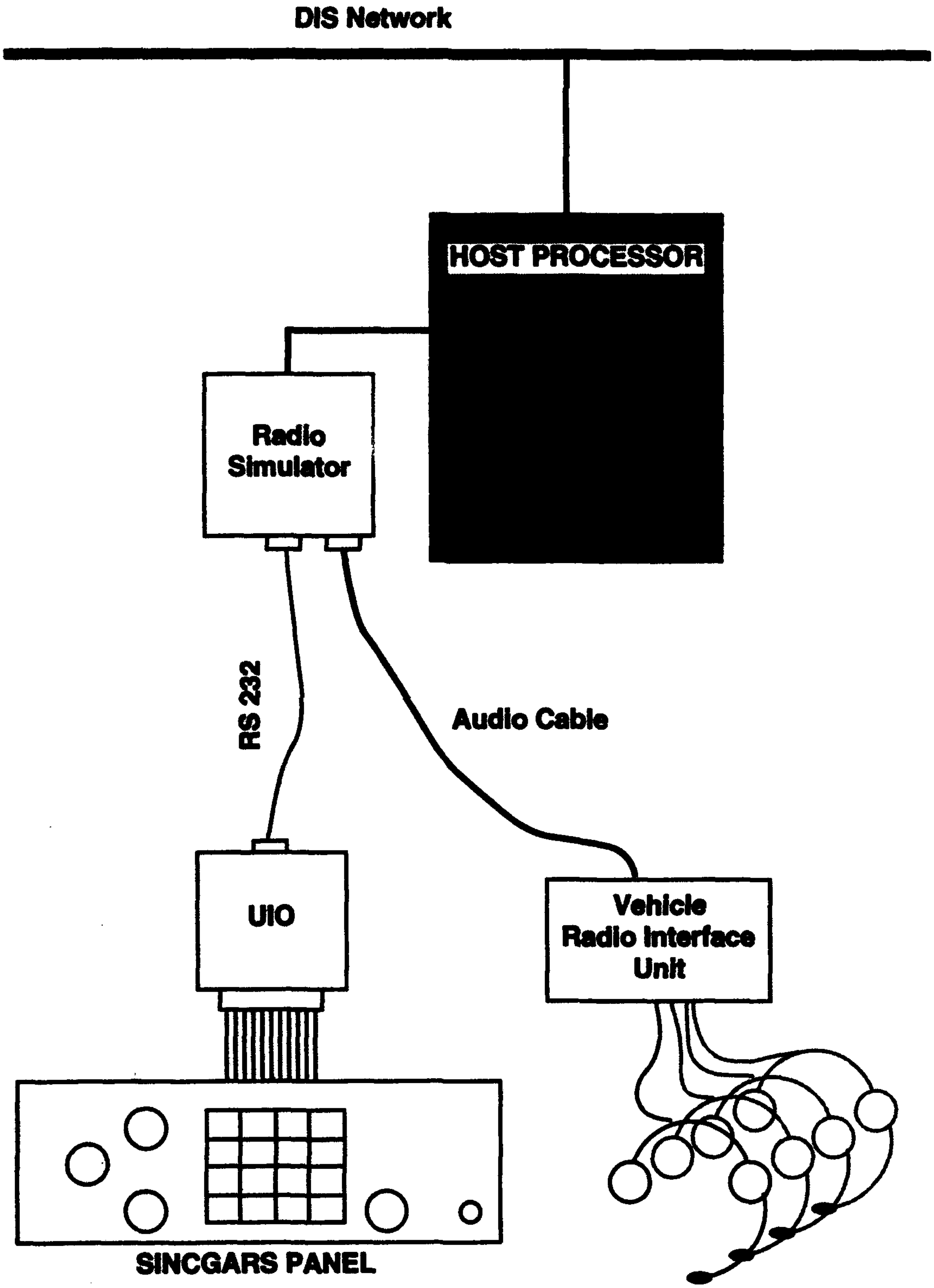


Figure 5.2.2.1-1 Non-IVIS SINCGARS Radio

All configurations use a common UIO and radio simulator.

5.2.2.2 Universal Input/Output Module.

The SMI control inputs will be hard-wired to a Universal Input/Output (UIO) device that will convert the discrete signals into RS 232 format for transmission to the radio simulator (software package is on a stand alone processor or part of the host computer). The UIO will be a ~~commercially available~~ embedded Single Board Computer (SBC) with I/O capability that will function as the intelligent interface between the SMI devices and the Radio Simulation module. The UIO will provide all local processing of input and output functions so that only changes in state will be reported to the Radio Simulation Module. The SBC can directly drive CRTs and LCD flat panel displays. It features an on-board 1.5 MB semiconductor disk allowing it to run in a diskless environment. The UIO will control all functions of the SMI panel assemblies including analog to digital and digital to analog conversion (non-audio), digital inputs and outputs for switches and lamps, local processing, BIT functions and bus I/O functions.
The UIO will continuously poll all panel controls, encode any changes in the state of the panel controls into a standard bus protocol, report the changes to the Radio Simulation Module, and convert data from that module into the appropriate signals to initiate state changes to indicators and displays. The UIO will be capable of being reprogrammed by a test processor station using commercially available software. Discrete I/O points will have the capability to be individually reprogrammed for each unique subassembly.

5.2.2.3 Radio Simulation Module.

This component transmits and receives digital data from the simulation bus, UIO bus, and analog data from the operator's headset. The digital data on the simulation bus are the communication PDU's (Transmit and Signal) and internal simulator data. Figure 5.2.2.3-1 illustrates the data flows for the Radio Simulation Segment. The digital data on the UIO bus are SMI controls and display data for the SINCGARS radio panel. The radio simulation outputs through the UIO for the displays on the SINCGARS panel or MFDs. The analog data from the operator's headset are the microphone voice inputs and the outputs are directly coupled to the audio distribution system of the vehicle. The microphone inputs are sampled, converted and compressed in the radio simulation.

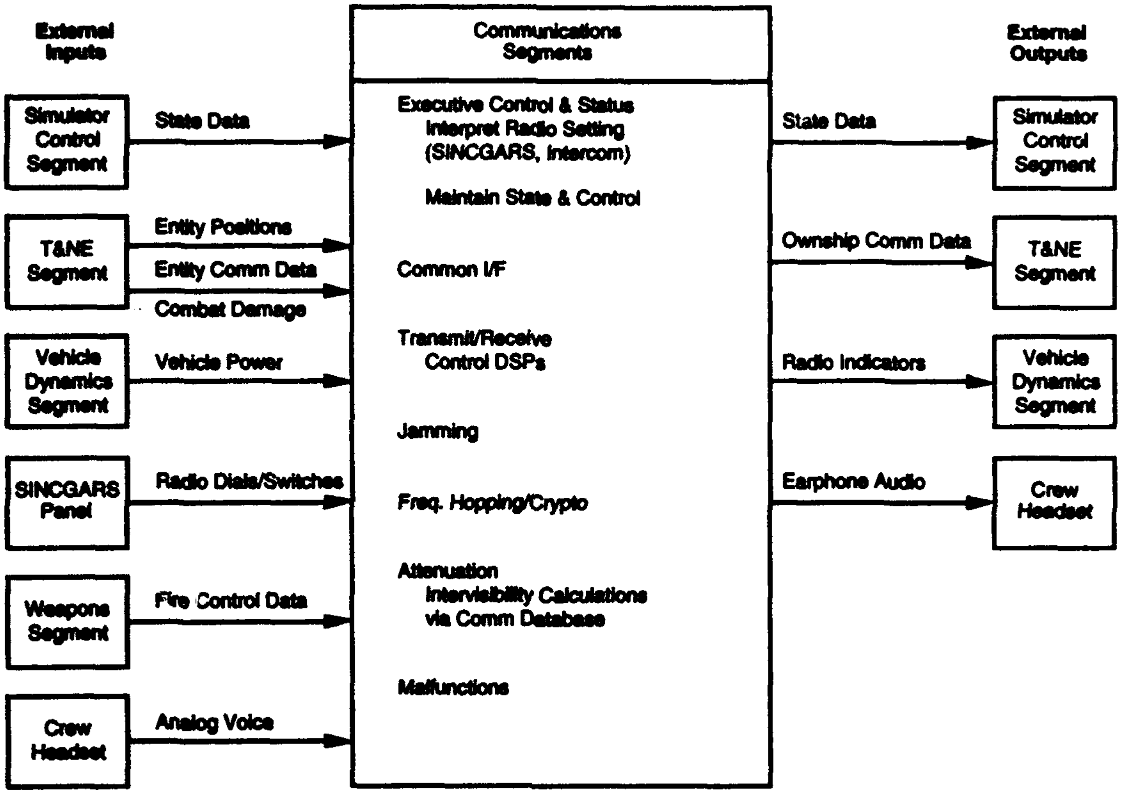


Figure 5.2.2.3-1 Radio Simulation Segment Data Flow

The radio simulation is a software segment which provides the SINCGARS simulation. The ability to communicate and the quality of the transmission will be affected by distance, terrain, and object obstructions (based on line of sight), interference, and jamming in the exercise area. The segment will accommodate frequency hopping data. This segment will also make provision for the simulation of cryptographic encoding. The outputs of the radio simulation are passed to the host processor for final incorporation into the DIS communication PDUs.

The segment consists of the following functional elements:

- Executive Control and Status Function. The function interprets radio settings, maintains the state of each piece of communications gear, and controls the timing and execution of the other functions within this segment.
- Common Interface Function. this function is responsible for dealing with the application layer of the protocol for the bus interface.

- Transmit/Receive Function. This functions is the hardware interface to the DSPs that digitizes the voice communication and formats the resulting data in accordance with the DIS network protocols.

- Jamming Function. This function simulates the jamming of communications and attenuates the communication signal accordingly. Inputs from the host processor concerning the location and frequency range of the jamming devices are used in the simulation.

- Frequency-Hopping and Cryptographic-Encoding Function. This function performs a check to determine if the communication devices are using the same encryption codes and performs the simulation of the SINCGARS frequency hopping (code sets checks only - not a simulation of changing frequencies).

- Attenuation Function. Voice communication is directly affected by obstructions and distance between the transmitter and receiver. This function performs intervisibility calculations via a special-purpose database and degrades the sound quality accordingly. (This will be a stepped attenuation based on X levels of attenuation.)

- Malfunctions Function. Each software module within a manned simulator is susceptible to stochastic and deterministic failures as well as combat damage. This function simulates the complete loss, or partial degradation, of the communications capability due to such failures.

5.2.2.4 Audio Distribution.

As mentioned earlier, the SINCGARS Radio Simulator can be utilized with four different SMI configurations. Each configuration has its own sidetone audio distribution. The sidetone volume control will be adjusted on the SMI device, fed to the radio simulation module through the UIO, and then the output audio levels adjusted within the radio simulation module. The audio distribution network from the module to the earphones is configuration dependent.

- ModSAF Workstation. In the ModSAF or stand alone mode, the output audio will be fed the SINCGARS radio panel AUDIO/DATA jack. The headset will be connected to this audio jack.

- M1A1 or non-IVIS equipped ground vehicle. In this configuration, the output audio will be fed the equipment audio distribution system. Depending on the number of crew members and the intercom options available, there may be a requirement for multiple outputs from the radio simulation module to support the discrete requirements for each station.

6 Experiments.

Six experiments are planned for the two phases of the A2 ATD program with the NLOS-CA or UAV simulators participating in experiments 2, 5, and 6.. Each experiment has specific scenarios, goals, objectives, and participants as specified by AMSAA. The first experiment will be conducted as part of Phase 1. Experiments 2-6 are part of the second phase. Experiments 2-5 are a defensive vignette of the High Resolution Scenario 29 utilizing a South West Asia terrain base. Experiment 6 is a rapid force projection initiative scenario based in Cuba. Additional information is provided in reference I of Section 12.

Details of the various experiments have not been solidified and change based upon simulator availability, site location, funding, etc. What is presented in Section 6 is the best data available at the time of writing. Figure 6-1 illustrates the present A2 ATD Experiment Schedule, the vignettes, and forces.

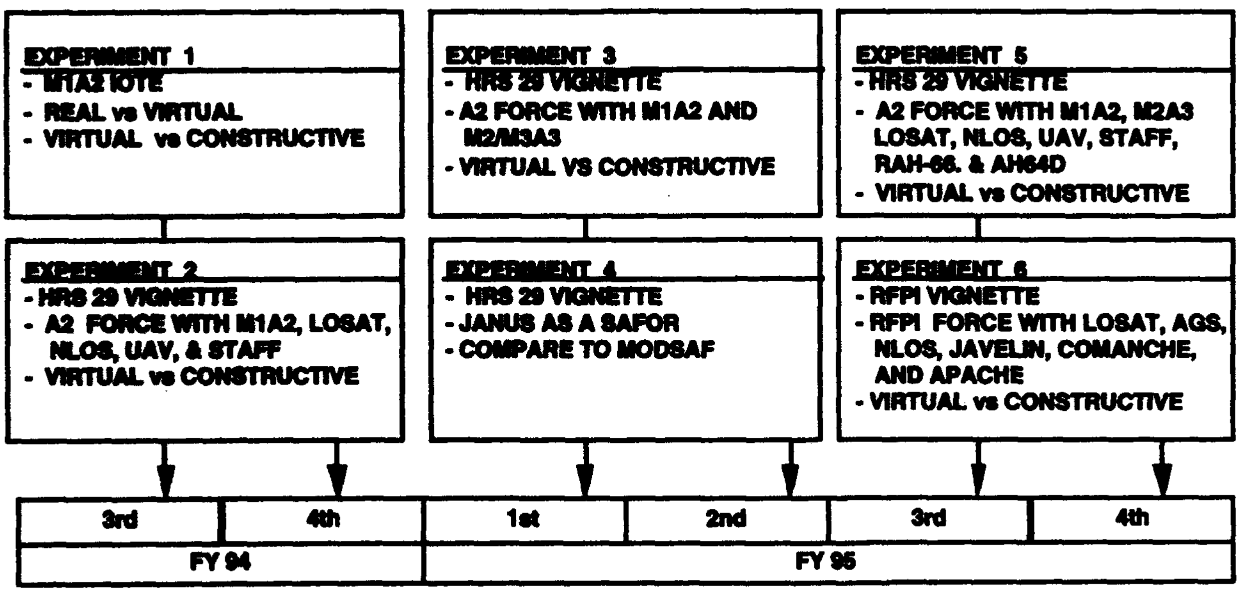


Figure 6-1 A2 ATD Experiments

As shown in Figure 6-1, Experiments 2 through 5 are HRS 29 vignettes that incrementally introduce new manned simulators or Semi-Automated Forces (SAFOR) into the virtual battlefield. The specific objectives of each experiment are described below in subsequent paragraphs of Section 6.

Sites associated with the various experiments will be connected via the Defense Simulation Internet, utilizing DIS PDUs. The physical connections typically are T-1 lines, with either Ethernet or FDDI serving as the local network. Local networks will use DIS PDUs, however SIMNET compatible simulators may be linked via a cell adapter unit.

It is presently not known the exact delivery locations on several of the simulators. An example is the Javelin devices that may be delivered to AVTB, MICOM or a new Ft. Benning site. Table 6-1 below lists all the known possible site, simulator(s) and associated site equipment requirements. In general, each time a site is added, it will require the addition of a Stealth, PVD, CIU, DSI network and data logger.

6.1 Experiment Two.

Experiment two is a high resolution defensive vignette (South West Asia) utilizing four different simulator types ; M1A2s, LOSAT, NLOS-CA, and UAVs. These forces are to be augmented by semi-automated systems generated by ModSAF (see section 5.1.). The purpose of the experiment is to demonstrate virtual prototypes and validate SAFOR representation of M1A2, LOSAT, STAFF, and NLOS-CA in an anti-armor force. Specific technical objectives include:

- Demonstrate DIS as an evaluation tool with multiple simulator types
- VV&A LOSAT and NLOS-CA simulators, ModSAF, and BDS-D
- Demonstrate analytical tools to evaluate causes of simulation outcomes
- Demonstrate M1A2, LOSAT, and NLOS-CA virtual prototypes

Currently eight replications of Experiment 2 are planned. Experiment 2 is scheduled for 3-28 Oct. 1994. Figure 6.1-1 illustrates the HRS 29 experiment resources for Experiment 2.

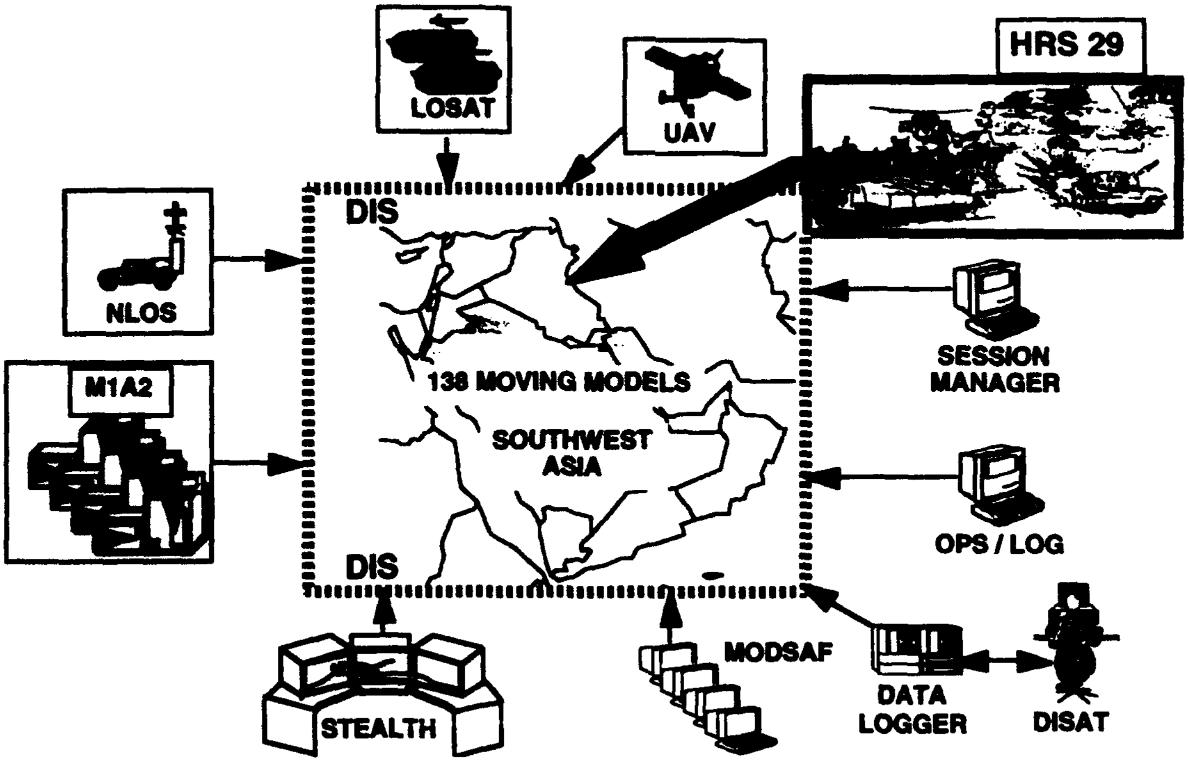


Figure 6.1-1 HRS 29 Experiment 2 Resources

Figure 6.1-2 illustrates the preferred network for providing the resources for Experiment 2.

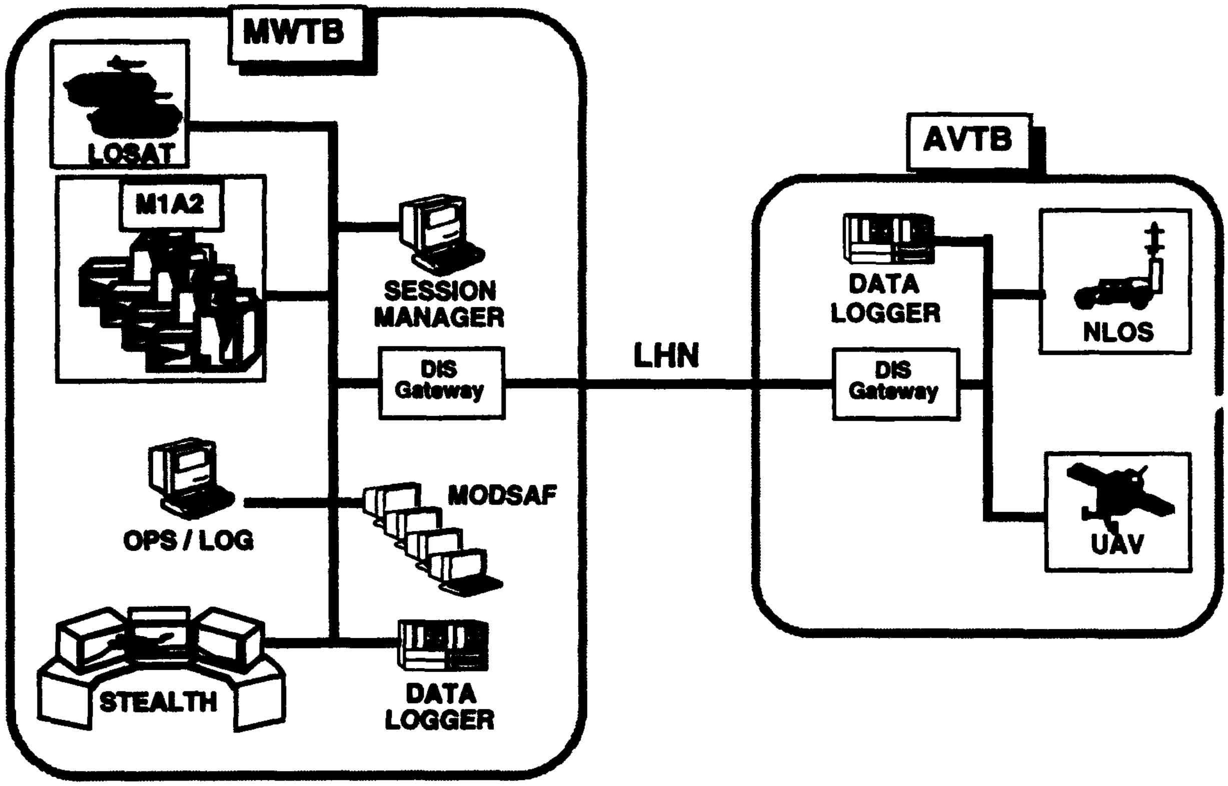


Figure 6.1-2 Experiment 2 Recommended Network

6.2 Experiment Five.

Experiment five is a high resolution defensive vignette (South West Asia) utilizing seven different simulator types ; M1A2s, M2/M3A3s, LOSAT, NLOS-CA, UAV, Comanche, and Apache Longbow. These forces are to be augmented by semi-automated systems generated by ModSAF (see section 5.1.). The purpose of the experiment is to demonstrate virtual prototypes and validate SAFOR representation of M1A2, M2/M3A3, LOSAT, STAFF, NLOS-CA, Comanche, and Apache Longbow in an anti-armor force. Specific technical objectives include:

- Demonstrate DIS as an evaluation tool with multiple simulator types
- VV&A Comanche and Apache Longbow simulators, ModSAF, and BDS-D
- Demonstrate analytical tools to evaluate causes of simulation outcomes
- Demonstrate M1A2, M2/M3A3, LOSAT, NLOS-CA, Comanche, and Apache Longbow virtual prototypes

Currently eight replications of Experiment 5 are planned. Experiment 5 is scheduled for 1-31 Aug. 1995. Figure 6.2-1 illustrates the HRS 29 experiment resources for Experiment 5.

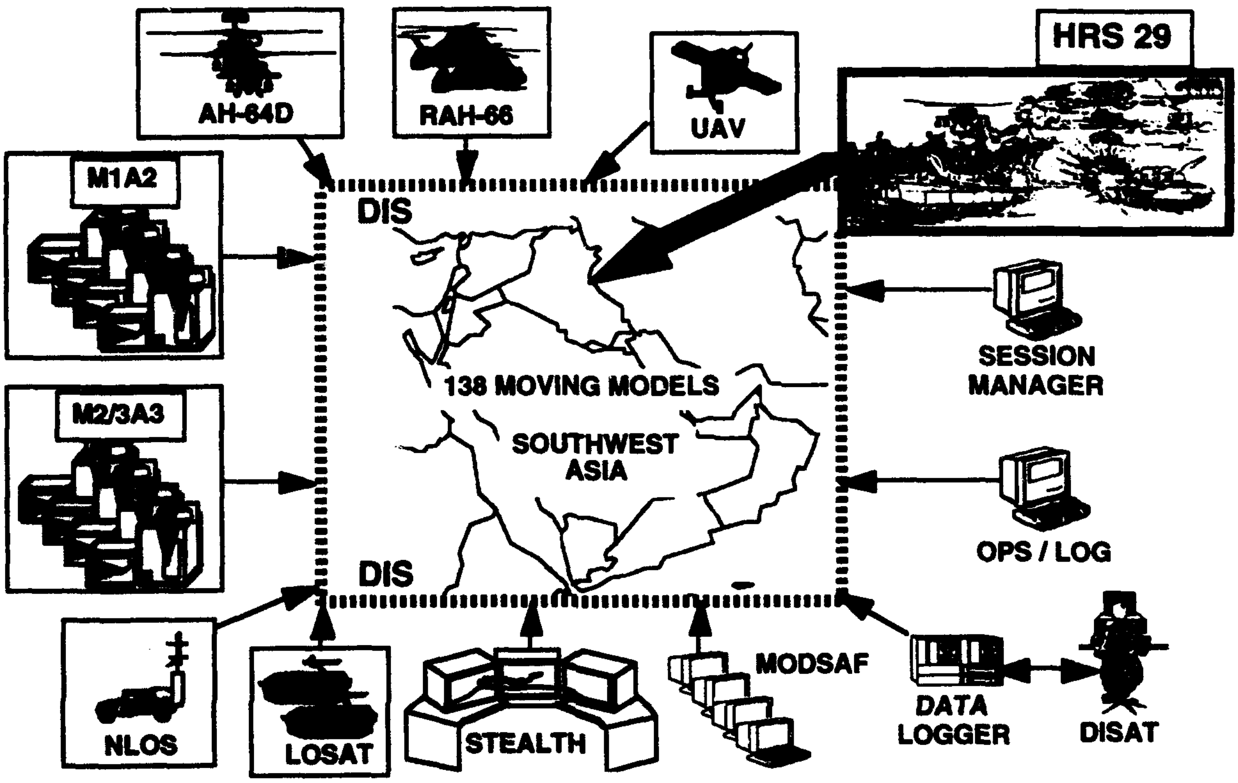


Figure 6.2-1 HRS 29 Experiment 5 Resources

Figure 6.2-2 illustrates the preferred network for providing the resources for Experiment 5.

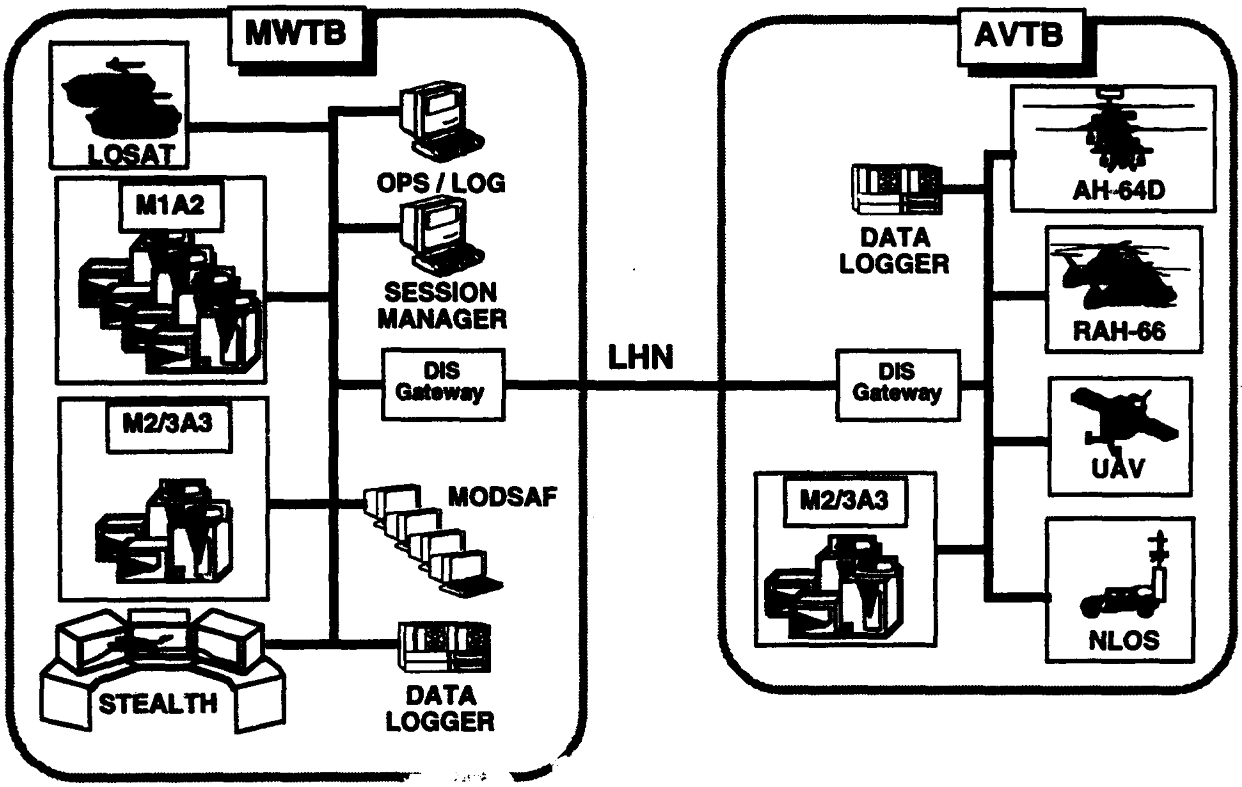


Figure 6.2-2 Experiment 5 Recommended Network

6.3 Experiment Six.

Experiment six is a high resolution Rapid Force Projection vignette (Cuba) utilizing seven different simulator types; AGS, NLOS-CA, UAV, Javelin, LOSAT, Comanche, and Apache Longbow. These forces are to be augmented by semi-automated systems generated by ModSAF (see section 5.1.). The purpose of the experiment is to demonstrate virtual prototypes and validate SAFOR representation of AGS, Javelin, NLOS-CA, LOSAT, Comanche, and Apache Longbow in an early entry force. Specific technical objectives include:

- Demonstrate DIS as an evaluation tool with multiple simulator types
- VV&A AGS and Javelin simulators, ModSAF, and BDS-D
- Demonstrate analytical tools to evaluate causes of simulation outcomes
- Demonstrate AGS, Javelin, NLOS-CA, LOSAT, Comanche, and Apache Longbow virtual prototypes

Experiment 6 is not yet scheduled beyond the 4th quarter of FY 95. Anticipated date is the full month of Sep. 1995. Figure 6.3-1 illustrates the HRS 33 experiment resources for Experiment 6.

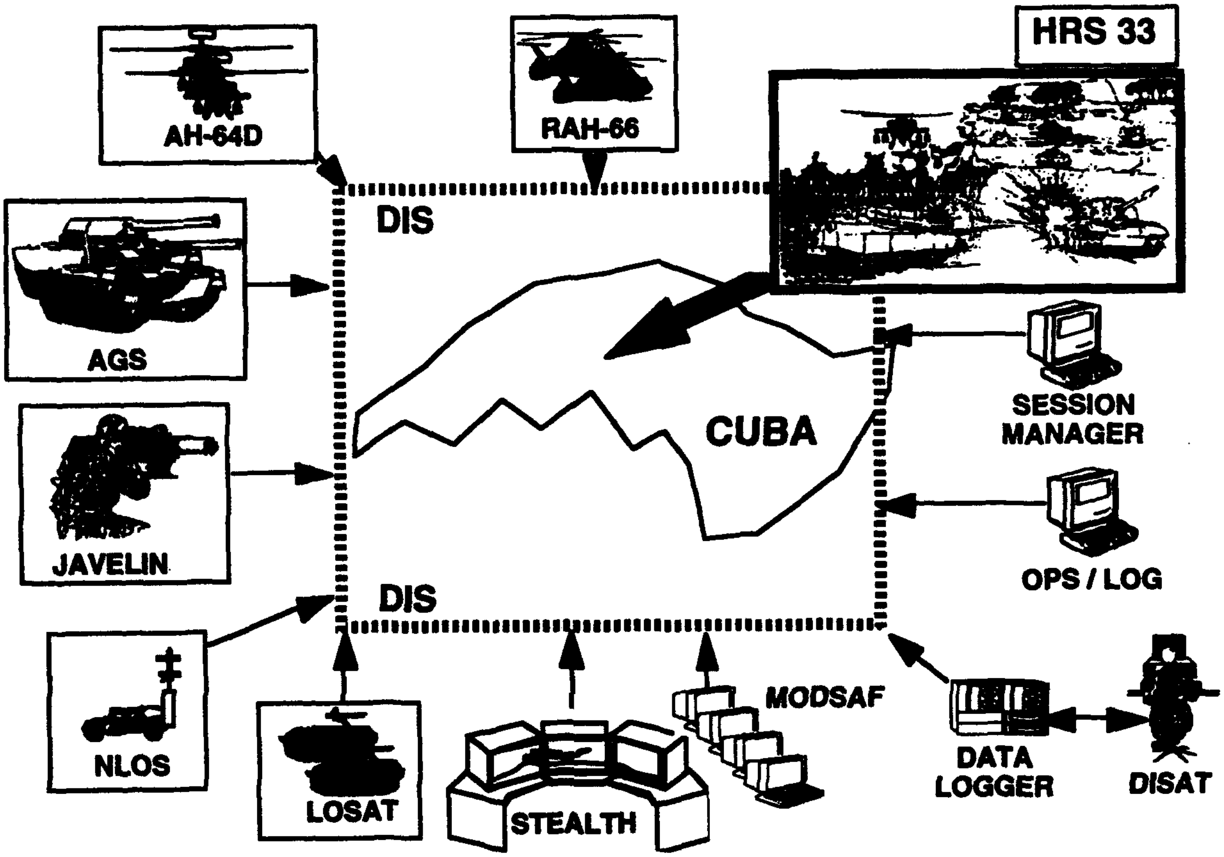


Figure 6.3-1 HRS 29 Experiment 6 Resources

Figure 6.3-2 illustrates the preferred network for providing the resources for Experiment 6.

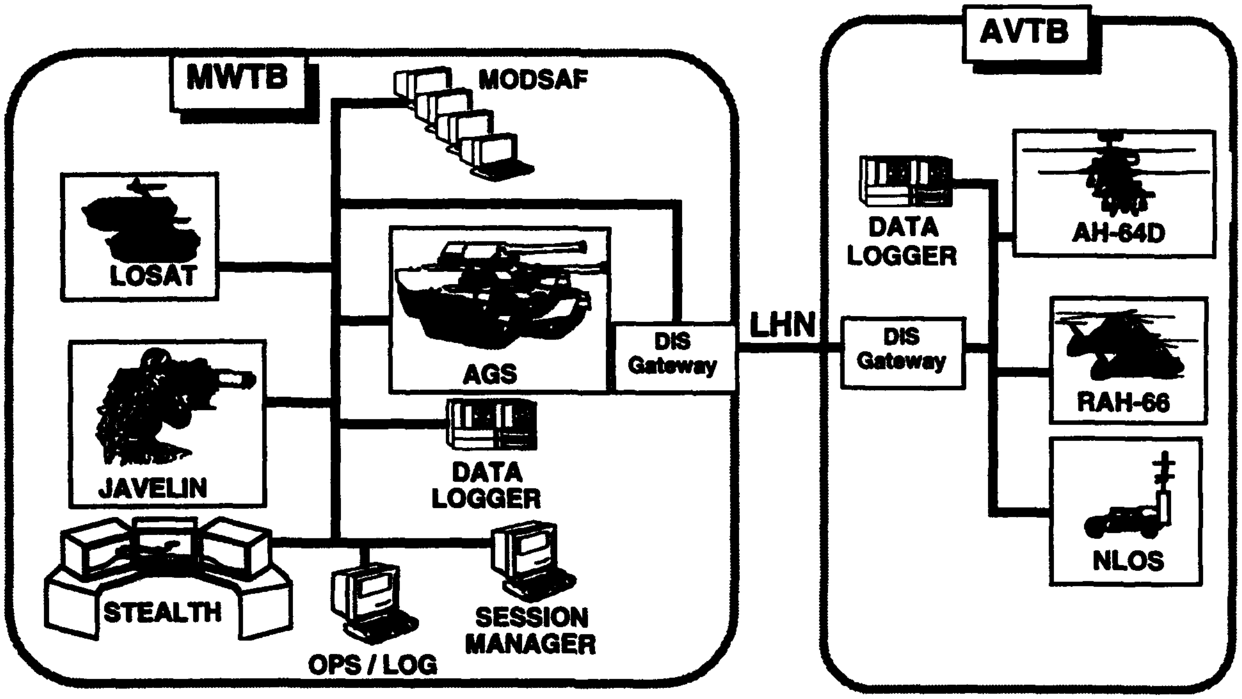


Figure 6.3-2 Experiment 6 Recommended Network

7 Glossary.

A2 ATD ....Anti-Armor Advanced Technology Demonstration

AMSAA.................................US Army Material Systems Analysis Activity, Aberdeen Proving Ground, MD

AGS.......................................Armored Gun System

AP..Armor Piercing munition

ARI..Army Research Institute

ARWA...................................Advanced Rotary Wing Aircraft

ASW......................................Area Suppression Weapon

AVTB ....Aviation Test Bed, Ft. Rucker, AL

BBN ....Bolt, Beranek, and Newman

BCIDS...................................Battlefield Combat Identification System

BDS-D ....Battlefield Distributed Simulation - Developmental

BFV.......................................Bradley Fighting Vehicle (M2 or M3)

CAU ....Cell Adapter Unit

CFV.......................................Cavalry Fighting Vehicle (M3)

CID..Commander's Integrated Display

CIG..Computer Image Generator

CITV.....................................Commander's Independent Thermal Viewer

CIU..Cell Interface Unit

CM ....Configuration Management

CSRDF..................................Crew Station Research & Development Facility, NASA Ames Research Center, Mt. View, CA

CVCC....................................Combat Vehicle Command and Control

DIS..Distributed Interactive Simulation

DISAT...................................DIS Analytical Tools

DISCSS ....Distributed Interactive Simulation Crew Station Simulator

DSI ....Defense Simulation Internet

EEA ....Essential Elements of Analysis

FDDI.....................................Fiber Distributed Data Interface

FLIR.......................................Forward Looking Infra-Red

GCDP....................................Gunner's Control and Display Panel

GFE ....Government Furnished Equipment

GFI ....Government Furnished Information

GPS ....Gunner's Primary Sight

HE ....High-Explosive munition

HRS..High Resolution Scenario

HW...Hardware

ICWS ....Improved Commander's Weapon Station

IFV ....Infantry Fighting Vehicle (M2)

IG ....Image Generator

ISU...Integrated Sight Unit

IVIS ....InterVehicular Information System

KEM......................................Kinetic-Energy Missile

LOSAT...................................Line-of-Sight Anti-Tank Missile system

LRF ....Laser Range Finder

MICOM ....US Army Missile Command, Huntsville, AL

ModSAF................................Modular Semi-Automated Forces

MWTB...................................Mounted Warfare Test Bed, Ft. Knox, KY

NLOS-CA ....Non-Line of Sight Missile system

PDU ....Protocol Data Unit

PM..Program Manager

Pos/Nav ....Position Navigation System

PVD.......................................Plan View Display

RFPI......................................Rapid Force Projection Initiative

SAP ....Special Access Program

SDF..Software Development Facility

SGI...Silicon Graphics Inc.

SIMNET.................................Simulation Network

SINCGARS............................Single Channel Ground and Airborne Radio System

SME ....Subject Matter Expert

SMI ....Soldier-Machine Interface

SOW ....Scope of Work

STRATA.................................Simulator Training Research Advanced Testbed for Aviation, Ft. Rucker, AL

SW ....Software

SWA.......................................South West Asia

TACOM ....US Army Tank Automotive Command, Warren, MI

TARDEC ....Tank Automotive Command (TACOM) Research, Development, and Engineering Center

TOW ....Tube launched, Optically tracked, Wire guided (missile)

UAV ....Unmanned Aerial Vehicle

VV&A ....Verification, Validation, and Accreditation

VV&A'd.................................Verified, Validated, and Accredited